The Edible Crab- Increased Utilisation Through New Product Development

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Industrial Development Unit

THE EDIBLE CRAB - INCREASED UTILISATION THROUGH NEW PRODUCT DEVELOPMENT

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SUMMARY

The following have been investigated for the edible crab Cancer pagurus:-

1. Its biology, stocks and potential for further exploitation.

2. The key features of handling and processing, and opportunities presented by new developments in the mechanical recovery of crab meat.

3. The profile of the UK industry and its markets and their development.

4. The development of a range of added value products utilising recovered meat.

It is concluded that there is considerable potential for increasing landings on the West Coast of Scotland, but

that the fisheries in the South of England are close to maximum exploitation and any increase in the declined East of England fisheries will require a change in fishing patterns. The complex life cycle of the crab leads to large seasonal variations in both catch levels and intrinsic condition. It is important that the fisherman selects only good crabs and returns the remainder. Cooked crab is susceptible to contamination and must be handled with care. It has a short storage life when fresh and even when frozen, compared to white fish. The mechanical recovery systems available double the yield of white meat but produce a fragmented product which has much of its flavour washed out.

The catching, processing and marketing industry in the South of England is highly developed compared to the more traditional industry in the East of England. The traditional market for fresh boiled crab is in decline. The Southern industry handles highly valued crab through a variety of markets. The expanding Scottish industry is fishery led with no local market and little processing capability, and with a limited and inelastic demand this could undermine the existing markets with harmful effects on the other fisheries unless new markets can be found. Development of new markets for processed added value products is recommended to stabilise the industry.

Youngs Seafoods Ltd. developed four experimental products:

1. Crab stuffed mushrooms
2. Crab stuffed plaice
3. Crab crepes in white wine sauce
4. Crab cakes.

A recurring problem throughout the development was the lack of crab flavour in the recovered meat. The products were assessed by the Food Products Intelligence Centre in group discussions with female panellists. Attitudes to added value crab products were positive, and each of the products was liked but in each case further development of the products is required, particularly in enhancing yet further the crab flavour expected of premium products.

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1 INTRODUCTION

Recent years have seen the development of machinery, firstly in America and then in the UK, to recover the white meat from the bodies and legs of the edible crab, these portions of the crab often having been discarded previously. The machinery can double the yield of meat from the crab, although the product is of lower quality than hand picked meat, being fragmented and lacking flavour.

It had also become clear that there is potential for increasing the landings of crab in the UK. The traditional fisheries on the South and South West Coasts had expanded significantly, and a new and potentially large fishery was starting on the West Coast of Scotland exploiting previously untapped stocks.

The Sea Fish Industry Authority, aware of the potential for increased exploitation, was of the view that the limited and stereotyped traditional range of fresh crab products marketed by the industry was in fact inhibiting its development. The modern consumer is wary about

tackling a fresh boiled whole crab, but is purchasing frozen added value convenience products in increasing quantities.

To aid the industry in overcoming the apparent restriction the Authority contracted Youngs Seafoods Ltd. to develop a range of added value products utilising recovered crab meat. To confirm the basis for development the Authority also contracted Dr. Eric Edwards of The Shellfish Association of Great Britain (SAGB) to report on the state of the fishery for the edible crab - its biology, stocks and potential for exploitation, and contracted John Early of Torry Research Station (TRS) to report on the key features of handling and processing of the edible crab - in particular the opportunities presented by the development of machinery for meat recovery. The Authority has also surveyed the current state of development of the UK crab industry, with particular reference to its existing markets and market development.

This work has produced much data which is presented in the four detailed appendices under separate authorship attached to this report. The body of the report is a relatively brief summary of this package of information.

The findings are considered to be of great value to the industry in recognising the potential for development, in guiding its development, and in avoiding the major pitfalls identified.

The work was carried out under MAFF Commission QFA 16, Fish Utilisation - Development of New Products.

2 THE EDIBLE CRAB - ITS BIOLOGY, STOCKS AND POTENTIAL EXPLOITATION

2.1 The Fishery

Crab fishing provides an income in excess of £4 million per annum for landings averaging 9,500 tonnes to some 2,000 full time inshore fishermen in the UK. Of the crabs caught, the edible crab Cancer pagurus is the most commercially significant. Smaller but increasing quantities of the spider crab Maia squinado and the velvet swimming crab Liocarcinus puber are being landed for export live to Continental markets.

Crabs are found around the entire UK coastline but the fishery is split into several distinct areas, 70% being landed in England although the Scottish landings are increasing. The main English grounds are off South Devon, around Cornwall and along the South Coast from Portland Bill to Dungeness. Other important areas include the East Coast grounds off Norfolk, Yorkshire, Durham and Northumberland. These East Coast grounds at one time provided 80% of the English landings, but since 1960 that fishery has declined and the South and South West Coast fisheries have developed such that now they provide nearly 80%. In Scotland there are established grounds around Shetland and Orkney and on the East Coast of the Mainland, and since the early 1980s a major new fishery has been developing around the Western Isles on previously unexploited stocks.

Crabs are caught throughout the year but the main season is from April to November, with the seasons on each ground being shorter but overlapping to form the total.

2.2 The Life Cycle of The Crab

The behaviour of the crab is dominated by its moulting and reproductive cycles. Young crabs moult several times a year, but mature crabs moult once a year or less. Moulting occurs during July to October when the crabs move close inshore seeking shelter. After the hard outer shell splits the soft crab emerges and starts to absorb water and swell. Full hardening will take 2 - 3 months by which time crab size has increased by 20 - 30%.

Mating occurs inshore between a hardshelled male and a soft shelled female immediately after moulting. The female carries the male sperm in 2 sperm sacs and usually spawns in November or December in a soft sea bed often in deep water, and then carries the eggs externally for about a further 7-8 months. After the eggs hatch the female moves back inshore the year after breeding. The free swimming larval crabs live amongst the surface plankton layers for about one month and become widely distributed by currents before settling on the sea bed.

In association with this larval dispersion the females undertake considerable migrations, which can be in excess of 150 miles, to release larvae. The migrations and larval dispersion link the various UK crab stocks.

2.3 The Variable Condition of Crabs

The edible portion of cooked crab consist of the white muscle meat from the claws, legs and body cavity and the brown meat from the reproductive and digestive tissues within the body. Prior to spawning the ripe gonads form bright red granular tissue within the body (coral) valued as high quality brown meat.

Crab sizes and yields of meat vary with the sex, fishing ground and season.

Crabs caught in the South Western fishery tend to be larger than those caught in the English East Coast and Scottish fisheries. These size differences are associated with differences in growth rates which are not fully understood.

Male crabs have large claws and thus a high yield of white flesh, whereas females develop coral prior to spawning. Overall the meat yield is higher for a male of a given shell size.

Recently moulted crabs are in poor condition and give a low meat yield. The crabs have recovered by late autumn and "ripe" females in good condition congregate on offshore grounds ready for spawning.

After spawning the (berried) females spend much of the next six to nine months in a shelter on the seabed and do not feed, and thus are seldom caught after November. When they move back inshore the following year, after the larvae have hatched, these females are in poor condition.

Sometimes crabs are affected by black lesions on the shell, called "black spot", resulting from bacterial attack. This is unsightly but unharmful to humans.

The landing of undersized, soft shelled, or berried crabs is prohibited by law, and indeed it is in the fishermans own interest not to do so.

2.4 The Potential for Exploitation

Despite several centuries of commercial fishing crab stocks have stood up well. Contributory factors to their survival have been their spawning migrations and larval dispersal, movement offshore in winter whilst the fishery remained confined to the coastal area, and the return of undersized, soft and berried crabs to the sea. However, the state of the various stocks around the coast varies.

The increased landings from the South and South West Coast fisheries has resulted from increased fishing effort and particularly from the recent transfer of effort to offshore grounds. Scientific studies in the Western Channel suggest that stocks are close to maximum exploitation.

The decreased landings on the English East Coast appear to result from a decreased fishing effort, although that effort is now concentrated by small boats fishing close inshore and within a limited range, and as such the relatively few areas fished are fairly heavily exploited. An increase in landings would be dependant on changing the pattern of the fishery, and would appear feasible on the basis of historical evidence.

Around the Scottish coasts although the East coast is generally heavily exploited there is scope for development of the Orkney, Shetland and particularly the West Coast fisheries. The Western Isles will probably become a major crab producing area.

3 PROCESSING THE EDIBLE CRAB - KEY FEATURES OF HANDLING AND PROCESSING, AND OPPORTUNITIES PRESENTED BY NEW DEVELOPMENTS IN THE MECHANICAL RECOVERY OF CRAB MEAT

3.1 Handling and Processing

The following are the major elements involved:

1. Selection
2. Live storage aboard and ashore
3. Inactivation
4. Cooking
5. Butchering or sectioning
6. Meat extraction
7. Product storage.

3.1.1 Selection

Primary selection by the fisherman is vital to comply with the law (and ensure continuation of the fishery) and to ensure a high quality product. Undersized, soft shelled or berried crabs are of course returned to the sea. Damaged (but alive) crabs, or those with the odd patch of black spot are acceptable for processing, but not for sale as whole boiled crab. But perhaps the most important and difficult selection criteria is the condition of the crab. Some experience is required to identify those out of condition crabs which are watery with a low meat content.

3.1.2 Live Storage

The crabs must arrive at the processing plant alive. To that end they must be protected from sun and wind and handled carefully. They should be tightly packed, backs uppermost, in boxes and placed below decks or covered

with damp sack cloth. Ashore they should be kept in a chill and processed as soon as possible. For extended live storage the crabs must be held in vivier tank facilities.

3.1.3 Inactivation

Inactivation is the process of rendering the crabs unable to damage themselves or each other whilst awaiting cooking and is essential if the shedding of limbs is to be avoided. Large crabs can be inactivated by spiking, but for smaller crabs "drowning" in fresh water is more practical.

3.1.4 Cooking

Whole crabs need to be boiled for 20 - 35 minutes, depending upon size, to ensure thorough cooking of the body meats. Separate claws can be cooked in approximately 15 minutes. Batch cooking is adequate for small throughputs, but continuous cookers are preferred for high throughputs. The freshly cooked crabs must be washed and cooled with water sprays and then left to air cool and coagulate the meats prior to picking.

Chilling is advantageous. Out of condition crabs which appear light and watery when shaken should be rejected from sale at this point.

3.1.5 Butchering

Crabs to be processed further to extract the meat are firstly butchered into their constituent parts.

Unlike most fish products, but similar to many meat products, crab is precooked and consumed without further heat treatment. Thus it is susceptible to contamination and must be handled with particular care. Butchering,

meat extraction and subsequent handling must be done in a separate room away from uncooked materials, and strict hygiene must be observed. Chilling retards the effects of contamination.

3.1.6 Meat Extraction

Following butchering the brown meat is spooned out from the opened body, and the white meat extracted from the claws and from the legs and body cores if not discarded. Yields vary with crab size, sex and condition but typically crabs from the East coast of Scotland yield 18.5% brown meat and 8% white claw meat, based on the raw crab weight. The potential white meat yield from body and legs made available by mechanical recovery is a further 10 - 12%.

3.1.7 Product Storage

Fresh crab has a short shelf life, and must be chilled rapidly after processing, ideally to $0^{o}C$, to inhibit bacterial growth.

At a temperature of $5^{o}C$ the crab is best eaten within 24 hours, but can possibly be kept for up to three days. At $20^{o}C$ rejection level is reached in a little over 24 hours! Packing in a controlled atmosphere can extend the shelf life.

Frozen crab meat does not store well compared to white fish flesh because of the high oil content of the brown meat and the high exposed area of the flaked white crab meat (particularly mechanically recovered meat). A life of 6 - 8 weeks at $-18^{o}C$ is possible, but this can be trebled at least by vacuum packaging before storage at this temperature.

3.2 Mechanisation of Meat Extraction

Factory scale crab processing in the UK developed from earlier cottage industry after the 1939 - 45 war. Manual processing is clearly laborious, and by the mid 1970s it was common for the white meat to be extracted from the claws and for the remainder of the crab to be discarded, particularly when the smaller sizes of crab were being processed.

At an early stage compressed air blowers were used in UK factories to aid white meat removal from the larger crabs, however the aerosol produced has been associated with respiratory diseases. In the USA machines have been developed for butchering and extracting the meat from their common crab species, the most important of which are soft shelled and with relatively poorly developed cartilage structure. "Mangle" type machines can simply squeeze the meat from the shell of several of these species. The European edible crab presents far greater meat extraction difficulties.

During the 1970s Torry Research Station, working in conjunction with the US National Marine Fisheries Service, determined that the centrifuge system produced by the American company, The Bird Machine Co., would extract the meat from the edible crab, by a technique of assisted flotation, and a few machines were introduced to the UK. More recently the British company, Bead Engineering Co., has developed an alternative assisted flotation system which has achieved wider usage. The latest known developments are by the Canadian company, Charlottetown Metal Products Co., which may be suitable for the edible crab.

3.2.1 The Bird Centrifuge System

In this system the crabs firstly have to be butchered and cleaned, then the legs and cleaned bodies are passed through a comminutor, the Fitzmill, and the comminuted pieces then pass through the centrifuge in concentrated brine to separate the flesh from the shell. The flesh is then dewatered on a screen, and the brine, 15% concentration, is filtered and recycled. The process is run continuously at an input of up to 363 kg/hr for up to 2 hours, after which the brine has to be changed to avoid the build up of bacteria and suspended solids, the latter affecting separation. The cost of the centrifuge alone is £20,000 - £30,000.

The texture of the product is good, but much of the flavour is lost and salt is picked up, although the saltiness is not excessive if the brine is replaced by a solution of 8% sugar and 8% salt. As such the system is suitable only for flesh recovery from bodies and legs, rather than for the valuable claw meat. Yields of 3% from the legs, 7% from the bodies (and a further 1% from previously hand picked claws) can be expected, based on whole raw crab weight.

3.2.2 The Bead System

In this system the cleaned and comminuted crab pieces are dropped into a flotation tank and separation is assisted by bubbling air through the liquid. The bubbles carry the flesh to the surface and across a weir to a dewatering screen. The liquid, which is again recycled, can be plain water but in practice a 2.5-3% brine solution improves product flavour. The system can operate at an input of up to 272 kg/hr, again for up to

2 hours before the liquid is changed. The cost of the flotation unit is £10,000.

The product quality, yields and usage of the Bead system, are similar to those of the Bird system.

3.2.3 Charlottetown Metal Products

A cocktail or barbecue claw cutter, a leg meat extractor and a meat recovery system have been developed recently, but as yet relatively little is known of their suitability for the edible crab. The claw cutter and leg meat extractor are mechanical devices designed originally for queen crab. The recovery system is based on the separation of comminuted material in a water sprayed, perforated, rotating drum.

3.2.4 The Requirement for Development

The currently available meat recovery systems enable the doubling of the yield of white flesh, but unfortunately the flotation processes involved wash much of the flavour from the product. The development of a dry process would be highly desirable.

4 A PROFILE OF THE UK EDIBLE CRAB INDUSTRY AND CONSIDERATION OF ITS MARKETS AND THEIR DEVELOPMENT

4.1 The Fisheries

4.1.1 The South Coast

This is a dynamic and thriving industry stimulated by its proximity to the Continental fisheries and markets. The fleet is now made up of modern well equipped vessels that have to achieve adequate returns on the high capital investment. The vessels are larger, faster and better equipped, and serve more ports than their counterparts in the East coast and Scottish fisheries, and often travel 20-30 miles from their base. They land a high value product which is effectively marketed. However recent indications are that increasing fishing effort is only slightly increasing landings, and thus there is concern over the stocks.

The South coast processing and marketing sector is diverse, supplying live crab to France and Spain, pasteurised whole crab to Sweden, fresh whole crab to inland markets, and fresh and frozen meats to the tourist, wholesale and catering trades. Facilities are well developed and the sector is drawing in supplies from other fisheries.

4.1.2 The English East Coast

This is a declined and traditional industry, the decline stemming from the switch to more lucrative white fish trawling in the late 1960s and the limited marketing achieving relatively low prices for boiled or dressed crab.

Fishing is carried out from overworking traditional small open boats close inshore within a few miles from port, and the stocks in those localities are inevitably heavily fished.

North East crab are marketed live or fresh boiled to inland wholesale markets, for some years a declining market, or dressed for the tourist trade. There are some recent deviations from this pattern, with some processors trying to diversify their marketing, and an active Producer Organisation is seeking alternative markets.

4.1.3 Scotland

This is a growing industry. In the past the major Scottish shell fisheries have been for Nephrops and lobster, and only recently has crab been considered worth exploiting in its own right. Whilst this has the benefit of a more diverse and balanced shellfishery, there remains considerable unresolved conflict between the requirements of the static gear fishermen and the trawlermen. The crab fishing fleet is varied as a result of involvement in the other fisheries. There is no doubt that landings can be significantly increased, particularly in the Western Isles, but there is uncertainty regarding the marketing of increased landings.

There is no local market. Crabs are sent to processors elsewhere, live to Continental markets, or processed and frozen. There are a few major buyers, who have only recently started developing the fishery seriously, and there is little processing capability. The industry

appears poised on the verge of a fishery led expansion but without developed marketing facilities and in an inelastic market.

4.2 Crab Products and Markets

4.2.1 Products

Live crab has good markets in France and Spain. Its price is generally high, but is frequently depressed by gluts, and the mortality in vivier transport can be excessive.

The traditional market for fresh boiled crab is in decline, but the demand for fresh dressed crab is increased although suppliers do not welcome its laborious production.

Frozen claws find a good market, but the demand for frozen hand picked white meat or brown/white meat packs, often sold into the catering trade, appears to be static.

Although several processors are producing mechanically recovered crab meat there is little market for it owing to its lack of flavour. The largest processors utilise it in added value products.

Pasteurised whole crab finds a good but limited and seasonal market in Sweden. There is a growing demand for frozen whole crab in Spain.

Brown meat has only a low value market for pastes and soups.

4.2.2 Supply and Demand Trends

The sophistication of the markets and buyers of crab affect catching and handling practices. Thus Scottish and North Eastern crab have been considered lower quality than South Western crab, but the development of a live crab trade from the Northern areas is raising standards. The provision of holding facilities in Scotland is required to further regulate supply.

Increased production in the near future is considered likely to lead to over supply (recovered meat was stockpiled in 1984) and this could lead to serious difficulty. The development of the Scottish fishery may well be pivotal as regards the entire UK crab industry.

As the demand for the primary products is limited and inelastic, an increase in production from one area is likely to be at the expense of another. Processors in the South West pay dearly for their crab in competition with vivier transporters, and consequently maximise their meat yields. Scottish processors pay less and have been able to throw away unpicked bodies and legs. Development of the Scottish fishery, particularly with mechanical flesh recovery, could undermine the existing balance and glut the market leading to offloading at low prices. The South West fishery geared to a high raw material price could then lose out to the Scottish fishery, and the emphasis of crab processing move to Scotland, leaving the South West more dependant on the vivier trade.

4.2.3 New Products New Markets

The above scenario is based pessimistically on static demand. In the UK the demand for whole crab and primary crab products is small and declining, with less than 1 in 20 households purchasing fresh crab. The export markets for live crab and crab meats are expanding slowly and no doubt could be stimulated further. The potential demand for processed crab products seems to be large, yet there seems to be an unwillingness on the part of most processors using traditional hand picking methods to develop this. A few companies are producing value added products and these products are finding ready markets in supermarket chains. The total sales of frozen value added fish products has been increasing significantly over recent years.

Development of new markets for added value crab products would help absorb an increased production by the industry, particularly of recovered meat. It would help diversify and stabilise the industry, absorbing some of the fluctuations in supply and demand, and enabling a vigorous grading policy to raise the quality of crab sent to live markets.

4.2.4 Meat Quality

A high and uniform standard of meat quality is crucial for the successful production and marketing of processed products. Observation has shown considerable variations in recovered meat quality, indicating that in practice the recovery machinery is either sensitive or is being misused. It is recommended that the SFIA investigates this problem.

5 THE DEVELOPMENT OF A RANGE OF ADDED VALUE PRODUCTS UTILISING RECOVERED CRAB MEAT

A two stage contract was placed with Youngs Seafoods Ltd., with possible extension to a third stage of collaboration. The first stage was a creative period of product development leading to the selection of several preferred products. The second stage was the production of samples of the preferred products and an assessment of their acceptability by groups of consumers leading to a further selection of the most preferred products, the selection including cost and marketing criteria. The contract was terminated at the end of stage two, coinciding with the reorganisation of Youngs within the Imperial Foods Group. The third stage, to continue with collaborative trial production and marketing of the most preferred products has not been enacted.

5.1 Stage One - Product Development

The market sector investigation involved the production of mainly high value products, but a commodity type product was included. Existing products from America (Maryland crab cakes, crab stuffed plaice) and Japan (surimi based crab), and products developed by TRS (mixtures of recovered crab meat and scampi meat or white fish flesh) were sampled prior to considering new product concepts. The Japanese products were rated highly, but the American and TRS products gave an early indication of the problems of the lack of intrinsic flavour of the raw material and the difficulty of added flavour control.

The following product concepts were proposed:

a) Large open mushroom with crabmeat filling, coated in Japanese crumb.

b) Stuffed plaice fillets with crabmeat and sauce filling, coated in Japanese crumb.

c) Crab croquette, formed from white crabmeat with added flavours and binders, again coated in Japanese crumb.

d) Crepes with crab filling and white wine sauce.

e) General development of crab dishes along the lines of the existing Youngs crab thermidor.

f) A pastry cornet/vol au vent/bouchee made from puff pastry with crab and avocado filling.

g) 'Steak' shaped formed crabmeat with smoked flavour and barbecue sauce.

h) Breaded crab 'dippers' in pastry with sauce.

i) Crab curry.

j) A modified Maryland crab cake.

Following kitchen scale recipe development, further sampling and consideration of production feasibility and market potential the list was reduced to the following for detailed development:

a) Crab stuffed mushrooms.

b) Crab stuffed plaice.

c) Crab crepes in white wine sauce.

d) Crab steaks.

e) Crab cakes.

These product concepts were then refined by means of recipe development from kitchen to production scale with regular sampling.

5.1.1 Crab Stuffed Mushrooms

Aimed as a restaurant "starter". Production would be labour intensive and thus expensive, but feasible. The concept is of an open cup mushroom with a crab filling and enrobed with Japanese crumb.

Initial sampling indicated good eating properties, although the mushroom flavour predominated, but there was a significant problem of the enrobing "shell" separating from the mushroom when cut and releasing mushroom liquor. Development was targeted at enhancing the crab flavour and improving the adhesion of the enrobing. The latter proved difficult because of the waxy surface of the mushrooms, but some success was achieved by a double enrobing process. An initial quick drying starch batter was applied to improve adhesion, followed by a pre-dust layer, a flour batter to achieve a softer eating texture, and finally coarse Japanese crumb.

The developed recipe was:

Filling - Add 61g powdered sauce mix (crab sauce mix from Witwood Food Products Ltd) to 227ml of water and mix this with 454g of recovered crab meat.

Method - Using blanched fresh mushrooms, fill the inverted caps with the mixture (quantity depending on size of cap), freeze and enrobe.

Note - The sauce mix contains vegetable oil, hydrolysed vegetable protein, cream (with anti-oxidant E320), skimmed milk powder, modified starch, flour, lactose, butter, onion powder, sodium caseinate, salt, spices, colours (E160, E24), herbs, and emulsifying salts.

For a restaurant starter for 2 people using 2 oz mushrooms, the estimated catering recommended sale price was £1.75 (based on raw material, labour, packaging, and overhead costs and trade margins).

5.1.2 Crab Stuffed Plaice

Aimed as a main course item for both the catering and retail trades. 2 plaice fillets sandwiching a crab mixture and coated with Japanese crumb, to be baked in an oven.

Initial sampling indicated that the appearance was excellent but that the plaice flavour overwhelmed the crab, and the texture was rather dry. Development improved the crab flavour somewhat, and the moistness by incorporating a crab flavoured sauce. The fibrous nature of the crab filling was liked.

The developed recipe was:

Filling - As used for stuffed mushrooms.

Method - 30g of the mixture is placed between two 75g fillets, freeze and enrobe using the same enrobing process as for the stuffed mushrooms but flash frying for 75 seconds in oil at 375^{o}F to enable the coating to absorb oil (enabling the product to be oven baked) and to obtain a golden brown colour. The product is then frozen again.

For a 9oz portion the estimated recommended retail and catering sale prices were £1.20 and £1.50 respectively.

5.1.3 Crab Crepes With White Wine Sauce

Aimed as an "up-market" retail product. Crepes filled with crab and cheese sauce then rolled and covered with wine and cream sauce and finally topped with cheese.

Initial sampling indicated that this was an excellent kitchen product, and development concentrated on the difficult task of scaling up this type of product for commercial production.

The developed recipe was:

Filling - 30g butter
15g calflo starch
3g salt
10g parmesan cheese
1.5g onion powder
0.5g dry mustard
284 ml milk
150g recovered crab meat
0.3g shellfish flavour (PPF advitaroma 4270 330)

Sauce - 30g butter
25g calflo starch
2g salt
0.2g pepper
375 ml milk
75ml white wine
0.1g dry parsley
0.7g onion powder

Method - For both filling and sauce make a roux with butter and dry ingredients and then add liquids. 50g of filling is placed in a 6" crepe which is then folded and sealed. A single crepe is placed in a foil tray, covered with 90g of sauce and finally topped with 5g of grated cheese. The tray is lidded and the product frozen.

For 2 crepes the estimated recommended retail price was £1.25.

5.1.4 Crab Cakes/Steaks

Aimed at utilising larger quantities of recovered crab meat in a commodity type retail product. The filling for both was similar consisting of crab meat and spices and the products were produced by simple forming machinery and coated with crumb.

Initial sampling indicated that the appearance and texture of these products was good, but that the crab cakes lacked crab flavour, being more spicy and meaty than crab-like, the flavoured crab steaks being even more so.

The crab steaks were dropped and development concentrated on enhancing the crab flavour and reducing the spicy flavours in the cake. Problems were encountered in controlling flavour addition in this type of product, and the preferred solution was to encapsulate crab flavour in a special crumb developed by Witwood Food Products Ltd.

The developed recipe was:

Filling - 454g recovered crab meat
80g fresh breadcrumbs
70g whole egg
30g mayonnaise
2.5g salt
0.5g pepper
2.0g worcester sauce
1.5g dry mustard

Crumb - The flavoured crumb contained wheat flour, soya flour, natural flavour, salt and monosodium glutomate and ribocides (or nucleocides) flavour enhancers.

Method - Mix ingredients together until they bind. If the mix is too dry add a little more mayonnaise. Form into 60g cakes, freeze, batter and crumb.

For 2 cakes the estimated recommended retail price was £1.12.

5.2 Product Assessment

Samples of the 4 products were produced by Youngs and supplied to the Food Products Intelligence Centre who conducted group discussions with 57 female panellists in 6 separate meetings. Firstly the panellists' awareness of and attitudes to crab were assessed, and then their reactions to the products. Assessments were made of their reactions to the product concepts, the eating quality of the products, their price, portion size, potential purchase, possible improvements, etc.

5.2.1 Attitudes to Crab

The majority had eaten and enjoyed crab, often when at the coast (crab salads, crab sandwiches). It was considered "up-market". A few prepared fresh crab regularly (fiddly, time consuming and difficult). Few were aware of crab recipe products. Purchases were mainly for the storecupboard (canned crab, crab paste, etc).

5.2.2 Crab Stuffed Mushrooms

The concept and initial appearance were found appealing, but on eating the product was found more disappointing and rated "just satisfactory". Comment was made on the lack of crab flavour, the toughness of the mushroom, and

the product falling apart releasing liquor. The panellists expected purchase price range of £1.00 - £2.50 (depending on the restaurant) compares with the estimated £1.75 sale price. Some potential for an improved retail product was indicated.

5.2.3 Crab Stuffed Plaice

The concept and appearance were found appealing. On eating the product was enjoyed and rated "fairly good", but comment was made on the toughness of the coating and the lack of crab flavour. The portion size was considered adequate or generous, but the expected purchase price was £0.60 - £1.00 compared to the estimated sale price of £1.20. It was thought to be an "adult" product.

5.2.4 Crab Crepes with White Wine Sauce

The panellists were familiar with savoury crepes and the product concept appealed. However the appearance and texture of the product were heavily criticised (considered "uncharacteristic"), although the flavour was enjoyed and overall the product was rated "fairly good". The poor appearance detracted from the "up-market" product concept, e.g. for entertaining. A fair price for this product was considered to be £1.00 - £1.25 compared to the estimated sale price of £1.25.

5.2.5 Crab Cakes

The panellists were familiar with fishcakes as a "down-market" product, and as such the crab cake concept did not greatly appeal. However the appearance and texture of the product were rated highly and the flavour enjoyed, and the product rated "fairly good". Most thought that the crab flavour needed "to be brought

out". The portion size was considered generous but the expected purchase price of £0.50 - £0.70 was less than the estimated sale price of £1.12. The product name was considered to detract from the concept and "crab croquettes" was recommended.

5.3 Further Development

The panellists' attitudes to crab reinforce the view that there is a potential for crab based added value products. Each of the products assessed has shown possibilities, but each needs further development. Underlying the panellists' responses is the expectation that a premium product should taste of crab, and it has proved difficult to achieve this with mechanically recovered meat. Further enhancement of the crab flavour, by natural or artificial means is required.

The Crab Stuffed Mushroom requires the adhesion of the enrobing to be improved. The Crab Stuffed Plaice would be highly rated if the enrobing texture and crab flavour were improved. Possibly both could be achieved with the crab flavoured crumb. The texture problem should be relatively easy to solve. The panellists' price expectation for this product appears low compared to other breaded plaice products already successfully marketed (bearing in mind the large portion size). The Crab Crepes would also be highly rated if the appearance and texture of the kitchen recipe were more successfully reproduced on a production scale. The panellists' response to the Crab Cakes was unexpectedly good. Further crab flavour enhancement and a change of name and thus marketing image are required. Youngs believe that the price gap between panellists' expectation and estimated sale price can be bridged by mixing recovered white fish flesh with the crab meat.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1

It is confirmed that there is considerable potential for increasing the landings of crab although the prospects for the individual fisheries vary. The Western Isles of Scotland will probably become a major fishing area, but the fisheries in the South of England are already close to maximum exploitation. The English East coast fisheries have declined through a transfer of fishing effort to white fish but the crab fishery is now concentrated in a few localised inshore areas which are heavily fished. An increase in East coast landings will entail a change in fishing patterns, possibly considering exploratory fishing offshore.

6.2

The crab has a complex lifecycle involving seasonal migrations associated with moulting and spawning. This results in a highly seasonal fishery and large variations in the intrinsic condition of the crab, but also gives the stocks some resilience to the effects of fishing.

6.3

The selection by the fisherman of crabs in good condition only and the return to the sea of poor condition, undersize and berried crabs is necessary not only to ensure a high quality product but also to conserve the stocks.

6.4
Cooked crab is susceptible to contamination and must be handled with particular care. It must be chilled, and even then has a short storage life. Frozen crab meat also has a short storage life compared to white fish, but its life can be greatly extended by vacuum packing.

6.5
The Bird (American) and Bead (British) mechanical meat recovery systems effectively double the yield of white meat from crab but the recovered meat is fragmented and much of the flavour is washed out, and as such the systems are best used to supplement the yields from hand picking operations. Both systems utilise augmented flotation to separate meat from shell after butchering and comminution. The Bird system centrifuges the crab in brine, and the Bead system bubbles air through the crab in water. Both systems require the liquid to be changed at regular intervals. The Bead system is significantly less expensive than the Bird system.

6.6
In practice the quality of recovered meat varies greatly and it is recommended that this is investigated and standards of operation set. Ideally a completely new "dry" meat recovery system should be developed to retain the flavour of the meat.

6.7
The English South Coast crab industry is highly developed, its vessels are large and fast and fish well offshore. They land highly valued crab which is effectively marketed in a variety of forms: live crab to

the Continent, pasteurised whole crab to Sweden, fresh whole crab to inland markets, and fresh and frozen meats to the tourist, wholesale and catering trades. The English East coast crab industry is declined and traditional. Fishing is carried out from small open boats and the crab is marketed in the traditional forms to the wholesale and tourist trades. The Scottish West coast crab industry is developing out of the nephrops and lobster fisheries but there is no local market and little live storage or processing capability.

6.8

There is a good but volatile market for live crab on the Continent. The traditional market for fresh boiled whole crab is in decline. There is a demand for fresh dressed crab but suppliers do not welcome its laborious production. The demand for frozen crab meats appears static.

6.9

The development of the Scottish fisheries may well be pivotal as regards the entire UK crab industry. The development of a low cost raw material supply, particularly if mechanical recovery is employed, could undermine the existing limited and inelastic market with harmful effects on the other fisheries unless alternative markets are found. The potential demand for processed crab products appears large yet few processors employing hand picking are willing to develop this. The development of this market would help diversify and stabilise the industry - and is recommended.

6.10
Youngs Seafoods Ltd. developed four experimental added value frozen products utilising recovered meat, each aimed at differing market sectors:

a) Crab Stuffed Mushrooms (catering trade)

b) Crab Stuffed Plaice (retail and catering trade)

c) Crab Crepes in white wine sauce (retail trade)

d) Crab Cakes (retail trade, more 'down market').

A recurring problem throughout the development was the lack of flavour of the recovered meat and the difficulty of flavour addition and control.

6.11
Samples of the products were assessed by the Food Products Intelligence Centre who conducted group discussions with 57 female panellists. Attitudes to crab were positive, being enjoyed and considered 'up market', and indicated the potential for added value products. Each of the products assessed showed promise but each needs further development. In particular further development is required to enhance yet further the crab flavour expected of these premium products.

6.12
The Crab Stuffed Mushrooms were liked but further development is required to improve the adhesion of the enrobing to the mushroom and to control the mushroom liquor. The Crab Stuffed Plaice were liked and would be

highly rated if the crab flavour were enhanced, which could possibly be achieved by using the flavoured crumb developed for the crab cake. The Crab Stuffed Crepes were liked and would be highly rated if their appearance and texture were improved in line with the original kitchen recipe, but the scaling up of this type of recipe is difficult. Despite their name the Crab Cakes were liked although the estimated retail price was considered high for this type of product and again the crab flavour needs to be enhanced. A change of name ("crab croquettes" was recommended) and image, and possibly the addition of white fish flesh to reduce the cost are required.

APPENDIX I

THE EDIBLE CRAB - ITS BIOLOGY, STOCKS AND POTENTIAL EXPLOITATION

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APPENDIX I

THE EDIBLE CRAB - ITS BIOLOGY, STOCKS AND POTENTIAL EXPLOITATION

Contents

THE EDIBLE CRAB - ITS BIOLOGY, STOCKS AND POTENTIAL EXPLOITATION

1 AN INTRODUCTION TO THE FISHERY

Several species of crabs are found around the British coasts but the most important one fished for human consumption is the European edible crab Cancer pagurus. This crab is particularly abundant in the coastal waters off north-west Europe, being found in large numbers where the sea-bed is rocky.

Although edible crabs are landed in most European countries, the major crab fisheries are found off Norway, around the coasts of Scotland and along the north-east and south coasts of England.

A large fishery for Cancer pagurus also occurs around France, mainly off Brittany, and around the Channel Islands. Smaller fisheries are found off Spain, Portugal and Ireland.

Crabs are caught in baited traps, the design of which varies around the coast.

Crab fishing is one of the major sources of income of the British shellfishermen, and at present provides a livelihood for some 2,000 full time inshore fishermen. In 1982 crab fishermen took more than 8,000 tonnes with a value at first sale of around £4.2 million; this figure representing nearly one tenth of the total value of the annual shellfish catch for that year (i.e. £42 million).

Bearing in mind the economic importance to Britain of the crab fisheries most of the biological studies on Cancer have been carried out by British scientists. Some of the earliest investigations on British stocks began in the 1800s and since that period all aspects of the biology and fishery for crabs have been studied in detail and there is now a considerable amount of information available on this species.

This review of the British crab fishery includes a description of the life cycle, emphasising various factors in the biology of this crustacean which affect catch levels or which are of importance to the fishery.

2 THE PRESENT AND PREVIOUS FISHERIES

2.1 Landings and Value

Table 1 overleaf details the landings of crab in the UK during the period 1973 - 1982.

During the last five years the average annual UK catch has been around 9500 tonnes, with a first-sale value of £4 million.

Table 2 overleaf details the landings at the major ports in 1982. Ports in England land the highest crab catches; on average 70 per cent of the UK crab catch being landed in England since 1978; landings at Welsh ports are minimal and the remainder (25/30 per cent over that period) landed in Scotland.

The main English crab fishing grounds are off South Devon, around Cornwall and along the south coast from Portland Bill to Dungeness in the English Channel. Other important fishing areas are found along the east and north-east coasts of England including grounds off Norfolk, Yorkshire, Durham and Northumberland.

The proportion of the crab catch landed in different areas of England and Wales is shown in Table 3. It can be seen how important the east coast of England has been for crabs over the 55 years (1904 - 59) when around 80 per cent of the country's catch was landed at ports in Northumberland, Yorkshire and Norfolk.

Since 1960, however, the East Coast Fishery has declined and an increasing proportion of the country's catch has been landed in the south coast area, which includes the important Devon fishery. By the 1970s over half the country's catch came from this area, based on fishing in the English Channel.

Table 1

Crab Landings and Their Value in Scotland, England and Wales, 1973 - 1982

Year	England & Wales (tonnes)	Scotland (tonnes)	Total UK (tonnes)	Value (£'000)
1982	5037	3161	8567	4,246
1981	6071	2637	9745	4,258
1980	6045	2530	9683	3,968
1979	6658	2380	10425	3,906
1978	6166	2638	9579	3,242
1977	6081	2394	8628	2,682
1976	5672	1996	7717	1,918
1975	4897	1686	6586	1,332
1974	4572	1510	6091	1,199
1973	4074	1209	5289	1,041

Note The figures for England and Wales exclude spider crabs and other species.

Total UK weights include all crabs.

Table 2

Top Ten Crab Ports, 1982

	England and Wales		Scotland	
		Wt. landed (tonnes)		Wt. landed (tonnes)
1	Dartmouth	1233	Western Isles (Stornoway/N.Uist)	796
2	Salcombe	602	Orkney	556
3	Cromer	332	Wick	353
4	Bridlington	267	Leith	280
5	Newlyn	240	Anstruther	192
6	Sheringham	229	Fraserburgh	160
7	Plymouth	155	Arbroath	156
8	Weymouth	143	Eyemouth	125
9	Helford	116	Shetland	106
10	Whitby	112	Gairloch	101

Table 3

Proportion of the Crab Catch Landed in Three Different Fishing Areas of England and Wales, 1904 - 1980

Period	East-Coast (Berwick-Deal)	South Coast (Dover-Isles of Scilly)	West Coast (Sennen Cove-Silloth)
1904-13	81%	16%	3%
1914-23	81%	16%	3%
1924-33	85%	12%	3%
1934-43	89%	9%	2%
1944-53	90%	9%	1%
1954-59	78%	21%	1%
1960-69	66%	33%	1%
1970-75	31%	68%	1%
1976-80	25%	72%	3%

In Scotland there are important crab fisheries around Shetland and Orkney, while the east coast has important crabbing centres at Eyemouth, Fraserburgh, Anstruther, Leith and Arbroath.

In recent years crab fishing has been expanded around the Western Isles and landings in Lewis and North and South Uist have increased substantially. A major new crab fishery has been developed here in the early 1980s on large stocks of crabs which have previously been lightly exploited.

2.2 Seasonality

In Britain some boats fish for crabs throughout the year, but the main season is from April to November. On the east coast of England peak catches occur in May and June but in the south-west of England catches are low in the early part of the year and higher from July to November. In Scotland the most important months for crabs are May to October but some landings are made throughout the year.

Crab landings in all areas are affected by various factors, such as weather or crab behaviour - including moulting and migrations - and by the seasonal emphasis on the capture of other fish or shellfish species. Typical seasonal variations are shown in Figure 1 overleaf.

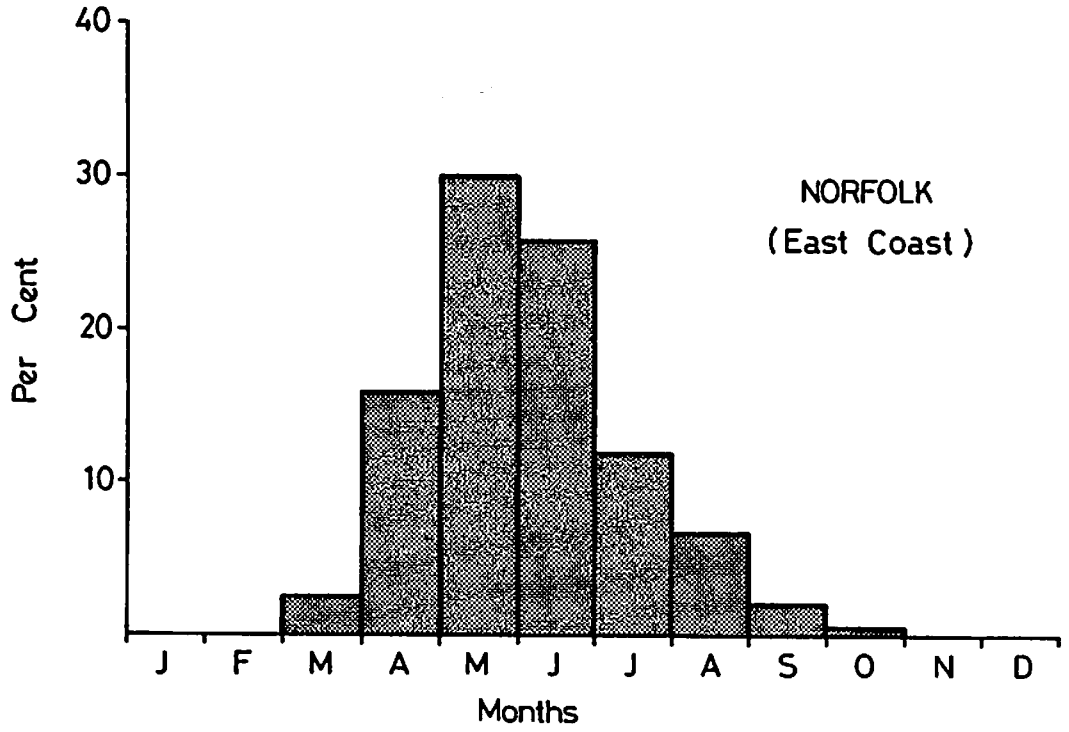
For example, in most areas lobsters are caught with the same type of traps, and since lobsters command a much higher price than crabs, there is at certain times a seasonal emphasis on lobster fishing.

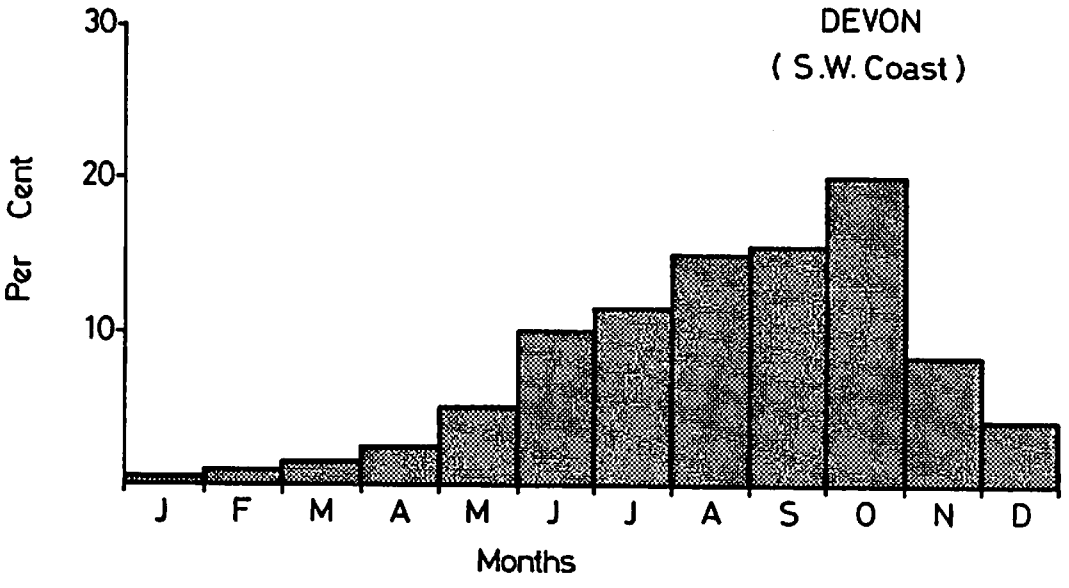
Also some boats, particularly the larger types, will only fish for crabs when catches are good and will turn to alternative fishing such as trawling, lining or trammel-netting, during the remaining months of the year.

The weather in particular controls the level of crab landings. Because crabs are cold blooded animals they take their body temperature from the surroundings; in cold water they are less active and their feeding is reduced. Catches during the Winter and early Spring are therefore poor because the inactive crabs are hibernating and not attracted by the bait in the traps.

Landings can also be affected by stormy weather when boats cannot leave port to haul their pots.

Appendix I





Monthly distribution of the crab catches in Norfolk and Devon
(based on landings in the early 1980's)

Fig.1

3 THE LIFE CYCLE OF THE CRAB

The edible crab Cancer pagurus is one of the largest invertebrates found around Europe.

This crustacean is a close relative of the lobster and around Britain crabs and lobsters often inhabit the same areas where they compete for food and shelter.

The crab, despite its reputation as a scavenger, feeds mainly on living food including small fish and marine worms. Shellfish such as mussels and barnacles are easily crushed in its powerful claws. It is extremely voracious and has a keen sense of smell which helps to find its food on the sea bottom.

3.1 Growth

Crabs, like all crustaceans, are covered with a hard rigid shell known as the exoskeleton. In order to grow crabs have to cast these outer shells, made of calcified chitin. This is known as moulting or ecdysis. During the first few years of life, when growth is rapid, a crab will moult several times a year, but by the time it becomes sexually mature moulting may occur only once a year or even less frequently.

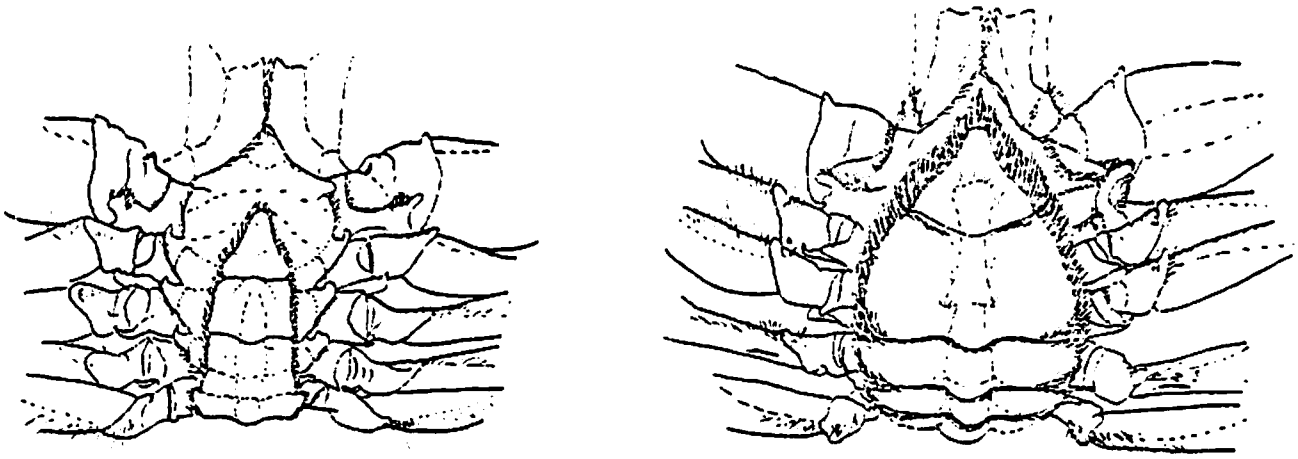
In Britain the main moulting period is from July to October each year. At this time the crabs move close inshore and seek shelter among the rocks. Moulting commences when the hard outer shell splits along a precise line dividing the upper and lower halves, and the soft crab inside slowly backs out through the gap.

The crab, now in the soft-shelled condition absorbs water and swells, increasing in size across the back by as much as 20 to 30% in one moult. On average a 3.5 inch (88mm) male will reach 4.5 inches (115mm) in one moult and 5.75 inches (146mm) in the next. After a moult has been completed the new shell slowly hardens and the crab's body will not increase in size again until the next moult. Research has shown that crabs which moult do not return to the final stage of calcification for at least two, or sometimes three, months after ecdysis has taken place. While the new shell is hardening the crab is called "soft-shelled" and by law it must be returned to the sea if taken by a fisherman.

3.2 Breeding

The sex of a crab can easily be determined; the female or "hen" crab has a broad abdomen, whereas the male or "cock" crab has a narrow abdomen, which fits tightly to the body, as shown in Figure 2 overleaf. The claws of the male are also larger than those of a female of the same size.

Mating occurs in inshore waters during the summer, immediately after the female crab has moulted and while it is in the soft-shelled condition. Prior to the moult, and for a period of up to a fortnight after, the female is attended by a hard-shelled male which is attracted to the female by a scent or pherome she exudes at this breeding time. Immediately the female has cast her shell mating takes place and the male sperm are introduced into the female's two sperm sacs. One supply of sperm may fertilise two or more batches of eggs in subsequent years, and the majority of females that mate in July or August will spawn, that is carry eggs, in November or December of the same year, but in some cases spawning is delayed until the next winter. Crabs usually select a soft sea bed for spawning, often in deep water, and the eggs remain attached to the 'swimmerets' on the abdomen of the parent for about seven months. A crab with eggs is sometimes called a 'berried' crab and the number of eggs carried can vary from half a million on a 5 inch (127mm) crab to three million on a 7 inch (178mm) one. A berried hen is shown in Figure 3 overleaf.



Cock Hen

Figure 2 Abdomens of Cock and Hen Crabs

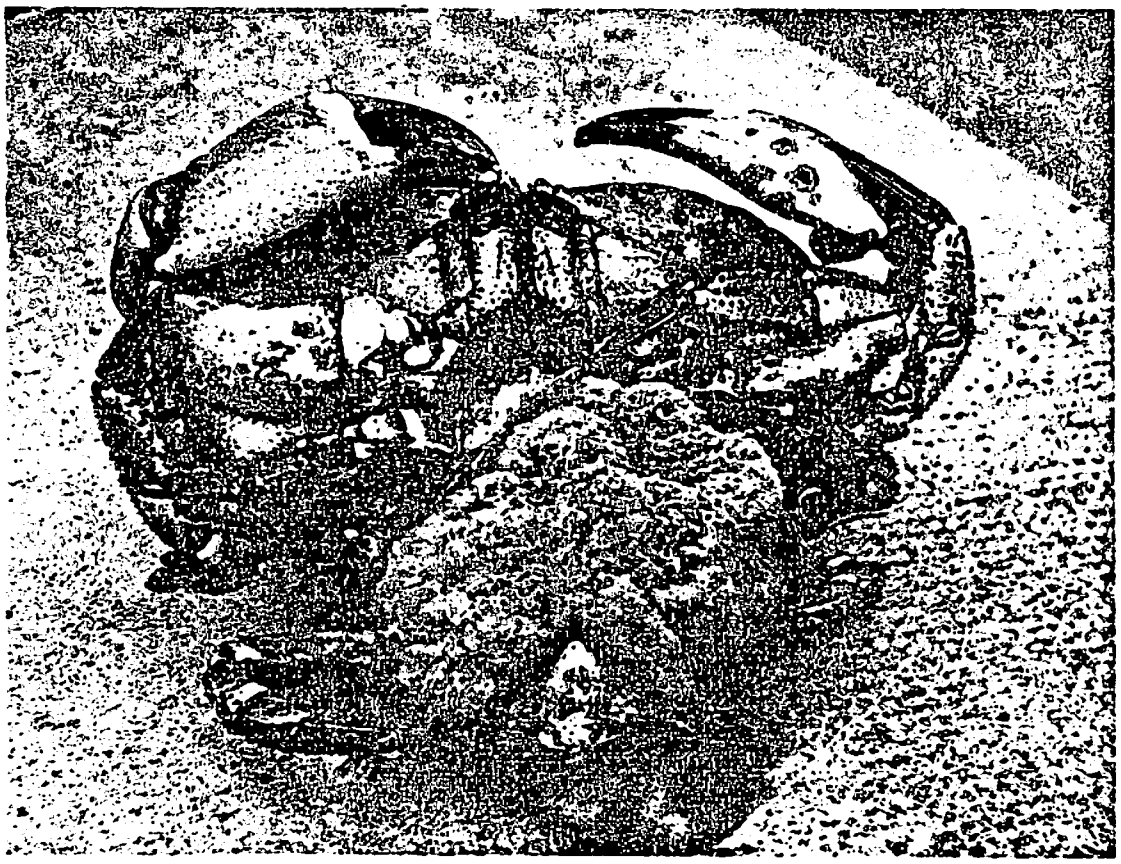


Figure 3 A Beried Hen Crab

3.3 Hatching and Larvae

In the Spring and Summer following spawning the 'berried' females move inshore where the eggs hatch. Hatching times vary for the different stocks of crabs around our coasts but the main periods are all between May and September.

The young larval crabs which emerge from the eggs have a shrimp-like appearance and live among the free-floating plankton in the surface water layers for about one month. Figure 4 below shows the larval stages. This period is a dispersal phase because the microscopic larvae can be transported considerable distances by water movements from where they first hatched. During this period they grow through several stages and by the time the larval crab has reached a size of 2.5mm it settles to the seabed and assumes the first crab stage. As described later (see migrations) the transport of crab larvae to an area where they will survive is aided by distinct migration journeys by adult female crabs.

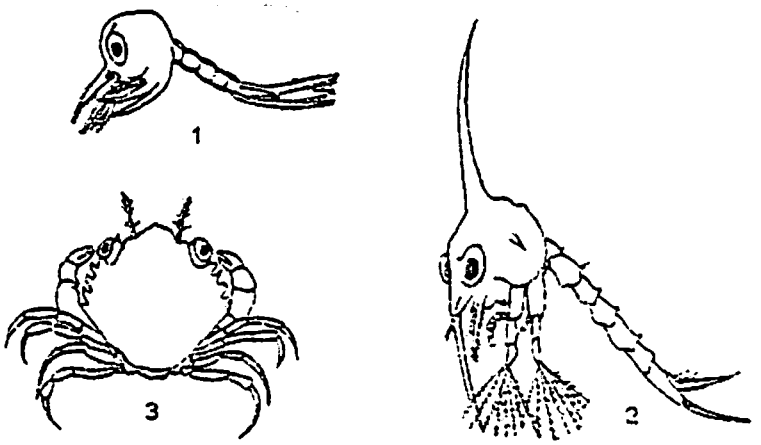


Figure 4. Stages in the development of the young crab. 1. Protozoëa, 2. Zoëa 3. first post larval stage (after Lebour, 1928)

Figure 4

3.4 Crab Migrations

Although generations of fishermen have known that crabs move about on the coastal fishing grounds the full extent of these migrations was never properly defined until marine scientists undertook extensive tagging studies in the 1960s and 1970s.

In these experiments a type of tag, which is not lost when the crab casts its shell, was attached to large numbers of crabs of both sexes. Each tag was numbered and a record was kept of the size, sex and shell condition of each crab marked in this way. Fishermen who caught tagged crabs were rewarded if they returned the crabs and also provided information on the date and position of recapture.

In 1965, in a major east coast tagging experiment, 3,400 tagged crabs were released in the Norfolk, Yorkshire and Northumberland crab fisheries. Just over a third were later recaptured by fishermen and the results added considerably to the available knowledge on crab movements along the east coasts of England and Scotland.

For example, in the Yorkshire experiments a total of 135 female crabs were recaptured and of these 40% were found to have moved distances of 20 miles and over. Nearly all these migrations were in a northerly direction, as shown in Figures 5 and 6 overleaf, the crabs being caught in North Yorkshire, Durham, Northumberland or Scotland. The longest distance moved was by a female released near Flamborough Head, Yorkshire which was recaptured off Berwick (Northumberland) 16 months later having moved 163 miles. For male crabs the results were different and only 5% of those recaptured had moved distances of 20 miles and over. Tagging studies in south-west England again showed that some crabs, particularly females, make extensive movements mainly west or south-west down the English Channel. The maximum distance covered was 155 miles but the results confirmed extensive migratory movements with crabs moving from one part of the Channel to another.

These migration patterns undertaken by Cancer pagurus are associated with the crab's breeding behaviour. The long distance movements, identified by tagging experiments, along the east coast of Britain and in the English Channel are believed to be part of an offshore movement in the Autumn, when the eggs are laid, followed by a return to the shallower inshore waters in the

Spring, when the eggs are hatched. Tagging experiments in Scottish waters have also confirmed that female crabs undertake considerable migrations, often in excess of 100 miles. Male crabs rarely moved far from the point of release.

4 MEAT YIELDS AND SIZE

The cooked meat, which composes the edible portions of the crab, consists of the white muscle from the claws, legs and the body cavities, and the brown which comes from the reproductive and digestive tissues of the body.

Tests have shown that the total meat yield from the edible crab varies around the UK, and even between grounds in the same locality. Yields are affected by the Winter fasting and by the moulting and breeding cycle. These aspects are discussed in more detail in Section 5.

More white meat is extracted from male crabs, which have larger claws than females, while more brown meat is available in females, especially during the breeding season in late Summer and Autumn when the reproductive tissues are ripe. Male crabs also yield more total meat than a female of a similar size.

The size of crabs caught around Britain is not uniform. In general edible crabs grow to a larger size in south west England than anywhere else in the country. In contrast, crabs along the east coast, especially off Norfolk and Yorkshire, have a smaller average size.

Growth rates have an effect on the size of crabs caught. Scientific studies using tagged crabs to evaluate growth have shown that the size a crab increases at a moult does not vary between the east and south west coasts of England. However, in Devon and Cornwall crabs moulted more frequently than in the Norfolk and Yorkshire fisheries. Furthermore, the studies showed that in the south west, males moult more frequently than females (hence the large 'cock' crabs in the area); the opposite is the case for the east and north-east crab stocks. A valid reason for this difference has not yet been established.

5 CONDITION OF CRABS

The condition of crabs can be affected by a variety of factors including the moulting and breeding cycles.

5.1 Moulting Condition

It has long been known that crabs which have recently undergone a moult and cast their shells are in poor condition and give a low meat yield. The hardening of the crab's exoskeleton is progressive and the final stage of calcification after moulting may take at least two or possibly three months.

In general, however, crabs which moult in July or early August will become hard-shelled before November of the same year and will have reasonable meat yields.

It should be emphasised that it is bad practice to land crabs which have recently cast their shells, because their quality is poor. Crabs of this type - which can be identified by their clean and not fully hardened shells - should be returned to the sea where they will soon improve in condition to become good crabs.

5.2 Affect of Breeding on Condition

The breeding cycle also affects quality, particularly in female crabs. Spawning of the edible crab begins in late Autumn and continues during the early Winter. Prior to spawning (egg laying) the crab's body becomes filled with the ripe gonads which have a bright red granular appearance.

This tissue known as 'coral' in the trade, improves the meat yield and forms a high quality brown meat ideal for the production of pastes or spreads.

In late Autumn stocks of these 'ripe' females concentrate on various offshore grounds ready for spawning. High catch rates of female crabs can be taken and these crabs have a good meat yield.

When the eggs are laid and attached to the underside of the female's abdomen she spends much of the next six to nine months in a shelter on the seabed and does not feed. This accounts for the lower catch rates of female crabs after November, when they have become 'berried' and do not readily enter traps.

In the Spring and early Summer the female crabs move inshore after hatching their eggs (see Section 3.3). These hatching crabs can easily be recognised by the dirty discoloured appearance of their shells and, because when in the 'berried' condition during the Winter they feed little, their quality is poor. However, during the Summer their condition improves and the gonads will slowly re-develop reaching a peak in October or November ready for another successive spawning.

5.3 "Black Spot" Shell Disease

Sometimes the quality of crabs is affected by black lesions on the shell, which is usually associated with pitting and a general discolouration of the exoskeleton. This naturally occurring condition in crabs - called 'black spot' in the trade ' is caused by bacteria which attack the shell. This shell necrosis or 'black spot' is normally more evident in older animals and its incidence is greater in lightly fished crab populations. In some areas crabs may be so badly affected that the shell is pitted and even underlying soft tissues are discoloured. Then the commercial value is so reduced in these 'diseased' crabs that fishermen will either kill or reject them. The micro-organisms which attack the shell are widely distributed in the marine environment but are not harmful in any way to humans.

6 REGULATIONS CONTROLLING THE FISHERIES

National and local regulations govern the size and condition of crabs which can be legally landed and marketed. This means that all crabs must be carefully examined and selected after being removed from the traps at sea.

In all areas of Britain under the Immature Crabs and Lobsters Order 1981 it is an offence to land any edible crab (Cancer pagurus) unless it is 115mm (4.5 inches) across the broadest part of the back.

However, along the coasts of Cornwall, Devon, Dorset, Hampshire and Sussex local Sea Fisheries Committee bye-laws have raised the legal minimum size to 5.5 inches (140mm).

In addition national regulations prohibit the landing of 'berried' (i.e. egg-bearing) female crabs and soft-shelled or recently moulted crabs which are in poor condition (except for use as bait).

Legal protection for soft-shelled crabs dates back to the last century; under Section 8 of the 1877 Fisheries (Oysters, Crabs and Lobsters) Act it was an offence to land or sell '.... Any edible crab which has recently cast its shell whether known as caster, white-footed crab, white-livered crab, soft crab or glass crab, or by any other name.' Nowadays few cases are taken to Court due to the difficulty in qualifying under the law the various stages in the shell hardening process.

The above regulations are aimed at conserving stocks and fishermen who contravene them may be fined. There is, however, no national closed-season for crabs or restriction on the number or type of traps fished. Several Sea Fisheries Committees do set a length limit on the size of vessel which can work pots in their Districts or have a licence system. Full details can be obtained from the local District Inspector of Fisheries.

7 STATE OF THE FISHERIES AND STOCKS

Records show that even as early as the 1800s there was a large and important fishery for crabs in many coastal areas of England and Scotland but stocks appear to have stood up to exploitation reasonably well despite decades of fishing, although there is little hard data on stock sizes and dynamics.

Tagging has shown that there is considerable movement of both the adults and the larvae between various populations which helps to maintain stock levels. Crabs also disperse offshore during the Winter and concentrate back inshore in the Spring and Summer. The fishery is still mainly confined to the coastal area - using static gear - and the small (undersized) specimens are returned to the sea unharmed to grow.

However, in 1985 the state of the stocks vary. Off the west coast of Scotland large stocks of crab exist which for various reasons have only recently been exploited. New fisheries have developed in places like Stornoway, Uist and Barra in the Western Isles.

The crab fishery in the south west of England, particularly off South Devon, has flourished in recent years with increased demand and big landings. Stocks in this area have been heavily exploited, and in order to maintain high catch rates, boats have had to work further offshore.

Scientific studies in the western Channel suggest that these crab stocks are not capable of withstanding any further large increases in exploitation. Conservation measures have been recommended which will raise the minimum landing size on a regional basis and also introducing a larger size for male ('cock') crabs.

This situation also applies to a certain extent to south coast grounds off Portland Bill, Selsey and Newhaven, where expanding fishing effort has raised the level of exploitation on the inshore crab stocks.

In the more traditional crab fisheries such as the Northumberland, Yorkshire and Norfolk grounds, landings have been fairly stable during the past five years. Following a decline in the Yorkshire fishery in the late 1960s, which coincided with a change of fishing practice from potting to white fish trawling, catch

levels are not being increased mainly because the boats are small and limited both in range and the amount of gear they can fish.

On this basis, while there is scope for developing these traditional fisheries, the stocks close inshore are fairly heavily exploited at certain times of the year and no large increase in long-term catches is likely unless major changes occur in the pattern of these traditional crab fisheries in the future.

There are opportunities to expand crab landings in Wales but although good stocks of crabs are reported in Cardigan Bay poor harbour facilities in the region hamper their proper exploitation.

Crabs are plentiful on all coasts of Scotland and fisheries around Orkney and Shetland offer scope for further development.

On the east coast the traditional fisheries along the regions of Grampian, Tayside, Fife, Lothian and Borders are all generally heavily exploited and no large increase in landings can be expected. As stated earlier in this section, the west coast of Scotland has ample stocks of crabs and there has been a rapid increase in crab fishing in the 1980s. Prospects are good and it appears that areas such as Skye, Barra, Uist and Lewis will become major crab producing areas in the future.

8 OTHER CRAB SPECIES

Although the edible crab (Cancer pagurus) is the main species used for human consumption in Britain two other crabs are taken in our waters - mainly for live export to continental markets. Both are relatively new fisheries. No local processing is undertaken and home sales are very limited.

These species are the spider crab (Maia squinado) and the velvet swimming crab (Liocarcinus puber), and their fisheries are slowly growing in importance.

Unlike the edible crab which is widely distributed around British coasts the spider crab and the velvet crabs have much more localised populations.

Spider crabs are a warm water-species and their distribution is restricted to the southern part of Britain. Stocks are abundant off the south and south-west coasts of England, and there is a small stock off Pembrokeshire (Dyfed) Wales. This crab is not present in the North Sea or around any coasts of Scotland.

This resource has not been regularly exploited by British fishermen because until quite recently the market outlets were limited. In 1976, small consignments of this crab were exported to Spain, and since 1977 this trade has progressively expanded to a currently estimated level of several thousand tonnes per annum. Now it seems likely that spider crabs will support lucrative fisheries especially along the Channel coast.

Spider crabs are caught in baited traps or in trammel nets. Sometimes they are taken when fishermen are working the inshore grounds for lobsters, crabs or crawfish. But in the Summer, when these crabs enter certain bays in vast numbers some fishermen concentrate on catching them making daily landings of 2000 to 3000 lbs from 300 pots.

There is further potential to expand the fishery for "spiders" since the English stocks are nowhere near being overexploited. Catches could be used to supply the overseas demand for the species but the possibility of mechanically recovering the meat at home and using it in added value products should also be considered.

The fishery for the velvet crab has developed in the UK over the last five years. Virtually all the crabs caught are exported either directly or indirectly to Spain. The growth of the UK fishery is a result of overfishing of the stocks in Spanish and neighbouring waters.

The species has only been exploited for a short time and statistics on the fishery have only been collected since 1984. Very little is therefore known about the current levels of exploitation and trade or about the species' biology and ecology.

Exploitation, which is based mainly on the West Coast and Islands of Scotland, is by means of creels like those used for Nephrops. Once caught and graded the animals are exported alive in aerated water tanks built into the trailers of articulated lorries.

It seems likely that about 1000 tonnes per annum are exported. There is potential for increasing this figure but only if certain problems, which restrict the growth of the fishery, are solved. These mainly concern learning more about how condition varies with season and how mortality rates during transport can be reduced.

Demand for the velvet crab is year round but it increases - as does the price - through late Autumn until Christmas.

There are probably no fishermen who fish exclusively for velvet crab. Because the same creels can be used for Nephrops, lobster, crawfish and velvet crab, the fishermen can change at short notice to whichever of these species is most profitable.

There is some potential for increasing the UK market, but it is likely to remain within the ethnic groups which currently eat it - those of Asian origin. Most other British people consider it too small to be acceptable.

APPENDIX II

PROCESSING THE EDIBLE CRAB
KEY FEATURES OF HANDLING AND PROCESSING, AND OPPORTUNITIES PRESENTED BY NEW DEVELOPMENTS IN THE MECHANICAL RECOVERY OF CRAB MEAT

Author: John Early (TRS)

APPENDIX II

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KEY FEATURES OF HANDLING AND PROCESSING, AND OPPORTUNITIES PRESENTED BY NEW DEVELOPMENTS IN THE MECHANICAL RECOVERY OF CRAB MEAT

Contents

PROCESSING THE EDIBLE CRAB - KEY EATURES OF CRAB HANDLING AND PROCESSING, AND OPPORTUNITIES PRSENTED BY NEW DEVELOPMENTS IN THE MECHANICAL RECOVERY OF CRAB MEAT

1 INTRODUCTION

Of the several crab species landed in the UK, only the edible or brown crab (Cancer pagurus) is important so far as processing is concerned.

Crab processing on a factory scale, as opposed to cottage industry, started soon after the 1939-45 War. The process of meat removal in such factories was totally manual, and this continued until recently with very few exceptions. These exceptions included the use of compressed air to blow meat from certain parts of the crab, and meat/bone separators. None of these mechanical systems gained great popularity and with the increasing cost of labour for manual extraction, processors chose to extract the most valuable and easily processed white meat, that from the claws, and to discard the other parts of the crab. By the mid-1970s this practice was quite common, especially where smaller crabs were being handled on the east coast of England and from around Scotland. Thus, attempts were made by Torry Research Station to introduce equipment for crab meat extraction. The first device found to be suitable was the Bird Centrifuge from the USA. A British firm, Bead Engineering of Kings Lynn, Norfolk, then developed a less expensive system which has found favour recently. Even more recently Canadian equipment, made by Charlottetown Metal Products Ltd. of Prince Edward Island, has become available. The scope of all these systems will be described.

Firstly, however, the full handling and processing procedure will be briefly discussed pointing out the key features for good quality. Mechanisation, and in particular mechanised meat extraction which after all is only part of the process, will then be discussed in greater detail.

2 THE HANDLING AND PROCESSING OF CRABS

Crab handling and processing involves the following steps:

1. Selection - primarily the responsibility of the fishermen.

2. Live storage both aboard and ashore to point of processing.

3. Inactivation.

4. Cooking.

5. Butchering and sectioning.

6. Meat extraction.

7. Product storage.

2.1 Selection

To ensure a good quality and hence profitable product crabs must be selected at the point of landing by the fishermen. Undersized, soft shelled, or berried crabs must be returned to the sea. Damaged crab, so long as they are still alive, are acceptable for the processing operation, as are crabs with the odd patch of black discolouration or necrosis of the shell. The fishermen will normally select out such crabs if the market is for whole boiled animals. Badly affected examples should, however, be discarded. Perhaps the most important and difficult point about selection is to ensure that crabs are full of meat and not watery indicating that they are out of condition - i.e. have moulted or spawned fairly recently. It takes some experience to judge the correct 'feel' for an acceptable animal and even then the odd mistake will occur. However, every attempt to select only good quality animals must be made. In the long run if such out of condition crabs are placed back in the sea both fishermen and processors will make higher profits from them when recaught at a later date.

2.2 Live Storage

After the selection stage the crabs should be handled and stored correctly to ensure they remain alive until they reach the processing plant. They must be protected

from sun and wind and should be carefully handled to prevent loss of limbs. For this they should be tightly packed, backs uppermost, in boxes to prevent them damaging one another. After filling, the boxes should be either placed below deck or covered with damp sack-cloth to keep cool and prevent drying out. They should be removed to the processors premises as soon as possible after landing and be placed in a chill store if they are not to be processed immediately.

Processors should only accept live crabs as this is the best way of ensuring raw material of reliable quality, although since it is a common practice to inactivate before cooking there is nothing wrong in processing a crab which has been dead for a short period, for instance 2 or 3 hours, if the processor can be sure that it is fresh. Crabs do not store or travel very well but depending on their previous treatment, both at sea and during land transportation, they can usually be kept alive in chill in boxes as described above at least overnight. For longer periods crabs must be held under controlled conditions in live storage tanks.

2.3 Inactivation

Inactivation prior to cooking is necessary, if whole cooked crabs are required, to prevent the shedding of limbs or 'autotomy'. Nowadays, if it is intended that the total production is to be processed this stage is very often omitted. Inactivation can be done in one of two ways. The first is by spiking through two nerve centres, the first located behind the eyes and the second above the vent. A spike has to be inserted through one of the eye sockets and through the vent to render the crab inactive. It is, therefore, a fairly laborious task and really only suitable for large crabs, such as are found off the south west of England. The second method of inactivation is by 'drowning' in fresh water and is by far the most usual technique for crabs destined for processing, as opposed to the whole boiled crab market. The period required in fresh water for inactivation is temperature dependent and ranges from around 30 minutes in water at 45 deg C to between 3 and 5 hours in water at 10 deg. C. Obviously the time to inactivate also depends on the size of the crab and on the handling practice since catching.

2.4 Cooking

Crabs are usually cooked by boiling either on a batch basis in a bottom heated insulated vessel fired by gas or oil or on a continuous basis if large quantities are to be handled. For quantities in excess of 2-3 tons per day a continuous method is best. The equipment for continuous cooking can be simple and often consists of a trough of water heated by a heating coil or live steam (which has to be raised in separate equipment, usually by oil). The crabs are loaded into plastic boxes resistant to softening at 100 deg. C and these are progressively pushed along the trough borne on flanges set above the heating coil/steam outlets. The cooking time is regulated by the rate of loading of the boxes and to facilitate the process and render it foolproof it is possible to have a preset timer with bell or indicator light to show when the next box should be loaded. Cooked crabs, having received the correct length of cook, emerge from the opposite end of the cooker as raw crabs are placed into the cooker. Such a system can be used for up to 8 tons per day but in a larger scale operation a continuous cooker, equipped with moving belt, is perhaps more convenient.

The cooking time for whole crabs ranges from 20 to 35 minutes, depending on size, the period of cook being counted from the time when the water returns to the boil. Usually a 20 minutes cook is adequate for all but the larger animals caught off south west coasts. When cooking the whole crab the most demanding requirement is thorough cooking of the body meats, especially the brown meat which is liver and gonad. Unfortunately, this results in a degree of overcooking of the claw meat which is, after all, the most highly prized meat in the crab. The result is a small reduction in yield and some deterioration in flavour and texture. However, if claws are cooked separately, 15 minutes is adequate.

It is essential that the freshly cooked crabs are washed and cooled by water sprays and that they are then left to air cool for a period of at least 2 hours. This allows the meats to coagulate and is especially important if the brown meat is to be saved, since it helps to maximise the yields. If the meats are to be picked it is an advantage to chill the crabs overnight if facilities are available; this helps to keep the bacterial load low during the period of exposure to ambeient conditions.

Selection of suitable crabs for sale whole takes place at this point. Animals which are dense and not watery, as judged by shaking, are suitable for sale in this form.

2.5 Butchering

The first operation, if the meats are to be picked, is to butcher the crabs into the component parts of claws, and carapace sometimes called 'cart' or 'back' (see Fig. 1 overleaf). The body ('apron' or 'honeycomb') and the small walking legs, both of which contain white meat, remain attached to one another.

The butchering of the crabs and, indeed, all subsequent operations must be done in a separate room away from uncooked materials to prevent recontamination of the exposed meats. Crab meat, as a precooked food material that is eaten without further heat treatment, is potentially a dangerous article of diet, unlike most fishery products. It is, in this respect, similar to precooked meat products. Thus, the greatest care in its handling should be exercised throughout processing, preventing contamination from any source but especially from uncooked material and from human sources by poor personal hygiene. All workers must be encouraged to wash their hands frequently, especially after using the toilet. Sores and boils etc must be reported to Management so that they can be suitably covered or the worker placed on other duties away from cooked meat. All working surfaces must be washed at least every 2 hours using appropriate detergents and disinfectants to keep the bacterial load as low as possible. Obviously, even with care, contamination will occur from time to time but, by keeping the temperature of the crab or crab meat as low as possible and by reducing the period of exposure to ambient temperature to the minimum, any added bacteria will be prevented from multiplying to the point of giving a dangerous product and/or of causing rejection by customer quality control.

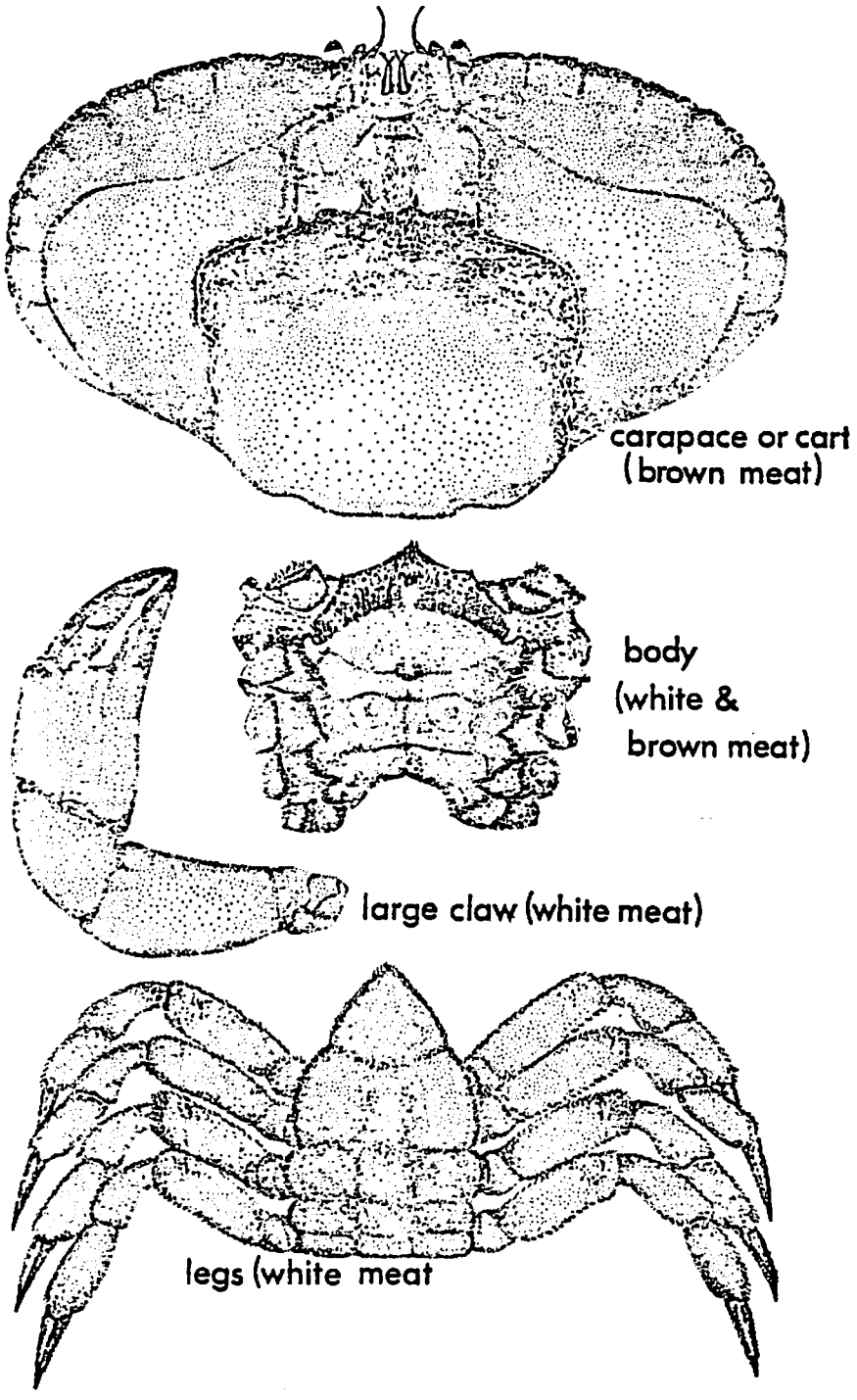

Fig. 1 The Parts of the crab

2.6 Meat Extraction

Following on from butchering the meats are removed from the shell, the brown meat from the carapace and from the top of the body by means of a spoon and the white meat from the various segments of the claws after the shell has been cracked. Even after the outer shell has been cracked and removed the meat often adheres to the endophragmal structure or 'cartilage' and must be scraped off by means of a fork or similar tool. Sometimes the shell is removed from the final segment of the claw leaving the meat intact on the cartilage. This is often called a cocktail or barbecue claw. As mentioned previously in a manual operation the body and legs are most often discarded. The yield of meat from crabs, particularly the brown meat, varies due to season and the sex and size composition of the catch. For crabs caught off the east coast of Scotland an average yield of 18.5% is often quoted for the brown meat and 8% for the claw white meat, both based on the raw crab weight. It should be remembered that for the total potential white meat yield, meat from the body and legs should be included which can amount to a further 10-12%.

2.7 Handling of Meats after Extraction and Shelf Lives

After picking, both white and brown meats must be carefully handled to prevent rapid deterioration. If they are not cooled to at least chill temperature, then bacterial build up is very rapid since contamination inevitably occurs during the picking process. Chilling in this way gives an enhanced but short-term shelf life; quick freezing obviously gives a considerably extended shelf life not limited by bacterial processes. Thus further handling such as simple packaging or incorporation into more sophisticated added-value products, followed by packaging prior to preservation, must be rapid.

Although it is desirable to use crab meat whilst very fresh, that is within 24 hours of extraction assuming storage at 5 deg C, it is possible to keep both white and brown meats in an acceptable condition at this temperature for up to 3 days. Ideally the storage temperature should be lower, at 0 deg C, but at high storage temperatures as might be experienced during the main Crab processing season, the shelf life can be drastically reduced. At 20 deg C, for instance, the rejection level is reached in a little over 24 hours.

Storage in an atmosphere of 40% carbon dioxide, 30% oxygen and 30% nitrogen gives an extension of the shelf life at 4 deg C of between 1 and 2 days.

Frozen crab meat does not keep particularly well in cold storage when compared with, for instance, gadoid (cod like) fish species. The reason for this is that the brown meat, which often contains a lot of fat, goes rancid and the white meat dehydrates easily due to the large surface area presented to the atmosphere by flaking after processing. For this reason mechanically recovered crab meat is even more prone to cold storage deterioration. However, a shelf life of about 6 - 8 weeks at -18 deg C is possible but this is at least trebled if the meat is vacuum packaged.

3 MECHANISATION IN CRAB PROCESSING

The handling and processing of crab is a particularly laborious operation and thus various attempts to mechanise different aspects of the process have been made, both in this country but more particularly in the USA, over the years. Considerable sums of Government money were spent in the USA in the 1960s and this led to the development of machines suitable for several of their species. Perhaps it should be mentioned that most of the commercially important species in the USA are soft-shelled crabs with relatively poorly developed cartilage structure. These species include blue crab (Callinectes sapidus) and red crab (Geryon quinquedens). The European edible crab, on the other hand, has a very thick calcified shell with much cartilage within the white meat, particularly in the body, rendering mechanisation much more difficult.

The main aspect of processing attracting attention has been meat removal but the butchering of crabs was also considered worthy of mechanisation.

3.1 Mechanical Butchering

Various systems exist in the USA for butchering, or as they call it 'sectioning', prior to meat removal. Some of these are linked to a particular meat removal system and will be mentioned later but one has been designed by the Key Electrosonic Company which is not and which, it is claimed, could work with relatively minor modifications on Cancer pagurus. However, when they were approached, the UK industry did not show particular concern about the need for a butchering device. Thus these claims have never been followed up.

3.2 Mechanical Flesh Recovery

The processing of several commercially important US species was solved relatively simply by the discovery that meat could be rolled out of the shell by a machine rather like an old fashioned mangle. This works on species such as Alaska king crab, red crab and blue crab but unfortunately this approach will not work on Cancer pagurus. The resulting meat from the process is in the form of lumps rather than small fragments and is relatively free of shell. It need not be treated with water or brine to remove the shell and even if it is, as the meat is in lumps, the flavour is not readily lost.

In the UK, at a relatively early stage of factory processing, processors did introduce a degree of mechanisation by using compressed air blowers to remove white meat from the body and small legs. This was mainly in the south west of England where crabs are relatively large and, therefore, easily handled, although compressed air was used in the Shetlands at a fairly early stage too. It should be noted that the use of compressed air results in an aerosol and has been associated with respiratory disease. Any future plans to use compressed air should only be put into effect after consultation with and clearance by the DHSS, Health and Safety Executive.

Additionally, the Paoli meat bone separator has been used to extract body white meat to be bulked with the brown meat for use in pastes and spreads.

By early 1970s it was obvious that some other means of mechanical separation was necessary for Cancer pagurus, demonstrated by the fact that processors were by then only utilising the brown meat and the white meat from the claws. The body cores and small walking legs were being discarded. At the same time processors were finding great difficulty in remaining profitable and it was thus highly desirable that more of the white meat from the crab be utilised. At this point Torry, with the help of the US National Marine Fisheries Service, surveyed the equipment then available and found that a modified solid bowl decanting centrifuge, the Bird Centrifuge, which had been developed for several US species, would work on Cancer pagurus. The Bird Centrifuge had not been widely adopted in the USA due to the success of the roller method for soft-shelled species and the fact that hard-shelled species are not very important in the USA.

3.2.1 The Bird Centrifuge (The Bird Machine Co., South Walpole, Mass, USA)

The Bird Centrifuge (see Figs. 2 and 3 overleaf) utilises the principle that in strong brine, the meat and shell separate, the shell sinking while the meat floats. This principle had been used in early crab processing systems in the USA and the Bird Centrifuge was intended to be an advance giving speedier separation than occurs passively, with less chance for exposure to brine so resulting in a better eating quality.

The red centrifuge (see figs. 2 and 3 overleaf) utilises the principle that in rotating brine, the meat and shell separate, the shell sinking while the meat floats. This principle has been used in early crab processing systems in the USA and this pilot centrifuge was intended to be an advance giving separation more quickly, with less chance for exposure to brine so resulting in a better eating quality.

3.2 The Pilot Centrifuge
(The Laird Seeding Co., South Walpole, Mass, USA)

In the UK, at a relatively early stage of factory processing, processors did introduce a degree of mechanisation by using compressed air blowers to remove white meat from the body and small legs. This was mainly in the south west of England where crabs are relatively large and, therefore, easily handled, although compressed air was used in the Shetlands at a fairly early stage too. It should be noted that the use of compressed air results in an aerosol and has been associated with respiratory disease. Any future plans to use compressed air should only be put into effect after consultation with and clearance by the HSE, medical and safety executive.

Traditionally, the hard meat bone separator has been used to extract body white meat to be bulked with the brown meat for use in pastes and spreads.

By early 1975 it was obvious that some other means of mechanical separation was necessary for Cancer pagurus, demonstrated by the fact that processors were by then only utilising the brown meat and the white meat from the claws. The body cores and small walking legs were being discarded. At the same time processors were finding great difficulty in remaining profitable and it was thus highly desirable that more of the white meat from the crab be utilised. At this point Torry, with the help of the US National Marine Fisheries Service, surveyed the equipment then available and found that a modified solid bowl decanting centrifuge, the Laird Centrifuge, which had been developed for several US species, was the most suitable. The Laird Centrifuge had not been widely adopted in the USA due to the success of the roller method for soft-shelled species and the fact that hard-shelled species are not important in the USA.

3.2 The Pilot Centrifuge
(The Laird Seeding Co., South Walpole, Mass, USA)

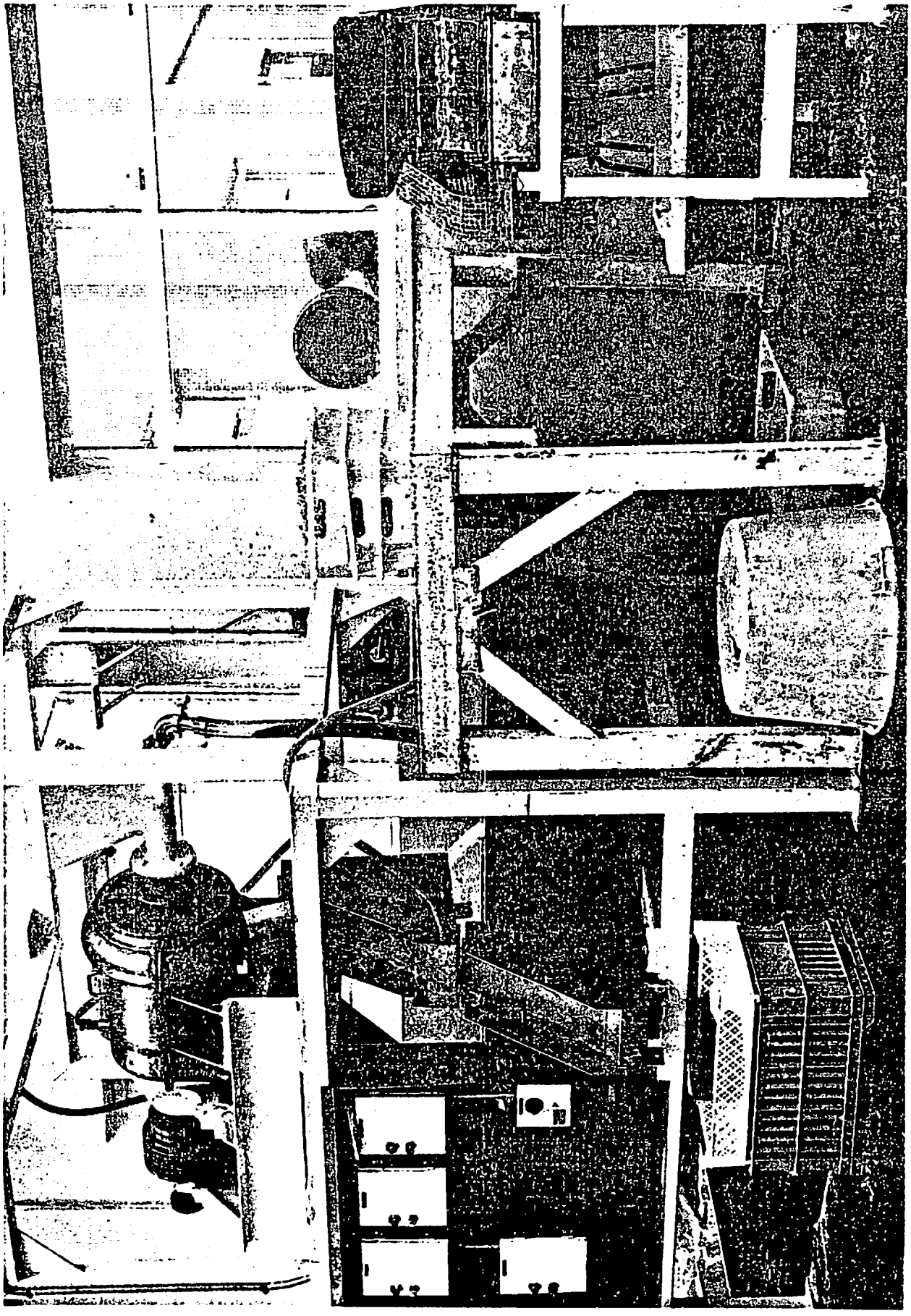

Fig. 2 Photograph of the Bird Machine

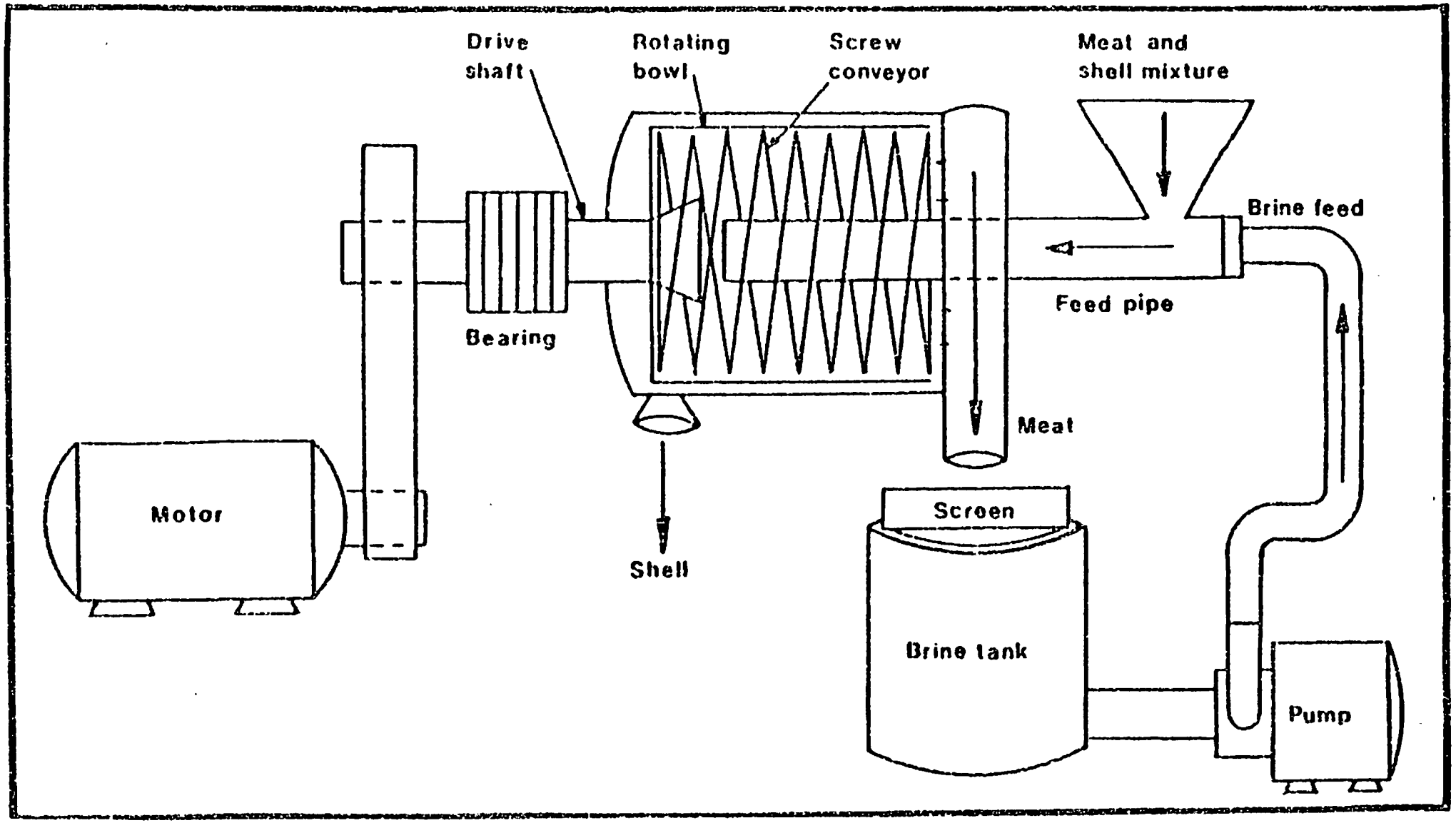

Fig. 3 Schematic of the Bird Machine

The method of working is firstly to clean the crab sections for separation. The legs are merely washed but the bodies require more labour since all residual brown meat and the various appendages, including gills (dead men's fingers) and flap must be removed. If this is not done they will float over with the meat. The need to hand clean is a definite disadvantage of the Bird system but cleaning could be mechanised. Whilst the Bird Centrifuge will cope quite adequately with claw meat separation this is not recommended as meat quality would be lost from this premium material. As it is a floatation technique the Bird Centrifuge should be regarded as a recovery technique for meat that would be otherwise discarded.

Prior to being fed into the centrifuge the cleaned crab sections, from which white meat is removed, are comminuted in an ancillary piece of equipment, the Fitzmill, which forms a part of the Bird system. The comminuted crab is then fed into a hopper and enters a stream of continuous circulating brine of approximately 15% concentration. It was found at Torry Research Station that a sugar/salt brine consisting of 8% sugar and 8% salt gives equally good separation but a less salty flavour. The brine with comminuted crab flows forward into the centrifuge and is flung by centrifugal force against the bowl of the centrifuge. The meat and shell separate at this point, the shell sinking and the meat floating in the pool of brine held against the wall of the centrifuge. As this occurs the brine, shell and meat are transported by a screw conveyor to the exit points of the centrifuge. The meat with the brine flows over a series of weirs in the end wall of the centrifuge and the shell passes out between inner (moving) and outer walls of the vessel. The meat and brine are then separated by a wedge-wire screen which forms a part of the system. The meat is then washed on a second wedge-wire screen to remove excess brine. The brine passes through a filter and back to the reservoir for reuse.

In a properly set up system the comminuter would be set over the hopper of the centrifuge and the crab sections transported after cleaning to the comminuter by conveyor. In fact in the two systems in use in the UK this has never been done so that throughput is reduced significantly. The machine is then fed at the rate of around 363 kg per hour for a maximum of 2 hours. The working period is set at the maximum of 2 hours in order to ensure satisfactory microbiological quality but in

any event it will be found that the brine will need renewal after this period, if not before, due to dissolved solids build up affecting performance. The brine also requires replacement as it is lost during processing. Again to maintain throughput and reduce down-time it is sensible to have a second batch of brine in a reserve tank ready for use after the system has been cleaned. If this is the case the lost processing time can be as short as 15 minutes. Note that dissolving salt is a fairly time consuming job. Whilst the extracted meat is drained by the wedge-wire screen, additional moisture must be removed; this has normally been done by pressing by hand but could be mechanised (and thus standardised).

In stating yields given by the Bird Centrifuge it is assumed that the system would only be used to recover white meat from the walking legs and body. Used in this way it can be expected to recover up to 3% from the legs and 7% from the bodies, both calculated on the basis of the whole raw crab weight, that is a total if processed together of up to 10%. If it is wished to recover residual meat from the claws after hand picking, a further 1% can be expected to add to the 8% claw meat recovered by hand.

The textural quality of the recovered meat is good, being described as flaky, but not chunky, as given by hand picking. The characteristic flavour is substantially lost but remains slightly crabby. If a sugar/salt extraction medium is used it is not excessively salty. The centrifuge, when properly used, gives a more or less shell-free product.

The cost of the Bird Centrifuge alone is £20,000 - £30,000. The ancillary equipment adds substantial further costs.

3.2.2 Bead System (Bead Engineering Co. Ltd., Kings Lynn, Norfolk, UK)

The Bead system (Figs 4 and 5 overleaf) utilise the same principle as the Bird Centrifuge, that of flotation. The difference, however, lies in the fact that brine is unnecessary as the separation is effected by bubbles of compressed air introduced into the separation medium which can be plain water. In practice a weak brine, 2.5 - 3%, is often used to improve the flavour. As flotation is used it is recommended that the Bead be employed, like the Bird, as a recovery system.

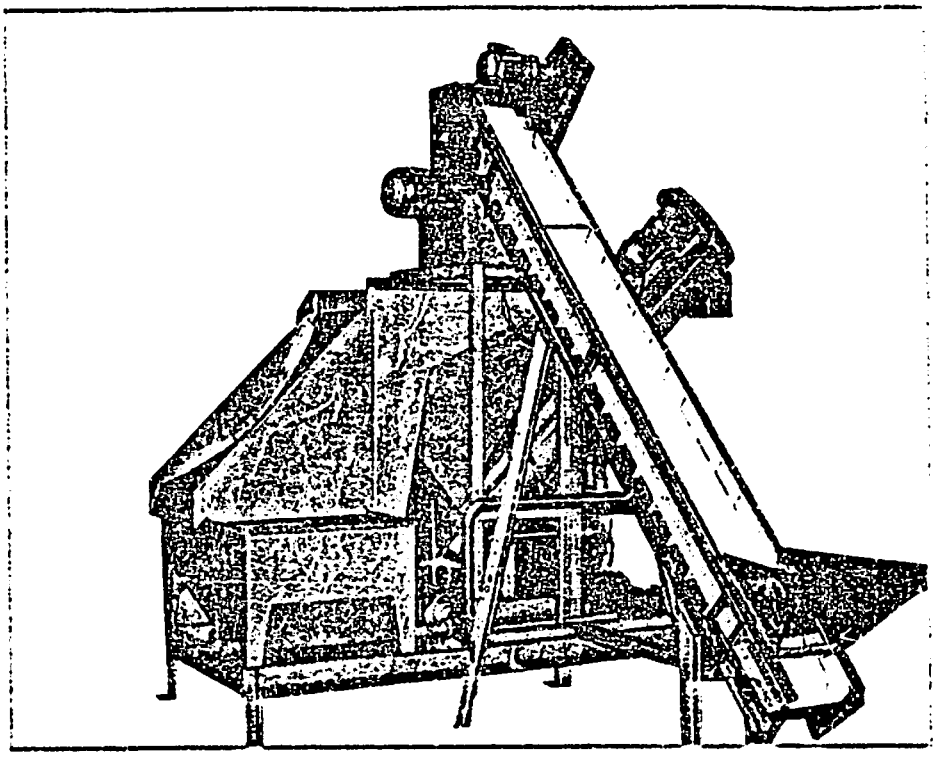

Fig. 4 Photograph of Bead Machine

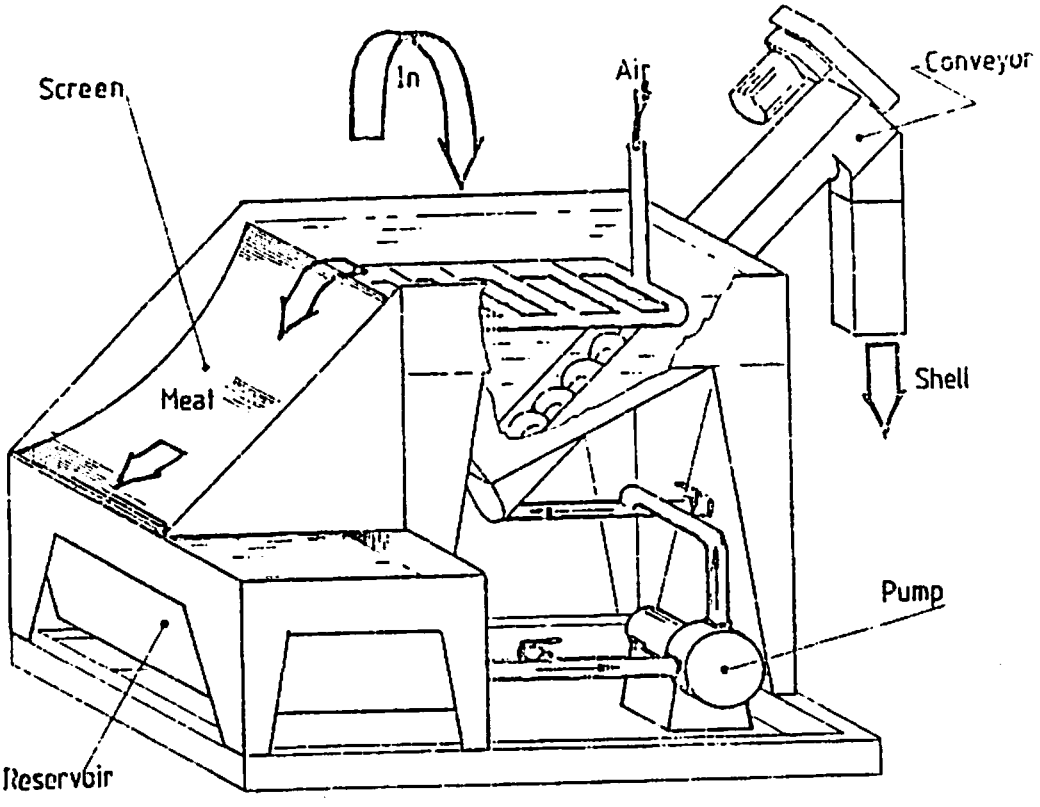

Fig. 5 Schematic of Bead Machine

Many aspects of operation are very similar to the Bird. For instance the sections of crab to be separated must first be cleaned and then comminuted in a similar device to that used in the Bird system set over the separation tank. The comminuted crab drops into this, the shell sinking and the meat floating buoyed up by bubbles of compressed air introduced at various points in the separation tank but mainly by a pipe array set about 10cm below the surface of the fluid in the tank. The system incorporates a reserve tank of separation fluid and this is pumped continuously into the separation tank which therefore overflows over a wedge-wire screen, taking the meat particles with it. The meat remains on the screen and is drained; the fluid passes through the screen back into the reserve tank. The shell is removed from the bottom of the separation tank via a screw conveyor.

The method of working is to clean the crab sections and pass them into a hopper from which they are transported by conveyer to the comminuter. The rate of feeding can be up to 272 kg per hour for up to 2 hours. As with the Bird the 2 hour working period is given to guard against excessive bacterial build up but will probably be found to be more than enough since dissolved solids build up reducing the separation efficiency. When this happens excessive shell will start to pass onto the wedge-wire screen. After this period the whole system must be washed through and refilled but since no strong brine is involved this is a simple operation not requiring a reservoir of premixed separating fluid.

As the Bead device is a recovery system it is recommended that only legs and body cores be processed. The yields given are very similar to the Bird. In trials using cleaned legs and bodies still attached yields of up to 35% were obtained. This is equivalent to almost 10% of the whole raw crab. It is not recommended that claw meat be extracted by the Bead but yields can be maximised by extracting the waste from hand picking, just as with the Bird, and a similar yield can be expected.

The textural quality of the meat recovered by the Bead system is similar to that given by the Bird but the flavour is obviously less affected by the separation medium. As a flotation system is used the crabby flavour is substantially lost, once again.

A drawback with early Bead machines was the possibility of excessive shell in the meat, especially in longer production runs. A modification, which can also be easily applied to older machines, has now been made which overcomes this problem.

The cost of the basic Bead equipment is £10,000, although ancillary equipment, such as the comminuter, adds further to the cost.

3.2.3 Equipment Manufactured by Charlottetown Metal Products Co. Ltd., Prince Edward Island, Canada

The equipment made by CMP is wider in scope than that already discussed. It comprises:

1. A cocktail or barbecue claw cutter

2. A leg meat extractor

3. A recovery system similar in scope to the two systems mentioned above.

The cocktail claw device has been modified from one designed for Queen crab (Chionoecetes tanneri). The leg meat device has been recently designed and built to remove lumps of leg meat from Queen crab and looks as if it may work with Cancer pagurus without modification. Little information is publicly available on these devices, although an example of the cocktail claw device is working already in this country. The cost of the claw cutter is around £10,000; the leg meat extractor is priced at £22,000.

The third device, the recovery system, works on a different principle from both the Bead and Bird systems. For Cancer pagurus the crab sections would be cleaned as before. Queen crab being a soft-shelled species is put through a roller device as previously described in Section 3.2. This procedure apparently works for the body cores of Cancer pagurus but the small legs may still have to be comminuted. The mixture would then be fed into the main part of the system which is a perforated stainless steel cylinder about 4 metres long and over half a metre in diameter. This rotates and the pieces of crab meat are washed through the cylinder by jets of water issuing from a supply pipe running down the centre of the cylinder. The shell remains within the cylinder and is expelled from the end. The meat, having passed through the cylinder perforations, goes to

a vibratory sieve to remove any remaining pieces of shell and then to a dewatering sieve. This apparatus has not been checked on Cancer pagurus but is expected to work as well as the two previous systems giving similar results in respect of texture, flavour and yield. It may give a better separation with respect to shell fragments, but it must be emphasised that this has not been proven for Cancer pagurus. A relatively high throughput is claimed of around 4 tonnes/hour of raw material. The cost of this equipment is approximately £30,000.

3.2.4 Future Development in Meat Removal

Although there have been substantial advances in mechanical meat removal in recent years, allowing the yield of white meat to be doubled, it cannot be denied that the product given is inferior to hand-picked meat. The textural quality given is good but the flavour is lost. In spite of this fact the meat can be utilised but in a separate range of products from hand-picked meat. Ideally meat removal would be accomplished 'dry', that is without flotation in or transportation by fluid, and would give lumps of meat rather than flakes, without flavour loss.

The CMP claw cutter and leg meat extractor do this already but what is required is a device to remove white body meat from Cancer pagurus.

There are several development programmes which may result in the 'dry' extraction of such meat but at this stage it is too early to comment on the possibilities of success. Since the body of the European edible crab contains almost as much high quality white meat as the claws the importance of success cannot be over-emphasised.

APPENDIX III

A PROFILE OF THE UK EDIBLE CRAB INDUSTRY AND CONSIDERATION OF ITS MARKETS AND THEIR DEVELOPMENT

Author: Libby Pell (SFIA)

APPENDIX III

A PROFILE OF THE UK EDIBLE CRAB INDUSTRY AND CONSIDERATION OF ITS MARKETS AND THEIR DEVELOPMENT

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1 INTRODUCTION

All the major crab producing areas were visited in 1984 and a large number of catchers, processors and merchants interviewed. From this a composite picture of the industry has been drawn, that picture being sub divided into the separate fisheries of the South Coast, the English East Coast and Scotland. The profile of each area includes a brief historical perspective and the current state of the industry in terms of stocks, catching, processing and markets.

From this standpoint and particularly in relation to market dynamics, both in the UK and abroad, an assessment of the development possibilities has been made, with a discussion of the potential and the limitations, in terms of the supply situation, developing processing methods, and the likely nature of future markets for crab products.

There is little hard data available on many aspects of the industry (e.g. absolute stock levels in the various fisheries, total quantities of the various products produced, etc.), but the data presented and discussion of that data is broadly based on observation and the views of those within the industry.

2 A PROFILE OF THE UK CRAB INDUSTRY

2.1 The South Coast Fisheries

The South Coast Fishery has been developing over the last thirty years, and is at the moment the most productive and dynamic crab fishery in the United Kingdom. The fishery has been matched by equally dynamic and progressive selling and processing businesses. The reasons for this are various, but major influences have been the development of the market for frozen crab meat, the large areas that are now covered by the fisheries, and the influence of the Channel Island fisheries which in turn are influenced by French fisheries and markets. It is likely that in terms of volume of crab landed, the fishery has reached its peak as increased fishing effort in recent years has not shown a comparable increase in landings.

Over the period of development the catching capacity has increased, and now the catching fleet is made up, for the most part, of modern well equipped vessels that need to have adequate returns for the high capital investments incurred. This has been possible because of the developing markets, especially the Continent, and the extension of the working grounds offshore. However, recent years have seen an increase in catching effort which has only slightly increased the level of catches - this is true of the South-West particularly. It seems that the people who catch the crabs are concerned that the fishery is being exploited at a level which is not sustainable, and are pressing for further conservation measures. The people who buy and process the crab however are not apparently greatly concerned about stock levels. They seem to be able to buy what they need at the moment, and if they need more crab, can buy from areas further afield now transport systems are more efficient. This fishery which is fully exploited does seem to yield a consistently better quality crab than an area which is over-populated, and under-exploited.

The buyers in the area cater for a wide range of markets. These include traditionally-based companies that supply live or fresh boiled crabs to the inland wholesale markets, and handpicked meats for the frozen food trade. Most companies are more diverse than this, selling live to the continental markets (in conjunction with other crustaceans) and producing cooked vacuum packed pasturised whole crab for the Swedish market, fresh and frozen meats for local tourist demand, and frozen meats to a variety of buyers for wholesale retail and the catering trade.

The organisation of supply seems to be well regulated (over the season if not in the short-term), and the processing facilities are well established and most are developing. The major buyers have holding facilities and well-organised live transport, and the major companies have explored and are developing the more obvious continental markets.

It is interesting to note that several of the more forward-looking companies are now buying in stock from other catching areas in an effort to diversify their supply base and therefore regulate their supply and extend their season.

The South Coast fishery has the advantage over other areas in that it is closest to the continent. It now has a well established trade with the continental markets, with efficient distribution and a beneficial working knowledge of the French and Spanish markets. This has developed in recent years and is now the most important part of the major buyers' trade. The outcome of these demands on the catching sector is a higher price paid to the fishermen than elsewhere in the UK.

The limits to growth of this fishery are twofold. It now appears that the stock is fully exploited, if not over-exploited, and the industry will be naturally limited by the inability of the area to yield a greater catch level. However there is the external influence of the limited size of the market for crab and crab products. Although this has been developing overall, the major influence in recent years has been the continental markets. As this is only likely to develop at a gradual rate, any influx of large amounts of cheaper crab onto these markets are likely to have a damaging effect on the South Coast fishery. Unfortunately this is outside the control of those involved in the area.

There is an encouraging feeling that businesses here are aware of the constraints and are looking to diversify their product base as a way of stabilising the situation and increasing the returns from the raw material.

2.2 The English East Coast Fisheries

From being by far the most important crab landing area in the country thirty years ago, the fishery has gradually become less important. This is partly due to the increasing importance of the South Coast and now Scotland, but the fishery has declined substantially in real terms as well.

The largest single factor to influence the decline was the transition from the small coble to larger boats capable of trawling in the late 1960s. Since then fishing for white fish has been more profitable than potting, and the number of boats engaged in the crab fishery has diminished substantially. The processing activity on the East Coast has declined and is rudimentary and there has not been a growing demand for crab, in contrast to the South Coast.

The method of fishing has limited the fishery and the areas exploited. The fishing grounds are limited to 3-4 miles off the coastline, and fishing seems to be limited to small areas within this. For example with the traditional small open boat it is a five hour steam from Bridlington to the best fishing grounds at Withernsea. Potting is physically hard work compared to trawling, and as the markets are underdeveloped and prices low, there is not much encouragement to the fishermen to develop the catching side. It is felt that the present grounds are fully exploited, but it may be the case that on more distant grounds there is potential for development of the fishery.

The major markets for the North-East crab are the inland wholesale markets, to which the crabs are usually sent live or fresh boiled. This has been a steadily declining market for some years, especially since rail links were reduced. Crabs are dressed for a local tourist trade in the season, but generally only the crippled crabs are processed in this way even though there appears to be a good demand for the product.

The East Coast fishery seems to be limited by tradition, and on the whole the industry has not sought out new markets as the traditional ones decline. There are exceptions however; on both the Yorkshire coast and the Norfolk coast there are processors who are aware of the trends in developing markets for crab products, and are working to develop and diversify from their present limited (though high class) trade, into a wider range of products that will include prepared products. In Yorkshire there is also an active P.O. which has encouraged the diversification of sales. Crab is now sent through to the South-West, (where better prices can be obtained) and vivier facilities are being built at Scarborough. This will enable crab to be held over to regulate supplies to the British Markets, and also enable it to be held for the live trade to continental markets.

2.3 The Scottish Fisheries

There are a few major buyers of crab in the area. These have been established for some time but have only recently started developing the crab fishery seriously. The most important fisheries in the past have been Nephrops and lobsters, and only recently has crab been considered worthy of greater exploitation.

In the last ten years the Scottish crab landings have risen considerably whilst the English and Welsh landings have remained fairly static in total.

People have begun to see an increased effort in the crab fishery as a good thing to aim for to balance the whole of the shellfishery i.e. to take some pressure off the prawn and lobster stocks. However there is an added problem in Scotland, in that there seem to be greater difficulties experienced with the management of the static gear fishery. Creel fishermen have been suffering worsening losses from the effects of trawling. There is new legislation to help protect the static gear areas but, as yet, the ways of using it have not been decided. Until this problem is resolved satisfactorily the fishery cannot be developed properly.

The fleet that prosecutes the crab fishery is that which fishes for lobsters and Nephrops. It is very varied, some of the boats being large converted trawlers, others being small (although often well equipped) with added facilities to aid pot handling. Recently there has been the significant addition of a modern vivier boat, bought

from the Channel Islands, not to fish, but to transport crab and lobster live from the Western Isles to the mainland for distribution.

There is no local market for crab. It is thus either sent to processors elsewhere, sent live to Continental markets, or processed and sent out frozen. One major buyer in the Orkneys has concentrated his business entirely on the French market for claws and brown meat, discarding the bodies and legs altogether. Another buyer has researched the Continental market and built up an intimate working relationship with one or two companies in a few countries, and over a period of years has developed these successfully. This is leading to the addition of processing facility for next season and also holding capacity for live crab. There seems to be an important foreign influence on the industry as a whole in Scotland, with the provision of Continental transport and capital investment from abroad in local companies. There is also incentive for development through agencies such as H.I.D.B. and I.D.P. which can provide low cost capital loans and grants for new developments.

However, there are only limited outlets for processed products. Several ventures have already collapsed because of a lack of knowledge of the market situation, as well as a fluctuation of supply. Youngs factory at Inverbervie was closed this year, and this was by far the largest buyer of crab in the area. This has had an affect on the market, but not as great as might have been expected. A new major buyer, Sheerwater, has taken up some of that production. There are worries for next season however, as various new West Coast co-ops are committed to selling their members catch - bringing extra catching capacity into the industry, and the fishermen on the East coast will be looking for new markets themselves.

There is no doubt that the stocks are there for a great development, and probably the quality of the crab will be improved by sustained fishing. The Scottish fishery seems to be at a crucial stage at the moment, with the uncertainties of an undeveloped and inelastic market for the products leading to anxieties for the economics of the fishery.

Sound development is taking place where individual companies have developed their own markets. Companies from other areas who have a long experience in wide markets are also poised to develop their activities from a Scottish source of production, because of the large stocks and cheaper raw material.

At the moment Scotland lacks the most basic requirement for modifying and regulating supply i.e. holding facilities. There is little local processing capability, and even less marketing experience, and suddenly everyone is suggesting that the Scottish fishery should be developed, not least the fishermen.

3 THE MARKETS FOR CRAB AND CRAB PRODUCTS

3.1 Product Types

3.1.1 Live Crab

There are good markets in France and Spain for live brown crab. Unfortunately, due to frequent over supply, glut situations are common which serve to depress the price and make it difficult to achieve a good return. Also there are considerable variations in the standard of the vivier transport leading to excessive mortality rates.

Other foreign markets may be available, but little work has yet been done to explore this possibility.

3.1.2 Fresh Boiled Crab

This is a traditional market, locally, and through inland wholesale markets. It is a declining market, and is likely to continue declining as the trend of demand for whole crab seems to be diminishing generally.

3.1.3 Fresh Dressed Crab

The demand for dressed crab has increased in inverse proportion to that of whole crab. Locally and on the inland markets, demand outstrips supply. The people supplying this product seem to do it only as a sideline, often as a way of getting rid of crippled crab. They say the effort and labour costs involved make it an unwelcome job and none of them are willing to try to develop a supply for this growing potential market.

3.1.4 Frozen Crab Claws

There is always a greater demand for this product than any other part of the crab, both here and abroad. Some processors sell only claws and brown meat, which seems a decided waste. There is a feeling that it would be easy to develop this market, although it has been said that this is also a finite market, and can be over-supplied.

3.1.5 Frozen Hand Picked White Crab Meat

There is a traditional demand for this product both for retail and catering uses; it appears to be a limited market however and although some of the large frozen food shops have sold it, the demand does not seem to have grown. This is surprising as, if vacuum packed, this is a top quality product which is ready to use.

3.1.6 Frozen Brown/White Crab Meat Packs

A 50% pack is the most common form of presentation. It is mostly sold to the catering trade and again demand appears to be static.

3.1.7 Frozen Brown Crab Meat

This is not sold on its own except for processing into pastes, pates and soups. The market is stable if not growing. The price is low. There is the possibility of a greater demand on the Continent, especially Germany.

3.1.8 Frozen Recovered White Crab Meat

There is as yet a very limited market for this product. The largest processors use it in their value added products. There appear to be as many different qualities of this as there are places which produce it. It does not have much flavour and needs to be put into a further processed product. Very few people seem to be doing this at the moment, although several people who have recovery machines are intending to go into some kind of prepared food production in the near future.

3.1.9 Vacuum Packed Pasteurised Whole Crab (Fresh and Frozen)

There is a good market in Sweden for this product, but only at a certain time of the year. This market has been developed and demand is now satisfied by producers in this country.

The Spanish market is also taking growing amounts of a frozen whole product. It is thought that there is room for growth in this market.

3.1.10 Brown Meat

This finds only a low value market for on-processing into pastes and soups.

3.2 Supply and Demand

Fishing for crab can be done with small boats and simple equipment. The level of development from this depends on how advanced the businesses are who buy crab in any particular area.

South-West boats are larger, faster, better equipped, travelling often 20-30 miles away from their home port and they service far more creels than their Scottish or East Coast counterparts, which generally fish within a few miles of base. They fish for the Continental market, which imposes high specifications, and as a matter of course, take care of their catch as it has to be in prime condition for the live trade. The Scottish and North Eastern boats do not have this reputation, being paid poorly for anything they land. Traditionally in Scotland the catch has been handled badly both on board boat and in distribution, and because of the poor prices paid, it has been a fishery which has been resorted to only when there is nothing else better. Much of the poor reputation of the crab in Scotland has been due to bad buying practices over a period of time. Now however the live trade is developing and buyers for processing are also imposing higher specifications. This means that the fishermen in turn are becoming more selective, taking care of their catch. This is resulting in the whole stature of the fishery being raised, and it is becoming widely accepted that the quality of the crab is as good as that from other areas. The provision of holding facilities for crab in Scotland must be the most important development that needs to take place before supply can be regulated.

Whatever happens in the Scottish fishery over the next few years may well be pivotal as regards the entire UK crab industry. There is likely to be a production, rather than market, led fishery and gluts in supplies that are possible could disrupt the fragile market structure that exists at present.

It is likley that in the near future there will be a substantial growth of production, and although there are some positive signs of a growth in orders, it is likely that there will be a substantial over supply during the best catching periods in June*. As a small over-supply causes a dramatic glut of the market, an over-supply of up to 25% over this period could have serious consequences for the rest of the season. Even if the processing is limited to the production of claws and brown meat, the market will not be able to cope.

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* Poor landings, probably due to poor weather, has meant that this forecast of over-supply has not happened by report publication.

Processors having invested in recovered crab-meat machines have not found markets for the product in 1984; even the largest processor/distributor is stockpiling the product. Small processors cannot afford to stockpile in this way, and it could cause serious difficulties if the situation is carried through into next season.

3.3 Market Assessment

Table 1 overleaf shows the quantity and value of UK crab supplies, including imports and exports in 1982. Table 2 shows the value of UK household consumption of fresh crab in 1983 and the percentage of households purchasing (which is very low).

In the UK the demand for whole crab and primary crab products is declining. The export market for live crab and crab meats is expanding slowly, with many hiccups on the way. It seems likely that this trend in exports will continue, and could be accelerated if the right marketing attitude is developed, and the improvements in handling of live crab continue.

Potential demand for processed products seems to be large, yet there seems to be an unwillingness on the part of most processors, using traditional hand-picking methods, to satisfy or develop this. This is difficult to understand as there is not such an overwhelming demand for whole crab.

There is obviously scope for development into new market areas, and a few processors are gearing themselves up to develop their production to take advantage of the opportunities. If high enough quality specifications are set, then there is every reason to believe they will be successful.

The product that is known within the trade to be in demand is simple dressed crab - either in the crab shell, scallop shell or a plastic substitute. There seems to be a universal attractiveness about this product, and yet very few people are willing to supply it in quantity.

	Tonnes	£'000s
Landings in UK	8,567	4,246
Imports (Fresh & Frozen)	23	99
Total Supplies	8,590	4,347
Exports (Fresh & Frozen)	3,819	4,465
Imports (Prepared & Preserved)	1,572	5,811

Table 1

Crab Supplies (Including Imports and Exports) in 1982

	Value £'000s			%'age of households purchasing		
	Whole	Other	Total	Whole	Other	Total
1st Qtr.	97.1	218.6	315.6	0.2	0.6	0.7
2nd Qtr.	450.5	289.8	740.2	1.0	1.1	2.0
3rd Qtr.	422.3	413.8	836.1	0.9	1.4	2.2
4th Qtr.	186.5	209.5	396.0	0.4	0.9	1.2
YEAR	1,156.4	1,161.7	2,287.9	n.a.	n.a.	n.a.

Table 2

UK Household Consumption of Fresh Crab in 1983

There is a real potential to expand the markets for processed crab products, to the great benefit of the individual company and the industry as a whole. The key to success in this area is the very high specifications which must be attained and maintained for the multiple retailers, etc.

THE DEVELOPMENT OF THE INDUSTRY

4.1 Development Trends

As the market for whole crab and primary crab products in the UK and Europe is limited, then any expansion of one fishery is likely to be at the expense of another. Unless significant new markets or new products can be developed, any increase in catching and processing will only result in increased competition, lower prices and a worsening glut situation.

Crab meat production has always been labour intensive. The brown meat is separated from the shell with relatively little labour in comparison to the white, but the white meat has a far higher value pound for pound than the brown, and usually the profitability of an operation hinges on this item. The yield from the crab of white meat affects the type of operation which is set up. The South-West processors pay a higher price for their raw material, however they remove as much of the meat as possible to try and compensate for this. In Scotland usually only brown meat and whole claws are produced and a high percentage of the white meat is thrown away unpicked in the body and legs. This kind of operation cannot pay as high a price for its raw material, but can cope with a higher throughput than a yield intensive operation. Obviously the operatives and quality control set up must be more sophisticated if legs and body meat are to be removed.

These factors have led to some sort of stability in the industry for several years, the South-West processors having to compete with the vivier operations for the raw material paying a higher price. Because of the higher raw material costs, they must produce maximum yield of brown and white meat to obtain an adequate return on capital employed. The Scottish buyers have had little competition in the past for the raw material, as transport costs and the primitive organisation of distribution have made live transport largely uneconomic until very recently.

As we can see the paths of the crab industry in the areas have diverged. The East coast is in decline, serving only inland markets, the national markets for hand-picked meats being satisfied by the South West and the claws market being satisfied by the Scottish fishery. Both areas sell brown meat to the soup and paste industries.

The demand for crab is inelastic, being only marginally sensitive in price changes. The new machinery to recover crab meat is now available and in use by a significant number of processors. This machinery extracts white meat from the claws and/or legs and body at high speed and with little labour cost in comparison to hand-picking. The product is of poor quality compared to hand-picked meat, however it is white crab meat and can be produced in large quantities.

Now there is a new primary product from the crab industry. Where will it fit into the market?

It could be put into the existing market for crab products. Consideration of the possible affects this recovered crab meat could have on present markets gives cause for great anxiety. If there is no increase in demand, then because of its lower retail price the recovered crab meat will become a low quality substitute for hand-picked white meat, severely affecting the market structure. Unless new markets are found for recovered meat this is a likely situation, so further consideration is necessary of what affect this situation could have on the overall market for crab.

As the market demand for crab is not price sensitive any increase in supply in the market will soon produce a glut. As the return on capital employed is now the main criteria for measuring the success and profitability of a company, it is very unlikely that the glut will be held by the processor. Therefore the products will be offloaded onto the market. A reduction in price will not lead to a great increase in demand, the reduction in price by one processor will only mean his product will be bought in preference to his competitors.

In such a situation processors will have to decide whether they wish to compete in this market. If they do then they will have to sell their product as competitively as possible in the short term, hoping for survival and eventual long-term gain. Hand picking operations have far higher costs than machine extracting operations, so apart from the part of the market that will not accept any reduction in quality of crab meat sold, all other processors will either have to go into other types of processing, or get a meat recovery machine. Where remaining firms have machine extracting facilities, then the throughput of the machine will affect profitability. The supply of crabs is largest in the South West and Scotland so these are the two areas where processing facilities are likely to be the most successful.

Of the two areas, the South-West has lower distribution costs, but the cost of raw material is higher. Also higher costs are incurred per unit of raw material by the South-West boats due to their lower catch rate per unit effort, and their higher fixed costs because of the more specialised and expensive boats of the fleet. Thus it would be impossible for them to produce raw material as competitively as the Scottish boats.

It would appear likely therefore that the emphasis for processing facilities will change to the Scottish area, whilst the South-West will become more dependent on the vivier operations to the Continent for its future. Inevitably as a result of losses because of fierce competition, the industry would become more streamlined and efficient.

This scenario is obviously pessimistic, being based on a static demand; however the potential for growth into new products and new markets could alter this gloomy forecast drastically.

4.2 New Products New Markets

A few companies are making value-added processed crab products already. These are widely accepted in the best multiple retail outlets. These processors and the retail managers feel there is potential for growth into this area, as supermarket chains are seeking to increase their luxury product ranges. There is a greater demand these days for finished food products, as can be clearly seen in the products presented in any supermarket.

There is also a feeling that there may shortly be a gap in the market for a product similar to breaded scampi, for retail and catering sale. This could come about if current MAFF investigations into the content of scampi products lead to the enforcement of stricter guidelines. Some of the practices which enable very cheap scampi products to be put on the market could be stopped, and the inevitable result would be a more expensive as well as a better product. This would leave a gap in a very price sensitive market for a cheaper substitute of some sort. A similar product made from crab meat could be just what the catering trade will be looking for. If a product is developed and accepted it could mean a volume market for processed crab meat.

If a market were developed for processed crab products then the benefits to the crab industry would be substantial. Processing could be done on a regular basis throughout the year. If there were gluts in supply then these could be absorbed by primary processing of the meats, and storing these for further processing when fresh crab is not available.

Because the option of processing is available, then the quality of crab sent to the live markets could be improved by vigorous grading. If there was a levelling out of gluts of supply to the fresh and live tradess, these markets could be developed gradually to give a better return. Suppliers could choose when to increase supplies to the markets to gain optimum prices.

If there were an increased yield from the raw material by the mechanical recovery of white meat, then the total cost of all meats produced including hand-picked meat would be reduced, thus giving the processor a greater return.

From research on this occasion, and from general experience, the greater the diversification of production and markets, the more stable the overall position of the business is likely to be.

It is still likely if this development were to take place that the greatest growth of the crab industry would be in Scotland. This is because of the cheaper and more plentiful raw material, but if there was a strong market for processed crab products, then this would not necessarily be at the expense of the Southern fishery. It could mean a real development in the whole of the crab industry.

4.3 Meat Quality

It is crucial for the development of the prepared crab products, that the quality of the basic raw material of a consistently high standard whether it is hand, air or machine extracted. To develop a market the product must be able to compete with other comparable foodstuffs, and the area where the greatest development is possible is where the most stringent quality specifications are applied. This should be seen as a great opportunity, even if problems have to be solved to achieve the standard set.

The considerable variations seen in the quality of recovered meat are cause for concern. It appears that in commercial practice the recovery machines and/or their ancillary equipment are either sensitive or are being misused.

It is recommended that the SFIA investigates this problem and carries out development or produces specifications for machine operation and product quality as required.

4.4 Promotion/Marketing Effort

If effort is put into promoting crab, it is important that it is channelled into the most productive areas. It seems obvious that marketing input should be in the area of processed crab products. The main reasons for this are outlined below:

Whole Crab

1. If the sales of whole crab were promoted then it would be attempting to reverse a long-term trend of decline in demand for this item.

2. Even if it were possible to increase the sales of this product it would be likely only to be a short-term gain, unless a long and substantial sales campaign were set up.

3. If sales were increased, it would do nothing to develop the stability of the industry, as it would only continue the present structure and seasonal activity, and would not promote a modernisation of approach.

Processed Crab Products

1. Promoting processed products would be seeking to enter and develop an area of foodstuff production which is a dynamic growth area.

2. The development would have long term ramification. Development of the processing capacity of the industry would involve a quality improvement as well as technical modernisation.

3. Encouraging a move into this kind of market would hopefully lead to an overall stabilisation of and increased profitability for the crab industry.

4. Entering the market for these types of product will open the way for greater future developments and diversification.

5. The exercise is likely to be much more cost effective in terms of the value of the markets developed.

APPENDIX IV

THE DEVELOPMENT OF A RANGE OF ADDED VALUE PRODUCTS UTILISING RECOVERED CRAB MEAT

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THE DEVELOPMENT OF A RANGE OF ADDED VALUE PRODUCTS UTILISING RECOVERED CRAB MEAT

1 INTRODUCTION

In 1983 the SFIA was aware of the potential for increasing the UK landings of crab and of increasing the yield of white meat from that crab by mechanical recovery, and was also aware that an expanded market must be found for the material produced, particularly for the recovered meat which has a somewhat bland flavour. At that time it was thought that the sterotyped traditional crab products, i.e. fresh boiled whole crab and fresh dressed crab, were of limited appeal to the current generation of consumers, whereas in contrast the consumption of frozen convenience and added value foods was increasing steadily. It was concluded that the development of frozen added value crab products utilising recovered meat should be stimulated.

Under sponsorship from MAFF and with the collaboration of TRS throughout the Authority contracted Youngs Seafoods Ltd. to develop a range of such products. Youngs were then processing large quantities of crab, had already installed meat recovery machinery, and had already produced a range of added value fish products (including crab thermidor which incorporated recovered meat). By contracting a major commercial processor to carry out this work the industry has benefited from the technical and commercial expertise available, and the processor has benefited from the direct experience and has gained time prior to completion and publication of the work to take up any product opportunities arising from the work .

A two stage contract was agreed with possible extension to a third. The first stage was a creative period of product development leading to the selection of several preferred products. The second stage was the production of samples of the preferred products and an assessment of their acceptability by groups of consumers leading to a further selection of the most preferred products, the selection including cost and marketing criteria. The optional third stage was to be trial production and marketing of a product or products. In the event

several promising products have been developed to the end of stage two and the contract terminated at that point, this coinciding with the major reorganisation of Youngs within the Imperial Foods Group.

2 STAGE ONE - PRODUCT DEVELOPMENT

2.1 Outline of Stage One

At Young's suggestion, the market sector to be investigated involved production of mainly high value products, but a commodity-type product was included at the insistance of the Authority. Products suitable for catering were included as well as retail sale.

Of ten initial ideas for products, five were selected for sample production as being commercially viable in production terms and able to be produced as final samples within the timescale allowed. Of these five, four samples eventually came to pilot production of samples for market research, two of the original five being too similar to be regarded as separate products.

The four products developed are:

a) Crab stuffed mushrooms
b) Crab stuffed plaice
c) Crab crepes in white wine sauce
d) Crab cake.

2.2 Initial Product Sampling and Product Concept Formulation

Products developed by TRS and commercial products from America and Japan were sampled.

The TRS products consisted of a mixture of 75% recovered crab meat and 25% minced whiting flesh or fragmented scampi flesh to bind the whole, moulded into scampi sized portions and enrobed with soft crumb. The TRS hedonic panel had rated these products at 6-7 (like slightly - like moderately) on a 9 point scale. The products were found to have a white flesh and an acceptable texture (although softer than scampi), but had a bland flavour with little evidence of crab. This lack of crab flavour in recovered meat proved to be a continuing problem in product development.

The American products were various Maryland crab cakes and crab stuffed flat fish, all utilising the flesh of the blue crab. The products proved to be of relatively poor quality, with a somewhat discoloured flesh and strong spice flavours swamping any natural flavour. The project team view was that these products could be much better. Again the difficulty of controlling flavour addition proved to be a continuing problem in product development.

The Japanese product was thought to be surimi based and consisted of a small crab claw embedded in a portion of crab flavoured flesh enrobed with Japanese crumb. The appearance, texture and flavour were considered good.

Following discussions the following list of product concepts for further development was devised:

a) Large open cup mushroom with crabmeat filling, coated in Japanese crumb.

b) Stuffed plaice fillets with crabmeat and sauce filling, coated in Japanese crumb. The fillets may either be paired flat or rolled singly.

c) Crab croquette, formed from white crabmeat with added flavours and binders, again coated in Japanese crumb.

d) Crepes with crab filling and a white wine sauce.

e) General development of crab dishes along the lines of the existing crab thermidor.

f) A pastry cornet/vol au vent/bouchee made from puff pastry with crab and avocado filling.

g) 'Steak' shaped formed crabmeat with smoked flavour and barbecue sauce.

h) Breaded crab 'dippers' in pastry with sauce.

i) Crab curry.

j) A crab cake along the lines of the American samples seen, but produced to give an improved texture and flavour.

After kitchen scale recipe development, further sampling and consideration of production feasibility and market potential this list was reduced to the following five product concepts for detailed development:

a) Crab stuffed mushrooms
b) Crab stuffed plaice
c) Crab crepes in white wine sauce
d) Crab steaks
e) Crab cake.

2.3 Development of Product Concepts

Each of the five product concepts was refined via recipe development from kitchen to production scale with regular sampling to guide that development.

2.3.1 Crab Stuffed Mushrooms

This concept was aimed specifically as a "starter" for the catering trade. The product consists of individual open cup mushrooms filled with a crab meat mixture, coated with a Japanese crumb and deep fried. Production would be labour intensive and thus high cost, but was considered feasible.

Initial sampling indicated that the eating properties of the product were good, although the mushroom flavour predominated, but that there were problems of crumb adhesion and mushroom liquor. When cut there was a tendency for the enrobing shell to split from the mushroom, and the free liquor from the cooked mushroom to escape. It was considered worthwhile to develop the product to overcome these problems.

Mushrooms have an unusual, waxy smooth skin. Starch was known to aid adhesion but excessive starch in the enrobing adversely affects its texture. The double enrobing process developed consisted of an initial quick drying cornstarch batter to improve adhesion, a pre-dust layer, a flour batter to achieve a softer eating texture and finally coarse Japanese crumb. This enrobing process considerably improved the product although not totally overcoming the problems.

The developed recipe was:

Filling - Add 61g powdered sauce mix (crab sauce mix from Witwood Food Products Ltd.) to 277ml of water and mix this with 454g of recovered crab meat.

Method - Using blanched fresh mushrooms, fill the inverted caps with the mixture (quantity depending on size of cap), freeze and enrobe.

Note - The sauce mix contains vegetable oil, hydrolysed vegetable protein, cream (with anti-oxidant E320), skimmed milk powder, modified starch, flour, lactose, butter, onion powder, sodium caseinate, salt, spices, colours (E160, E24), herbs, and emulsifying salts.

Youngs estimated costs for production and sale of the product - 2oz mushrooms, for a starter for 2 people - were:

Production -

Raw material	34.4p
Labour	10p
Packaging (catering)	2p
Overheads	4.64p
	51.04p

Trade selling price 85p

Catering recommended sale price £1.75

(See section 2.4 for notes on prices)

On the basis of the above it was decided to proceed to stage two with this product.

2.3.2 Crab Stuffed Plaice

This concept was for a main course item for both retail and the catering trade. The product consists of 2 skinned plaice fillets with a layer of crab mixture between them, coated with a Japanese crumb and baked in the oven. The filling operation would again be labour intensive.

Initial sampling indicated that the appearance of the product was excellent but that the flavour was disappointing and the texture rather dry. The contrast in colours between the plaice fillets and the filling, and the clearly fibrous nature of the crab mixture were liked. However the strong flavour of the plaice almost completely masked that of the crab. It was considered worthwhile to develop the product.

The use of a more delicately flavoured fish, such as lemon sole, was considered but rejected on grounds of economy and irregularity of supply. Thus development centred on increasing the flavour and moistness of the filling, and resulted in the incorporation of a crab flavoured sauce mix to the recovered crab meat.

The eating properties and appearance of the developed product were good, although again the plaice flavour predominated. The fact that plaice flavours vary significantly with season and fishing grounds will remain a problem for all stuffed plaice products.

The developed recipe was:

Filling - As used for stuffed mushrooms.

Method - 30g of the mixture is placed between two 75g fillets, freeze and enrobe using the same enrobing process as for the stuffed mushrooms but flash frying for 75 seconds in oil at 375 deg F to enable the coating to absorb oil (enabling the product to be oven baked) and to attain a golden brown colour. The product is then frozen again.

Youngs estimated costs - 9oz portion - were:

Production -

Raw material		33p	
Labour		5p	
Packaging	(catering)	2p	10p (retail)
Overheads		4p	5p
		44p	53p
Trade selling price		75p	96p
Recommended sale price		£1.50	£1.20

2.3.3 Crab Crepes with White Wine Sauce

This concept was for an "up-market" retail product. It consists of crepes filled with crab and cheese sauCe and then rolled and covered with wine and cream sauce and finally topped with cheese. The recipe was developed in a kitchen, rather than production environment and it was accepted that large scale production would be specialised and difficult.

On initial sampling the product met with universal acclaim, the only suggestion made being that a dusting of paprika would enhance the appearance. The flavour was good and the fibrous nature of the crab evident. Development then centred on commercialisation of the recipe.

The recipe was:

Filling - 30g butter
15g calflo starch
3g salt
10g parmesan cheese
1.5g onion powder
0.5g dry mustard
284 ml milk
150g recovered crab meat
0.3g shellfish flavour (PPF advitoroma 4270 330)

Sauce - 30g butter
25g calflo starch
2g salt
375 ml milk
75 ml white wine
0.1g dry parsley
0.7g onion powder

Method - For both filling and sauce make a roux with butter and dry ingredients and then add liquids. 50g of filling is placed in a 6" crepe which is then folded and sealed. A single crepe is placed in a foil try, covered with 90g of sauce and finally topped with 5g of grated cheese. The tray is lidded and the product frozen.

Youngs estimated costs - 2 crepes in retail pack - were:

Production -

Raw material	31p
Labour	10p
Packaging (retail)	10p
Overheads	5.1p
	56.1p

Trade selling price £1.00

Recommended sale price £1.25

It was decided to proceed to stage two with this product.

2.3.4 Crab Cakes/Steaks

These concepts were aimed at utilising larger quantities of recovered crab meat in a commodity retail market. The crab cake consisted of a filling of largely crab meat plus spices formed into fish cake shapes and enrobed. The crab steaks were a similar filling formed into steak shapes and enrobed with barbecue or smoked flavour crumb.

Initial sampling indicated that the appearance and texture of these products was good, but that the flavours were not. The white and fibrous nature of the crab meat was apparent, but the crab cake tasted spicy, more "meaty" than crab-like, and the crab steaks were even more strongly "barbecue meaty" flavoured. It was decided to drop the crab steaks and concentrate on developing the flavour of the crab cake.

The problem was to enhance the delicate crab flavour without risking loss of flavour control by adding highly active flavourings to a largely crab meat filling. Adding rusk to the filling to absorb flavouring or adding brown crab meat were considered, but the preferred solution was to encapsulate the flavour in a special crumb developed by Witwood Food Products Ltd. This achieved a significant improvement in flavour allowing the quantity of spices in the mix to be reduced.

The developed recipe was:

Filling - 454g recovered crab meat
80g fresh breadcrumbs
70g whole egg
30g mayonnaise
2.5g salt
0.5g pepper
2.0g worcester sauce
1.5g dry mustard

Crumb - The flavoured crumb contained wheat flour, soya flour, natural flavour, salt and monosodium glutomate and ribocides (or nucleocides) flavour enhancers.

Method - Mix ingredients together until they bind. If the mix is too dry add a little more mayonnaise. Form into 60g cakes, freeze, batter and crumb.

Youngs estimated costs - 2 cakes in retail pack - were:

Production -

Raw material	36.1 p
Labour	3 p
Packaging (retail)	7 p
Overheads	4.61p
	50.71p
Trade selling price	90p
Recommended sale price	£1.12

It was decided to proceed to stage 2 with this product.

2.4 Notes on Product Costs

The costs are based on 1984 data. Overheads have been set at 10% although some of the processes may be involved and require a higher figure, but for others if built into an existing range the figure is achievable. The presumption in the frozen food trade for a processors trade margin is 40% on sale of catering packs and 45% for retail packs. The retail stockist is given a margin of 20% on return, although multiples discount very heavily from this, cutting into the above margins. Multiples have been discounting about 18-19% of posted manufacturers selling price. The caterer is given a margin of 50% on return.

3 STAGE TWO - PRODUCT ASSESSMENT

Samples were produced in quantity by Youngs and given to Imperial Foods market research unit, the Food Products Intelligence Centre (FPIC) at Leamington Spa. Group discussions were conducted with 57 female panellists (93% of whom owned home freezers) in 6 separate meetings. FPIC reported as follows.

3.1 FPIC Report Part I - Consumer Awareness, Attitudes and Use of Crab in General

3.1.1 Background Information

84% of panellists had eaten crab in some form. 19% of these stated that "they were not keen"/"weren't impressed" by crab, commenting:-

a) "Nothing sort of food"
b) "Not overkeen on that type of fish"
c) "Do not like the flavour much"
d) "No particular reason"
e) "Just did not like it".

Those that had never eaten crab, commented:-

a) "I've never bothered"
b) "Never tried and not wanted to"
c) "Never got round to trying"
d) "The thought puts me off"
e) "I fancy trying it but a waste of money if I don't like".

3.1.2 Consumer Attitude to Crab

For most panellists crab was perceived as a "luxury"/"special" item, most commenting that it was expensive and therefore had to be luxury:-

a) "More special if prepared for you"
b) "You expect it to be expensive"
c) "You have to have an occasion to serve"
d) "A luxury item".

Asked what other fish/seafood products would be comparable, many mentioned salmon, prawns, lobster, (a few commenting that it was more special than salmon).

(One panellist who used fresh crab regularly did not see it as particularly special/luxury).

The majority of panellists indicated that prepared products using crab would warrant a price premium because of the "fiddly" preparation involved. Those panellists who had not eaten crab reserved judgement on whether crab justified a price premium or not.

3.1.3 Purchase, Preparation and Serving of Fresh Crab

35% of this panel had purchased and prepared a fresh crab at some time.

For most this was very infrequently and usually a result of being on holiday at the coast and able to buy what they considred "a really fresh crab", not thought to be possible in the Midlands by these panellists. The few panellists who did so more often said that they purchased the crab from Birmingham/Coventry fish markets.

Those panellists not using fresh crab regularly thought the preparation process "fiddly", "time consuming" and quite difficult initially.

The majority of panellists had never prepared a fresh crab, commenting:-

a) "Do not fancy"
b) "Too fiddly"/"difficult" (comment of several)
c) "Have to be careful of the poison bits"/ "Frightened to".
d) "Never got round to it"
e) "I don't like the look of them"
f) "Expensive to buy".

Only those panellists purchasing fresh crab regularly had any idea on price, thought to be "£1.20" per lb. and for one - "£2.00 for a crab to serve 3".

Asked whether panellists required more information on the preparation and use of crab in general, opinions were mixed.

Some panellists said they knew little of seafood in general and would like to know more.

Others thought there was sufficient information in cookery books for those wanting to use/serve crab.

Being Midlands based for some panellists was thought to be a reason for the lack of knowledge and use of crab and other similar products.

3.1.4 Purchase and Serving of Crab Based Products

Canned crab and pates, spreads, pastes were the main crab based products purchased by 47% of panellists in each case. Brands mentioned were - Princes, John West, Libbys and Shippams. As purchase was mainly "occasional for the store cupboard", brand/price awareness was low.

Specific occasions for serving were not mentioned by the majority.

10% of the panel said that they had purchased frozen crabmeat from freezer centres, again brand awareness not evident. This was mainly used for salads/recipes. (One panellist had purchased Young's Dressed Crab).

3 panellists said that they had purchased "Crabsticks" - other members of the panel told them that this was not real crab.

Sharwoods Crab Soup was purchased by one; fresh dressed crab from the market by another.

Asked whether they had seen any crab recipe products on the market, the majority did not think they ever had. Three panellists mentioned seeing Young's Crab Thermidor but none had ever purchased. (One panellist thought Findus did a crab product but was not sure).

3.1.5 Eating Out

46% of panellists said that they had chosen crab when eating out - "Crab Salad" (very popular), "Crab Sandwiches" (also popular), "Crab in a Sauce", "Avocado & Crab", "Dressed", "Seafood Platter", for one "In all ways - I love it".

Again, for many panellists, crab was eaten more when at the coast.

Those that tended not to choose crab from a menu commented:-

"Doubtful of seafood things on a menu" and for most "Other things I prefer".

3.2 FPIC Report Part II - Discussion of Development Products

Approximately half the panel were shown crab cakes and crab stuffed mushrooms (aimed specifically at the catering market). The other half, crab stuffed plaice and crab crepes with white wine sauce.

3.2.1 Crab Stuffed Mushrooms

3.2.1.1 Present: 27 panellists

3.2.1.2 Background

The product was explained, 88% of panellists considered it appealing - "Sounds nice", "Interesting", "Different".

No panellist thought they had ever tried anything similar, a few having had breaded mushrooms, herb/garlic mushrooms when eating out.

The few panellists to whom the idea did not appeal, commented - "Crab and mushroom both have strong flavours", "I don't really like fried foods".

3.2.1.3 Sampling

A selection of various sized mushrooms were served on a platter garnished with watercress and panellists helped themselves. Lemon was available if required.

COMMENTS	QUALITY ASSESSMENT
Most thought initial appearance was good - "Look nice", "Attractive", "Different from how I expected". Several commented that "Some are rather too large - smaller ones look better". On cutting into the product - "It's fallen apart", "Lot of liquid coming from the mushroom", "I think the liquid is oil". The crab content was lacking. For most, the appearance was disappointing on eating. The outer coating was described as "Crisp", "Not greasy" by most. The mushroom was thought "Tough", "Rubbery", "Chewy" and "Leathery" - thought by most typical of frozen mushrooms. For most, the texture of the crab was not particularly noticeable, a few commenting "Watery", others "Dry and stringy". For most, the flavour was thought disappointing, the crab described as "Lost", "Lacking", "Overpowered", "Too delicate". Several panellists however enjoyed the product in any case.	Panellists 6.2 (just satisfactory) FPIC Independent Quality Assessment 6.5 (just satisfactory)

Note:

The quality assessment is based on a 10 point hedonic scale detailed in section 3.4, by the panellists and independently by FPIC staff.

3.2.1.4 Improvements

Most panellists overall were disappointed in the product on eating, however with suggested improvements the product was thought a good idea:-

i) "Make mushroom less tough" (several suggested chopping it finely and mixing with crabmeat).

ii) "Use smaller mushrooms".

iii) "Do not fry the product" (some panellists thought the crab flavour may be more evident if not fried).

Several panellists however thought the crab was lost in such a recipe regardless of improvements/modifications.

Those that normally did not rate crab highly, found this product quite acceptable because they could not taste the crab!

The regular crab eaters however considered the product to have insufficient crab flavour overall.

3.2.1.5 Occasions for Serving

Most panellists thought it suitable as a starter (for entertaining), other occasions suggested - supper snacks, buffet idea, teatime with salad.

3.2.1.6 Attitude to Product as a Restaurant Starter

Compared with other starters available in restaurants, most panellists said they may have tried this as it sounded so different. Regarding the product compared to starters normally available, the following comments were made:-

a) "Interesting idea - restaurant starters are boring"
b) "Different - go down well in a restaurant"
c) "Depends where you eat"
d) "There are nicer starters around"
e) "I would have been disappointed had I ordered it" (Comment of several).

3.2.1.7 Potential as a Retail Product

Although panellists thought the concept sufficiently interesting, this was not as a "deep fried product" - if this were to be the only method of preparation it would be off-putting - especially if to be used for entertaining. Those panellists who thought it sufficiently interesting, did so based on the modifications suggested.

As a retail product - packs of 2-4 servings were suggested.

3.2.1.8 Portion Size

As a starter 1 large mushroom/2-3 smaller was considered adequate.

Overall the larger mushrooms were considered less suitable in any case.

3.2.1.9 Price and Potential Purchase

As a menu item - "£1.00" - "£1.20", "£1.50" - "£2.50" were suggested by the panellists "depending on the restaurant".

If available on the retail market £1.25 - £1.50 for two servings was suggested. Many panellists expected the product to be expensive because of the crab content but based on the quality perceived did not think the product as such justified a high price at present.

Having not tried the product, 78% of panellists thought they may have selected from a restaurant menu, less thought they would now, based on their opinion of the product.

As regards retail purchase, only 11% expected to purchase, based on what they had tried.

Reasons for not purchasing:-

a) "Did not like sufficiently" - for many.
b) "Disappointing".
c) "Other things I enjoy more".
d) "Not keen on deep frying".

3.2.2 Crab Stuffed Plaice

3.2.2.1 Present: - 30 panellists

3.2.2.2 Background

The majority of panellists had seen Breaded Stuffed Plaice products on sale.

23% had purchased, for most on an occasional basis. (Two panellists however purchased regularly).

Brands mentioned were - Bejam, Marks & Spencer and Sainsbury, those buying have enjoyed the products.

The majority however had never purchased giving the following reasons:-

a) "Not keen on breaded fish".
b) "Wary about portions in packs - not usually big enough".
c) "My children prefer plain things".
d) "Family would not like".
e) "I've not had the occasion to buy".
f) "Never heard of them".

The product was explained and for nearly all panellists it was considered an appealing way to use crab.

3.2.2.3 Sampling

A whole portion was shown in the centre of the table. Each panellist was served a half portion cut lengthways and garnished with watercress. Lemon was available.

COMMENTS	QUALITY ASSESSMENT
The product was described as "Appetising" "Lovely", "Good size". The filling was considered "Well filled" and "Plenty of it" by some though lacking by others. For most, the coating was described as "Too crunchy" "Too crisp", "Too hard and chewy" and there was thought to be too much coating in any case. The texture of the fish was thought "Good". The texture of the crab was not really noticed. Flavour described as "Tasty", "Fishy" with a good plaice flavour. For most the crab was thought "Lost" and "Lacking in flavour".	Consumers 7.5 (Fairly good) FPIC Independent Quality Assessment 6.3 (Just satisfactory)

Although overall, the product was enjoyed, the majority of panellists thought that the use of crab was lost in this type of product as the flavour had not really "come through".

3.2.2.4 Improvements

a) "Reduce quantity of coating".
b) "Make coating less hard - more crisp".
c) "Put the crab in a sauce and make more flavourful.

3.2.2.5 Preparation and Serving

In oven instructions for this product was welcomed, most panellists avoiding frying when possible.

Suggested occasions for serving were - evening meal, supper, freezer standby.

This product was considered more an adult idea by most, thought to be too sophisticated and probably too expensive for children. Some panelists who had older children thought they may enjoy.

3.2.2.6 Portion Size

Considered adequate by most and generous by others; panellists wanting to be able to purchase single portions as well as in multiple packs.

3.2.2.7 Price and Potential Purchase

Suggested price per portion ranged from 60p - £1.00 most considering 80p, per portion as reasonable.

Having tried the product, 43% said they would consider purchase.

Those that would not commented:-

a) "Disappointed")
b) "Did not like coating") Comment of many
c) "Prefer the types I already buy"
d) "Much prefer the M & S ones"

3.2.3 Crab Crepes with White Wine Sauce

3.2.3.1 Present: 30 panellists.

3.2.3.2 Background

All panellists were familiar with the term crepes. Characteristics of savoury crepes were thought to be:-

a) "Thin, crisp with plenty of filling" - comment of many.
b) "Savoury pancake with a filling".
c) "Light and fluffy".
d) "Thin, very crisp edges".
e) "Cheesey".

Two-thirds of the panel considered savoury crepes as "special", the remainder commenting:-

a) "People try more these days".
b) "Depends what you do with them".
c) "Usually make to use up leftovers".
d) "Have a lot at home".

One-third said that they occasionally made savoury crepes. Various fillings were mentioned - mincemeat, mushroom, turkey and ham, prawns, cheese, salmon and rice, chicken.

Only 3 panellists said they had purchased savoury crepes, they thought the brand was Birds Eye but were not sure. (I suspect they were either confusing crispy pancakes with crepes or Birds Eye with Findus!).

As regards frozen fish/seafood entree products in general, Marks & Spencer Fishermans Pie was popular being purchased by 27% of panellists.

One panellist mentioned Young's Coquille St. Jacques and Salmon and Mushroom Supreme as occasional purchases.

Others mentioned were - Marks & Spencer Cod and Prawn Pie, Haddock & Pasta au Gratin and Ross Cod Crumble for individual panellists.

As regards the Young's range of frozen seafood entrees, the majority of panellists did not think they had seen them on sale.

Reasons for not purchasing this type of product were:-

a) "Portions are never big enough".
b) "Not fish lovers".
c) "Husband does not like".
d) "Make my own".
e) "Not really aware of this type of product".

The product concept was explained and to 83% of panellists, it was considered an appealing idea. Most panellists appeared quite enthusiastic.

3.2.3.3 Sampling

A whole crepe garnished with watercress was placed in the centre of the table. Each panellist was served half a crepe.

(**Note:** On preparation, the appearance of each individual crepe varied somewhat.)

COMMENTS	QUALITY ASSESSMENT
The majority considered the appearance unacceptable, describing it as "Like scrambled eggs", "Uncharacteristic", "Insipid", "All right at a distance - not close up". "Could not use when entertaining" - "Looks and smells nice", "Probably taste better than it looks". Mixed opinion on texture, sauce described as "Thick and creamy" by some "Too thick". "Slimy" by others. Crepe was considered "Too soft", "Not crisp enough", "Flabby" by most. Filling considered "Just right", "Quite nice" by some but a "Little dry" and "Stringy" by others. Overall, the flavour was enjoyed described as "Lovely", "Quite pleasant", "Slight wine flavour" with a mild crab taste. Some panellists thought the crab flavour could have been stronger.	Consumers 6.7 (Fairly good) FPIC Independent Quality Assessment 5.4 (Just acceptable)

Overall the product appears to have been enjoyed from a flavour point of view which is reflected in the quality assessment. However both appearance/texture of this product were not considered characteristic by this panel.

3.2.3.4 Improvements

Several improvements (mainly for appearance/texture) were suggested: -

i) Thinner pancake
ii) Put the sauce inside (this was expected to give a crisper crepe on cooking)
iii) Improve the crab flavour - use chunks not flakes or crab.
iv) Brown the surface more - crisp up the edges.

One panellist suggested having the sauce in a separate boil-in-the-bag sachet to be poured over after baking, and this was thought a good idea by other panellists.

3.2.3.5 Preparation and Serving

For most, the preparation required was considered satisfactory; a few however not wanting to use their ovens "just for a crepe".

Suggested occasions for serving were:- starter, fish course, main meal, supper snack.

As regards entertaining, the product concept was considered suitable but most panellists had reservations about this particular product, mainly from an appearance point of view.

3.2.3.6 Portion Size

One was considered adequate for a starter, two for a more substantial meal/course.

Multiples of two were thought necessary on the retail market, a multipack being suggested but panellists said they would want to be able to use the crepes individually however.

3.2.3.7 Price and Potential Purchase

The suggested price of £1.50 was considered rather expensive - "Seems a lot for a little crab", "Nothing to it", "Must be expensive because of the crab:, "Could make your own cheaper".

A fairer price was thought to be £1.00 - £1.25 for a pack of two.

At £1.50 - 16% of panellists said they would consider purchase.

At £1.25 - 26% thought they may purchase.

The majority would not, commenting:-

"I'll make my own"
"Just the look puts me off"
"Quality not good enough"
"Too expensive".

3.2.4 Crab Cakes

3.2.4.1 Present: 27 panellists.

3.2.4.2 Background

44% of panellists said they occasionally served homemade fishcake products, coley, cod, salmon, tuna, mentioned.

59% of panellists occasionally purchased fishcakes, Ross, Birds Eye, Sainsbury and James of Pershore were the brands mentioned.

This type of product was mainly served at "teatime" or as a "snack meal" and in particular to children.

Asked what image they thought fishcakes had, the following comments were noted:-

a) "Everyday product".
b) "They put the leftovers in them".
c) "Not very nutritional".
d) "They do not put good fish in".
e) "Childrens product".
f) "Same as fishfingers".

The product concept explained, for 51% it did not appeal - these panellists associated with typical fishcakes and were not enthusiastic for this reason.

The remainder were more interested, commenting "A bit different", "Sounds nice". "I'd try it", "Special idea".

Several panellists commented that crab "was too good to use in this way" and expected the product to be rather expensive.

3.2.4.3 Sampling

The crab cakes were served with a garnish of watercress, lemon being available.

COMMENTS	QUALITY ASSESSMENT
Appearance thought good, described as "Homemade", "Good size", "Chunky", "Natural colour to coating. The crab content thought "well filled". "Crablike".	Panellists 7.4 (Fairly Good)
For most the texture of the coating was enjoyed, described as "Crisp and dry" for most. A few thought it greasy. Crab content for some was expected to be "Sloppy" but panellists found it "Held together well", otherwise thought fairly typical in texture.	FPIC Independent Quality Assessment 7.0 (Fairly Good)
Overall the flavour enjoyed but for most "Bland" and "Lacking crab flavour". A few thought the flavour "Salty". For most the crab flavour needed "To be brought out".	

Although most panellists had enjoyed the product overall, the crab flavour was considered lacking.

3.2.4.4 Preparation and Serving

Again panellists stated that they would not deep fry such a product, most opting to shallow fry or grill in this case.

Occasions for serving were thought to be - supper, teatime, Saturday lunch.

3.2.4.5 Portion Size

The cake was thought larger than average and thought "Good" for this reason. One for children, two for an adult was thought sufficient.

(Many panellists however did not expect younger children to enjoy it; in any case the product was expected to be too expensive and upmarket for children. Teenage children were expected to enjoy however.)

For retail packaging, multiples of two was suggested, a pack of six being mentioned by several.

3.2.4.6 Price and Potential Purchase

As this product contained crab, it was expected to cost more than other fishcake products available. Between "50-60p" and "60-70p" for a pack of two was thought reasonable by this panel.

59% of panellists said they would consider purchase at this price on an occasional basis.

Those that would not commented:-

a) "Did not like sufficiently".
b) "Disappointed with flavour".
c) "Not really keen on fish".

3.2.4.7 Suitability of Product Name

All panellists agreed that Crab cakes was not a suitable name for this product, seeing it as a far more upmarket product than typical fishcakes available.

Other names suggested - "Crablets", "Crab crunchies", "Crab patties", "Crab cutlets", "Seafood cakes".

However the most popular suggested name was "Crab croquettes". Some panellists thought even the shape could be changed to match this name and be more suitable for the image of crab.

3.3 FPIC Report Part III - Summary of Findings

3.3.1 Crab

The majority of panellists had eaten crab at some time, most enjoyed it.

Crab was regarded as a luxury/special and expensive item compared by some to Salmon, Prawns, Lobster and thought by most to warrant a price premium when prepared.

Just over one third of the panel had occasionally prepared fresh crab, most having purchased direct at the coast. (A few panellists prepared crab quite regularly.) It was considered a fiddly and time consuming procedure by most and for those less experienced quite difficult.

Opinion was mixed as to whether there is sufficient information on the preparation and use of crab. Many thought their lack of knowledge was due to the fact they were "Midlands based".

Purchase of crab products was mainly in the form of canned crab and crab pate, pastes, spreads - these items regarded as storecupboard products by most.

Only 10% of panellists had ever purchased frozen crabmeat for use in salads and recipes.

The majority of the panel were unaware of any crab recipe products on the market, 3 individuals having seen Young's Crab Thermidor but nobody had purchased.

When eating out, just under half had chosen crab at some time, again especially when at the coast. Crab Salad and Crab Sandwiches were particularly popular for this panel.

3.3.2 Crab Stuffed Mushrooms

The product concept was considered both different and appealing by most panellists, not having tried anything directly similar before.

The product was assessed as "Just Satisfactory", the eating enjoyment lowered by:-

a) Toughness of the mushrooms.
b) Bland and apparent lack of crab flavour.

For serving, as a starter was considered most suitable, one large or 2-3 small mushrooms thought an adequate portion. (The smaller sized mushrooms were thought "better" than the large in any case).

As regards suitability for a restaurant starter, most panellists thought the product was interesting however based on the quality perceived, most would have been disappointed on ordering.

Taking into account the suggested modifications, several panellists thought it would be an interesting retail product, however as a product requiring deep fat frying it had less appeal than if prepared by alternative cooking methods.

Before sampling, three-quarters of the panel said they would have chosen from a restaurant menu, suggesting a price range of £1.00 - £1.50 - £2.50 per serving depending on the restaurant.

As regards being available as a retail product, £1.25 - £1.50 for 2 servings was thought reasonable, however only 11% expected to purchase based on what they had tried.

3.3.3 Crab Stuffed Plaice

The majority were aware of Breaded Stuffed Plaice products, nearly one-quarter having purchased, Marks & Spencer, Bejam, Sainsbury, the brands mentioned.

The concept was considered appealing by nearly all panellists.

The product was enjoyed overall rating "Fairly Good", the major criticism being:-

a) Too much coating - too chewy/hard in any case.
b) Lack of crab flavour.

Evening meal, supper, were the main occasions for serving suggested.

The concept was thought to suit adult tastes in particular, some panellists with older children thought that they may enjoy.

Suggested price per portion for most panellists was in the range of 80p and based on this, 43% of the panel would consider purchase.

3.3.4 Crab Crepes with White Wine Sauce

All panellists were familiar with savoury crepes, for most the characteristics described as "Thin, crisp with plenty of filling".

For the majority, crepes were considered an upmarket and special product.

One-third of panellists had made crepes at home at some time with a variety of fillings.

Only 3 panellists said they had ever purchased, none being very sure of the brand.

As regards frozen fish/seafood entree products, apart from Marks & Spencer Fishermans Pie, purchased by over one quarter of the panel at one time, purchase was low and infrequent.

The product concept appealed to the majority.

Overall the product rated "Fairly Good", however this appeared to be based mainly on flavour, both the appearance and texture heavily criticised and thought uncharacteristic.

The product was thought suitable as a starter/fish course, main meal or supper snack. As regards being served for entertaining, panellists expressed reservation owing to the disappointing appearance of the product.

A suggested price of £1.50 for 2 was thought too expensive, only 16% prepared to purchase.

£1.25 was thought more reasonable and at this price, 26% said they may purchase.

3.3.5 Crab Cakes

Nearly half the panellists served homemade fishcakes using a variety of fish. Slightly more purchased fishcake products, Ross, Birds Eye, Sainsbury the mentioned brands.

For this panel, fishcakes were served on an occasional basis, mainly at teatime/snack meal with children particularly in mind.

Panellists expectation of Crab cakes was mixed, half associating with typical fishcake products and therefore not thought very interesting, the remainder considering the idea different and rather special.

The product was enjoyed, rated as "Fairly good", the main criticism being the lack of crab flavour for many.

Deep frying for this product was not a method of cooking practised by this panel, most opting to shallow fry or grill instead.

Supper, teatime, Saturday lunch were the suggested occasions for serving.

Very young children were not expected to enjoy, the product being considered too special/expensive in any case. Older children in particular teenagers were expected to enjoy by some mothers.

50-60p - 60-75p for 2 cakes was suggested, most panellists expecting to pay more for Crab cakes than other fishcakes. At these suggested prices 59% expected to purchase.

Crab cakes as a name was thought to give the wrong image to the product which was seen as more special/upmarket than fishcakes in general.

Other names suggested - "Crablets", "Crab crunchies", "Crab patties", "Crab cutlets", "Seafood cakes" and the most popular - "Crab croquettes". (A suggestion of shape modification was also made).

Notes:

The major criticsm for each product regarding flavour was the lack of crab taste in relation to the other ingredients. As panellists anticipated to pay more for crab recipe products, they expected to taste what they were paying for.

Those panellists who had previously not eaten crab were asked their opinion:-

a) "I enjoyed but the flavour was bland".
b) "Surprised".
c) "Quite liked it".
d) "Not keen on fibrous texture".
e) "Take it or leave it".
f) "Would not try whole crab but may recipe dishes".
g) "I don't see why it's so special".

Asked whether they had any other product ideas, utilising crab, the following were suggested:-

Crab Soup (suggested by several) - probably based on Chinese Crab and Sweetcorn

Crab Provencale
Rice based dish
Crab Mousse
Crab Quiche
Crab Vol-au-Vents
Upmarket Crab Paste.

3.4 FPIC Hedonic Quality Scale

10	Excellent
9	Very Good
8	Good
7	Fairly Good
6	Just Satisfactory
5	Just Acceptable
4	Not Quite Acceptable
3	Poor
2	Bad
1	Inedible

Note:

Of FPIC quality evaluations of approximately 50 commercial crab products less than 20% have scored more than 7.

4 FURTHER DEVELOPMENT

4.1 General

The assessment of attitudes to crab has reinforced the view that there is potential for crab based value added convenience products - crab is viewed as "up market", and enjoyed, but fresh whole crab is offputting.

The assessment of the development products has shown that each has possibilities but that in all cases further development is required. Underlying the development problem is the lack of flavour of the recovered meat although its appearance and fibrous texture, which make its presence in these products obvious, are liked. Development can be targeted at adding crab flavour by natural (e.g. brown meat) or artificial means, or at modifying the meat recovery process such that less of the natural flavour is lost.

Youngs retain an active interest in these products, but any large processing/marketing organisation is unlikely to introduce such products in isolation. The policy is to introduce or extend product families (e.g. various stuffed plaice or savoury crepes) in order to share the considerable investment in both production and marketing.

4.2 Crab Stuffed Mushrooms

The assessed response to the product concept was favourable, and Youngs have received encouragement from their trade contacts, but the technical problem of fixing the enrobing to the product has not yet been overcome and this detracts from its acceptability. Expectations of purchase price are in line with estimated production and distribution costs and margins.

4.3 Crab Stuffed Plaice

The assessed responses to the product concept and its appearance and eating qualities were favourable, although there is scope for further development of both the enrobing texture and the crab flavour. Possibly both these problems could be tackled together via a crab flavoured crumb similar to that used for the crab cake. This product could then be highly rated. The panellists expectations of purchase price are low compared to the estimated sale price, but in this instance the panellists expectations appear low compared to simple

breaded plaice products already successfully marketed (bearing in mind the size of the crab stuffed plaice portion).

4.4 Crab Crepes with White Wine Sauce

The assessed responses to the product concept and its flavour were favourable, but its appearance and texture detracted from its acceptability. This reflects the difficulty for this type of product of scaling up a highly acceptable kitchen recipe, which probably necessitates specialised production and technical facilities. The expected purchase price is in line with the estimated sale price.

4.5 Crab Cakes

The assessed responses to the concept of this product were not as favourable, but following considerable difficulty in development the responses to its appearance and eating quality were favourable, although there is scope for further enhancement of the crab flavour. This could again result in a highly rated product. There is considerable disparity between the low expected purchase price and the estimated sale price, but Youngs believe that gap can be bridged by substituting white fish for part of the crab content (bearing in mind that the flavour is largely in the enrobing). The problems of product concept and expected purchase price appear to be associated with the product name and shape, which place it "down market", and which may be overcome by simple changes. Youngs believe that this product may be better suited to the Ross label.

3.3 Hatching and Larvae

In the Spring and Summer following spawning the 'berried' females move inshore where the eggs hatch. Hatching times vary for the different stocks of crabs around our coasts but the main periods are all between May and September.

The young larval crabs which emerge from the eggs have a shrimp-like appearance and live among the free-floating plankton in the surface water layers for about one month. Figure 4 below shows the larval stages. This period is a dispersal phase because the microscopic larvae can be transported considerable distances by water movements from where they first hatched. During this period they grow through several stages and by the time the larval crab has reached a size of 2.5mm it settles to the seabed and assumes the first crab stage. As described later (see migrations) the transport of crab larvae to an area where they will survive is aided by distinct migration journeys by adult female crabs.

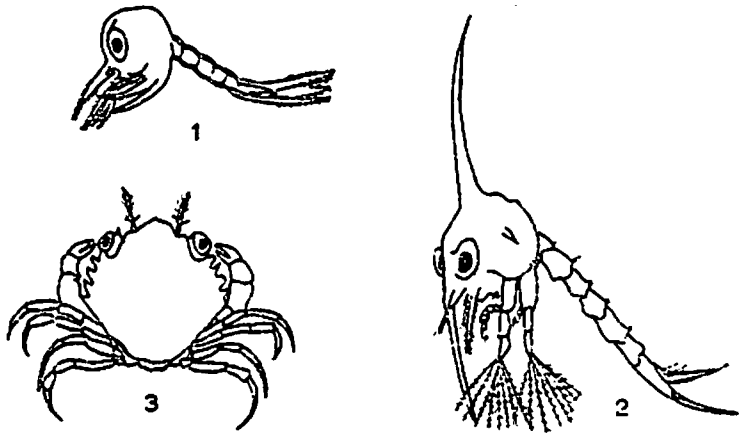

Figure 4. Stages in the development of the young crab. 1. Protozoëa, 2. Zoëa 3. first post larval stage (after Lebour, 1928)

Figure 4

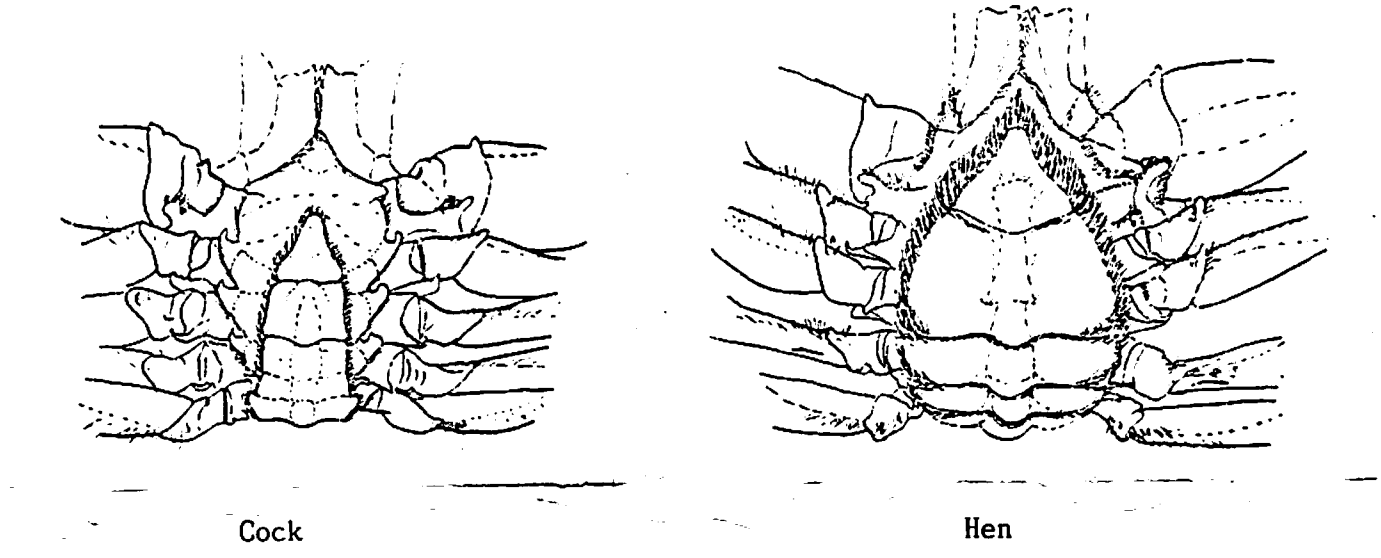

Figure 2 Abdomens of Cock and Hen Crabs

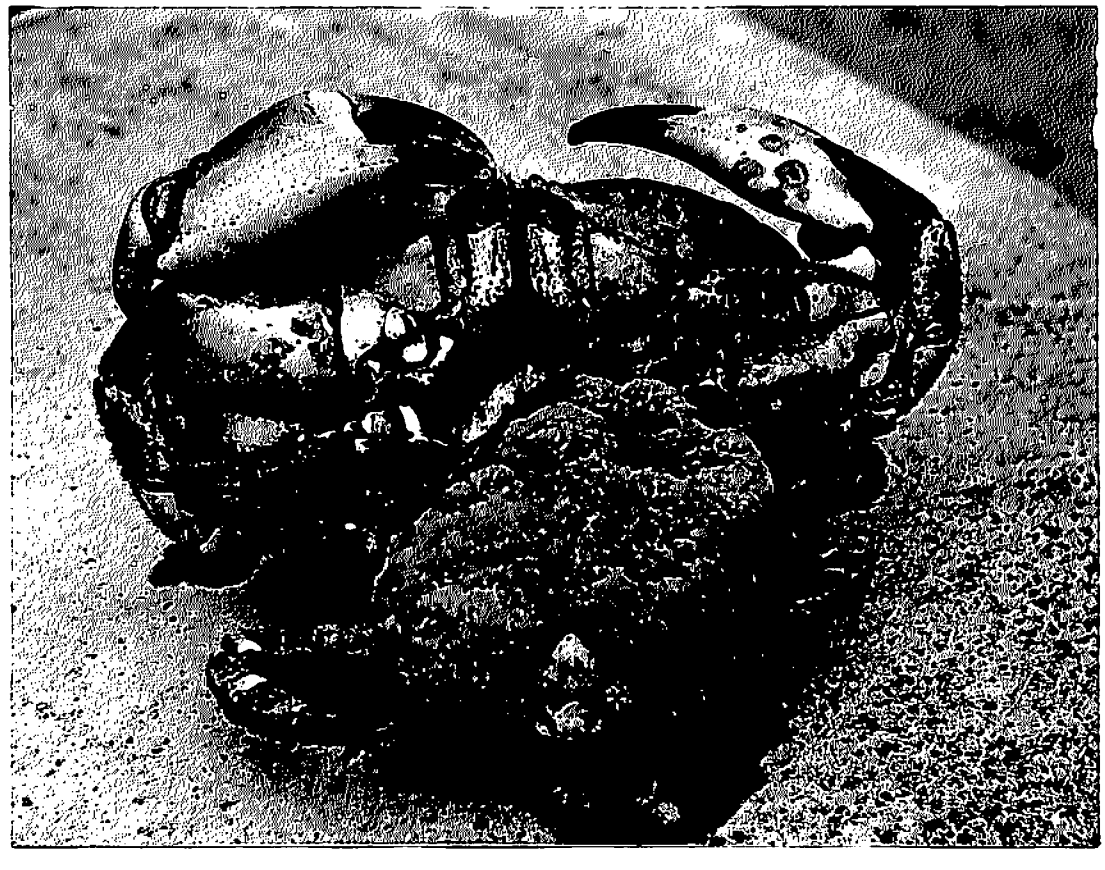

Figure 3 A Beried Hen Crab

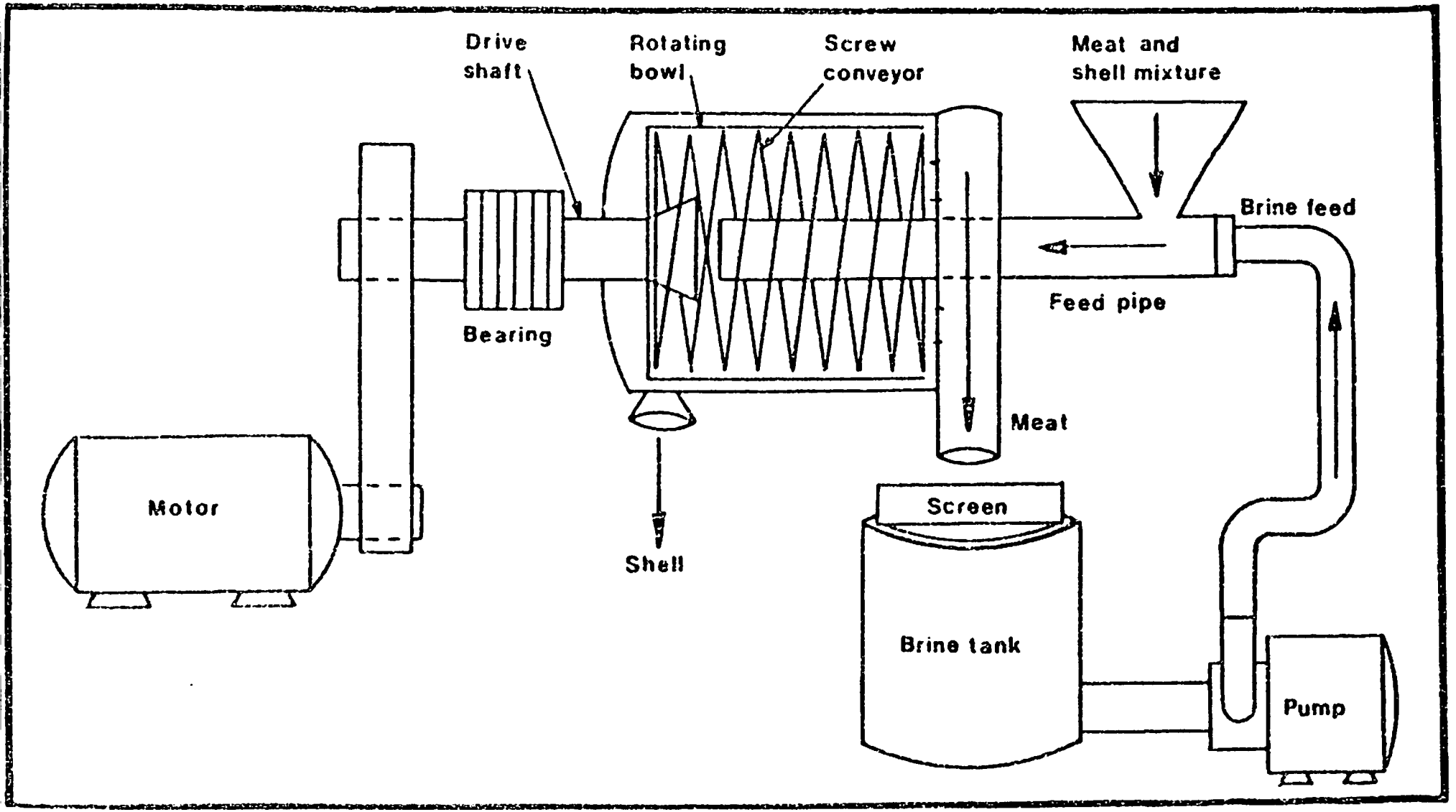

Fig. 3 Schematic of the Bird Machine

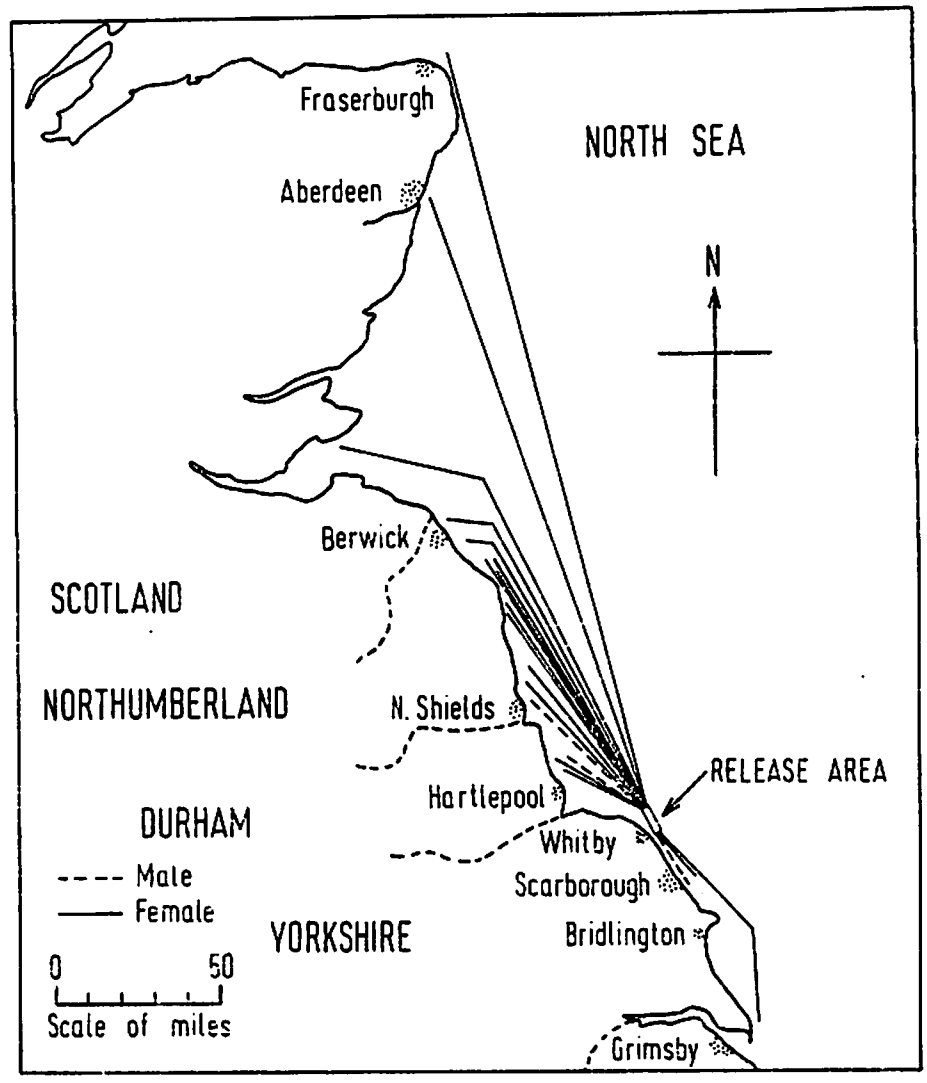

Figure 5. Migrations, 20 miles and over of suture-tagged crabs released off Whitby in 1962 and 1963.

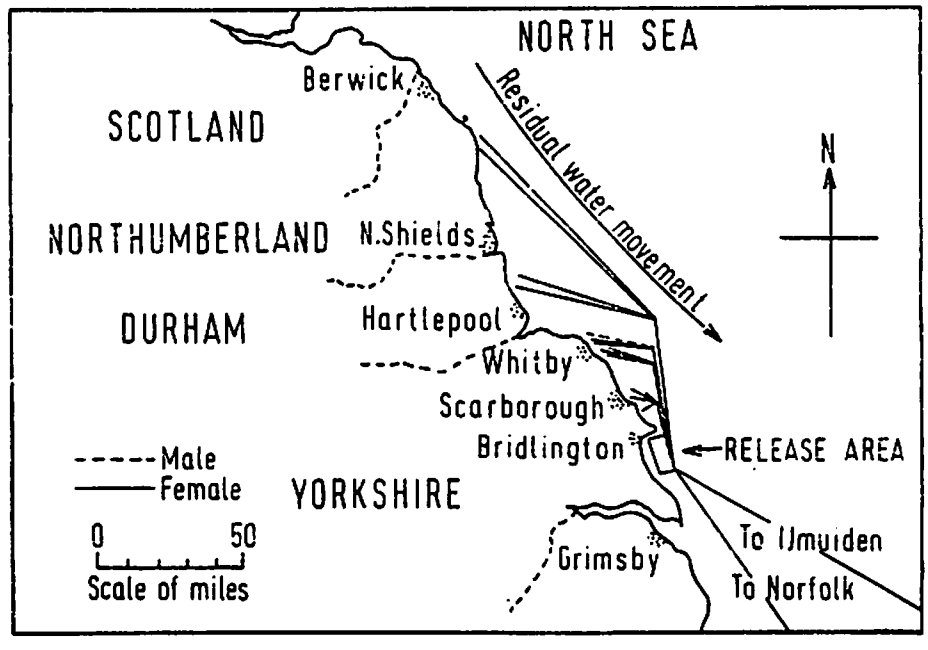

Figure 6. Migrations, 20 miles and over of suture-tagged crabs released south of Bridlington in 1962 and 1963.

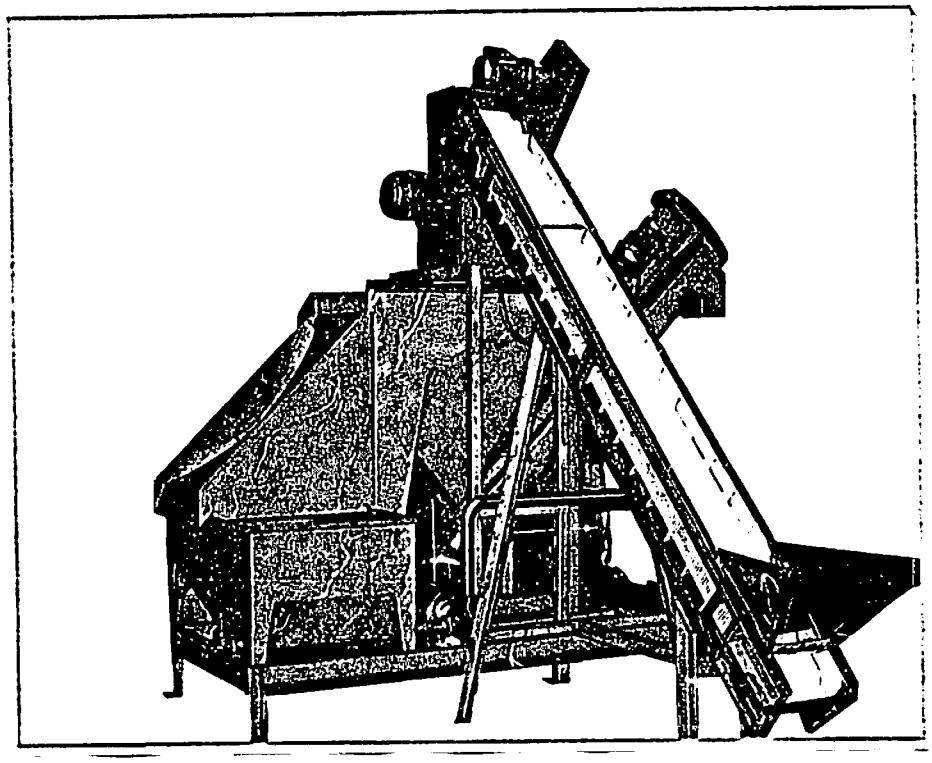

Fig. 4 Photograph of Bead Machine

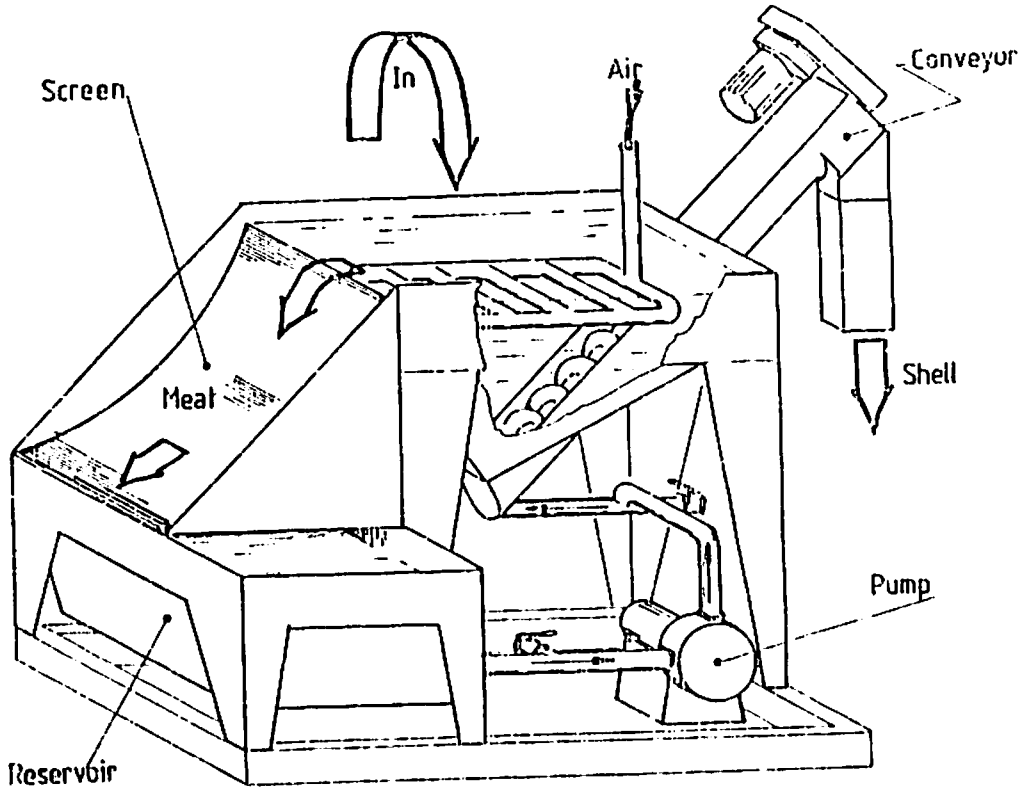

Fig. 5 Schematic of Bead Machine

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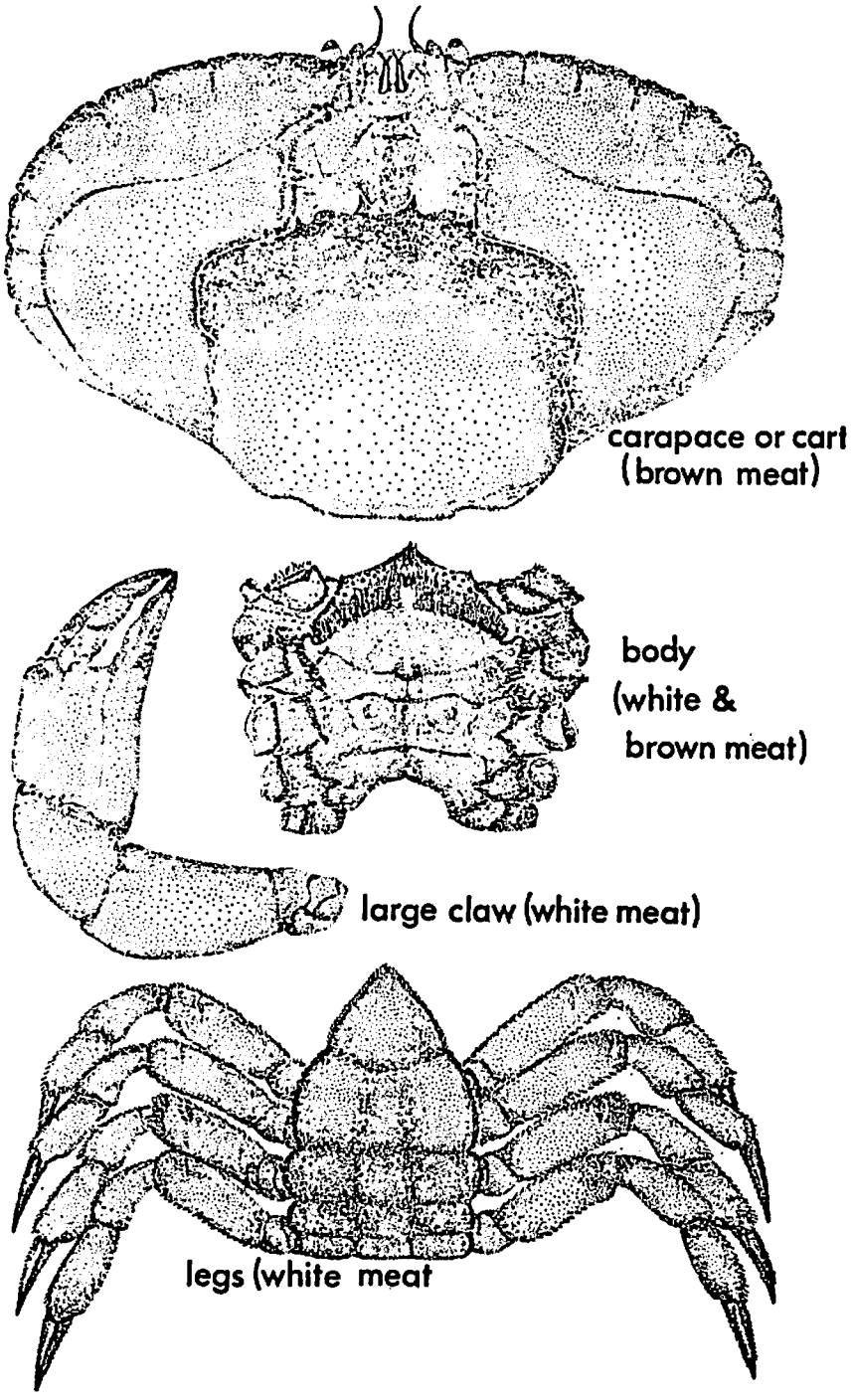

Fig. 1 The Parts of the crab

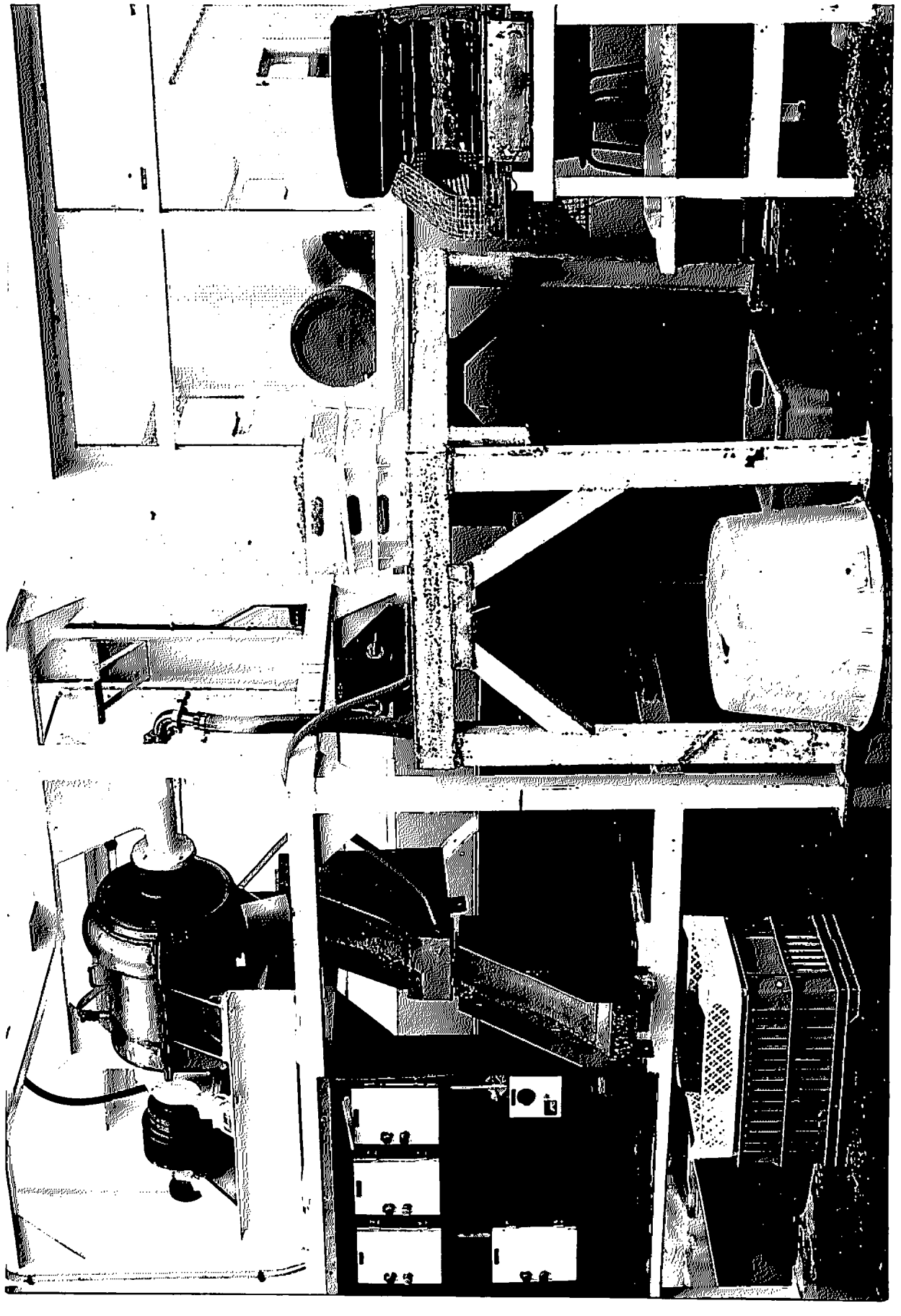

Fig. 2 Photograph of the Bird Machine