OTOLITHIC AGE DETERMINATION OF MATURE SOUTHERN BLUEFIN TUNA

(*Thunnus maccoyii*)

FIRTA 85/76

INTERIM REPORT, DECEMBER 1985

INTRODUCTION

No results are yet available from this study. However, manuscripts are appended describing an earlier, related study; validation of annual banding in the otoliths of juvenile southern bluefin tuna ('The age and growth rate determination of southern bluefin tuna (Thunnus maccoyii), using otolithic banding). May I suggest that at least the abstact of this manuscript is read in conjunction with this report.

PLANNING AND LOGISTICS

As this project has relied heavily on the co-operation of the catching and processing sectors of the industry, forward planning and liaison with fishermen, processors, and co-operating scientific agencies has been essential. Liaison with the Australian Fisheries Service, Department of Primary Industry has been excellent and invaluable; I particularly wish to thank Messrs Albert Caton and Neil Trainer. Mr Kevin Williams of W W Fisheries has also been most helpful in liaison with fishermen and with the industry in general. I thank Undine P/L and Port Lincoln Tuna Processors for their long-standing co-operation in allowing me to sample from their boats and processing plant respectively. Sampling, no matter how carefully and discreetly conducted, invariably causes inconvenience to the fishermen or plant operators, consequently I would be happy to see some tangible form of recognition available for their co-operation.

The planning and organisation of this project has proved more complex than anticipated. 'Kit' design has been finalised after testing of various components and liaison with Australian, Japanese and New Zealand scientists, fishermen and processors. The necessary components have been purchased and approximately 1000 kits assembled. An explanation, request and instructions to be included with the 'kit' have been translated into Japanese and printed on water-resistant paper. Unfortunately, no suitable 'business reply postage' system is available for the return of otoliths; the Australian Embassy, Tokyo has agreed to act as a forwarding agency.

The attachment of 'kits' to southern bluefin tuna destined for Japanese sashimi markets has been approved by Mr Tanabe, Managing Director of the Japan Marine Products Importers Association and access to Japanese carrier vessels has been organised from January 1986.

Co-operation from the New Zealand Department of Fisheries and Agriculture has been excellent. They have offered to both assist with the attachment of 'kits' to fish caught in their waters and to help sample otoliths from 'reject' tuna at processing plants, though to date only two pair of otoliths have been recieved (one from an 143 kg, 225 cm fish).

Co-operation from the Japanese Far Seas Fisheries Research Laboratories has been fair, considering their limited time and funding. Liaison on our behalf at the markets in Japan will be minimal. However I must acknowledge the courtesy and assistance in finding industry contacts provided by Dr Horido Kono. It is worth mentioning here that Dr Kono cited two examples of assistance given to CSIRO Division of Fisheries Research scientists that went unacknowledged, providing little incentive for the Japanese to continue being helpful. Mr Ryuichi Tanabe, Executive Managing Director, Japan Marine Products Importers Association has also been of great assistance.

The limited Japanese liaison has emphasised the need for a personal liaison trip to Japan. Current plans are to travel in late March (after the season ends and just prior to the arrival of the tuna in Japan) in association with a tour of tuna fishermen led by Mr Peter Doyle. A considerable saving in cost is anticipated combined with the benefits of Mr Doyles knowledge of the markets, personal contacts with the major wholesalers, and the ancillary services available (eg. interpreter).

FIELD OPERATIONS

It is planned to attach 'kits' to fish caught from Australian waters from early January, and to fish in New Zealand waters in June - July of 1986. At the suggestion of Dr Talbot Murray I plan to visit New Zealand and participate in this operation.

An unexpected bonus has been the landing of large fish (to 165 cm) at the P.L.T.P cannery, Port Lincoln. Arrangements have been made to sample these fish in early January. In excess of 50 pairs of otoliths may be available.

The possibility of sampling otoliths using a drill and hole saw has been explored with excellent results (see appended manuscript 'A new technique for sampling the otoliths of sashimi - grade scombrid fishes').

* Addendum: 850 kits have been attached to fish to 49kg whole weight from the Showa Maru 31 in the Great Australian Bight in early January.

GENERAL COMMENTS

As principal investigator I am satisfied with the progress made to date with this project, particularly considering the intrinsic logistical complexity. Through close liaison with The University of Sydney, the N.S.W. Department of Agriculture Fisheries Research Institute, the CSIRO Division of Fisheries Research, and the Department of Primary Industry I have enjoyed ready access to a comprehensive range of advice, information and services; I thank all those involved.

Having attended and gained great benefit from international and inter-institutional southern bluefin tuna workshops, I have been twice dissapointed this year at being prevented from attending 'east coast tuna workshops'. These workshops, involving personnel from state and Commonwealth institutions and a private consulting firm, whilst dealing primarily with species other than southern bluefin would clearly be of benefit to my keeping abreast of the field. Further, having now been involved with tuna biology for five years I consider it likely that I may be able to make significant contributions at such workshops.

Although a minor point, I feel it would be of benefit if a tax number was available so that larger purchases could easily be made sales tax exempt.

Lastly, I cannot praise highly enough the assistance given to me by Mr Russel Neuman, as acting FIRC secretary.

AGE AND GROWTH RATE DETERMINATION OF SOUTHERN BLUEFIN TUNA (Thunnus maccoyii), USING OTOLITHIC BANDING

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ABSTRACT

Otoliths of southern bluefin tuna (Thunnus maccoyii) taken from waters off New South Wales, South Australia, and Western Australia, of between 42 cm and 167 cm F.L. were prepared to reveal annual banding. Methods of preparation and examination are detailed.

Otolith growth was demonstrated to be directly proportional to fish growth for the size range studied.

Sampling over 13 months provided validation of the annual nature of bands for fish in their 3rd, 4th and 5th year of growth. Band formation of fish in their 2nd, 6th, 7th, 8th and 9th years of growth also appeared to be annular, though samples were available from an insufficient number of months for confident validation.

Von Bertalanffy growth parameters were derived from determined age-at-length data (L_{∞} 261.3 cm, k 0.108, t_0 -0.157).

KEY WORDS

Thunnus maccoyii, age determination, otoliths, marginal increment, validation.

INTRODUCTION

The southern bluefin tuna, Thunnus maccoyii, distributed throughout the southern temperate oceans, is a resource of high economic value to Australia, Japan and New Zealand. The critical biological state of the population has been identified by Australian (Murphy and Majkowski, 1981) and Japanese (Shingu, Hirada and Suzuki, 1981) scientists. Rational and responsible management of the fishery is dependent upon a reliable and up-to-date biological data base, including information regarding age and growth.

The southern bluefin tuna is a long lived, late maturing, highly migratory species. To date, indirect methods relying on statistical analysis of length-frequency samples and, tag release - recapture data provide the most accurate age and growth rate information (Murphy, 1977; Shingu, 1978; Majkowski and Murphy, submitted). Longevity combined with variable growth rate between individuals (Murphy, 1977) can be expected to produce variance in length-at-age statistics (Hurley and Isles, 1982). Further, the decline in growth rate with age (Murphy and Majkowski, 1981; Shingu, 1970) results in length frequency modes that are increasingly indiscreet (Majkowski and Hampton, 1983).

Consequently, a method of direct age determination utilising age-related banding in calcified structures has been sought. Hynd (Robins pers. comm.) considered scale banding an unreliable reflection of age, whilst Yukinawa (1970), after examining scales from 2 508 southern bluefin tuna over a period of five years, reported annual banding evident in a proportion of the scales from fish to 130 cm F.L. (seven bands). The clarity of banding decreased with increasing fish size; scales from fish greater than 130 cm F.L. were unreadable.

Little attention has been given to other structures. Yukinawa (1970) found no evidence of banding in sagittal otoliths from southern bluefin tuna. The present study shows that with appropriate preparation, banding of varying clarity can be revealed in several structures including scales, vertebrae, fin spines and otoliths. The most distinct banding has been produced in otoliths using a modification of Christenson's (1964) technique of burning the otoliths.

MATERIALS AND METHODS

Collection of samples

Otoliths were collected over a 13 month period, from approximately 600 fish landed in New South Wales, Victoria, South Australia, and Western Australia. Otoliths were removed from fish either at sea, on the wharf, or at processing plants (after thawing). Fish sampled ranged in size from 42 cm FL to 167 cm FL. In all cases the Fork Length of the fish was recorded to the nearest centimeter, and in most cases weight in Kg also was recorded. The sex of tunas greater than 100 cm FL was recorded.

Otolith Preparation and Examination

The sagittal otoliths, removed from the sacculus with fine forceps, after decapitation of the the fish using a hacksaw (as for *T. thynnus*, Butler, Caddy, Dickson, Hunt and Burnet, 1977) were transported and stored in small, capped, plastic vials. Rather than attempting to clean the otoliths during sampling and using paper envelopes for storage, vials were found to offer greater protection from damage and facilitated more through chemical cleaning. Later cleaning of otoliths was less time consuming if adhering tissue was prevented from drying out and in fact allowed to rot in the sealed vials (though not if the otoliths were to be later examined for microincrements).

In the laboratory, otoliths were cleaned of adhering soft tissue by alternate immersion in bleach (sodium hypochlorite, 13.5 % by volume) and hydrogen peroxide (27.5 % w/w), before finally being rinsed and allowed to dry.

Using a modification of Christensen's method (1962), otoliths were placed on a hotplate, at between 100° - 200° C, depending on otolith size. The most even oxidation was obtained if the otoliths were placed lateral side down. Otoliths burnt for approximately 10 minutes, until taking on a golden dark brown appearance. On close inspection dark bands of heavily oxidised material (protein rich) are seen.

In this study otoliths were mounted on glass slides using a rubber O-ring to contain a medium of high refractive index (such as "Entellan") and were examined under a dissecting microscope using incident light against a black background.
Otoliths were measured along the axis of rostum - postrostrum.

Both transverse and longitutinal sections were examined but showed no greater clarity of banding than whole otoliths.

RESULTS AND DISCUSSION

Clear and discrete banding was found in otoliths of fish up to 167 cm FL (9 bands) (Plate 1a - b). Not all otoliths had clear banding, though more than 80 % of the approximately 600 otoliths examined were read with confidence. No correlation was found between the clarity of banding and fish size, other than the inermost two bands typically were broader and correspondingly less defined than later bands.

igures 1a - b

Relation of Fish Size to Otolith Size

A prerequisite of growth calculations based on the measurement of a skeletal part is the establishment of a relation between the growth of that part and the growth of the whole body (Partlo, 1955). The following regression derived from otolith length plotted against fork length (Figure 2), indicates a directly proportional relation.

Fork Length (cm) = 11.2 otolith length (mm) - 31.44

percentage of variance accounted for, 88.3

igure 2

Determining the Periodicity of Band Formation

To confirm that the identified bands do represent years of growth, the marginal increments were measured and plotted by month for each age-class (Figure 3). Despite no data for a number of months (the consequence of being dependant on the commercial fishery for sampling) a clear peak in the marginal increment can be see around June - July.

Figure 3

Observed rates of increment deposition indicate that growth is rapid over the months November - June, with a significant decrease in the rate of growth over the remaining months. The seasonality of growth shown here is similar to that found by Hearn (Pers. Comm) from tag - recapture data for southern bluefin tuna from New South Wales and South Australian waters, where growth was found to be at a maximum over the period late summer to early autumn. Growth checks (appearing dark in burnt otoliths) therefore appear to be formed in late winter - early spring, roughly coinciding with scale checks found to be laid down in September - October by Yukinawa (1970). During November, late in the southern hemisphere spring, shelf water temperature typically begin a seasonal rise in temperature (Edwards, R.J., 1979).

The decrease in growth rate with increasing age can be seen reflected by the decrease in marginal increment width in Figure 3.

Converting "length at band" to "length at age"

Since check formation does not coincide with the fishs birthday, January 1st being accepted as the arbitrary middle of the spawning season (Yukinawa, 1970; Majkowsjki and Hampton, 1982; Kirkwood, 1983) in order to produce results comparable with previous studies it was necessary to convert the data from a 'length - band number' form to a 'length - age' form. From marginal increase it was estimated that 1/4 (November and December) of the period of rapid growth (November to June) occurs before the arbitrary January 1st birthday. Therefore length at age was derived by adding 1/4 of the difference between two consecutive length at band estimates to the smaller of the two estimates. For example, the length at band estimates for two and three band fish is 52.8 and 78.9 cm respectively, the difference being 26.1 cm. The length at age estimate for two year olds then is 52.8 + (26.1 / 4), or 58.1 cm. It was considered that the first discernible band was deposited in the first year of growth.

Age - Length and Age - Weight Relations

Four different estimates of the parameters of the von Bertalanffy growth equation have been widely used in population studies of southern bluefin tuna, namely those of Yukinawa (1970), Shingu (1970), Murphy (1976) and Kirkwood (1983). These estimates, based on banding in scales, on length-frequency analysis, on tagging studies, and on combined length-frequency and tagging data respectively, are derived from the growth of tuna up to a maximum of eight years of age (with the exception of Murphy's and Kirkwood's estimates which include a small number of older fish). The growth curves of Shingu and Yukinawa are remarkably similar, those of Kirkwood and Murphy showing significantly slower growth rate (Figures 4a and b). Estimates of the von Bertalanffy parameters, for the prediction of age from length (Kirkwood, 1983), from otolithic banding have been derived by the least squares method, and the growth curves plotted in Figures 4a and b. The length-weight relation of Warashina and Hisada (1970) was used in each case to convert length to weight.

Figure 4a and b

As with earlier estimates, that derived from otolithic banding suffers from a lack of data covering older age classes.
The largest recorded southern bluefin tuna was 225 cm FL (Yukinawa, 1970). Estimates of L_{∞} from this study are higher than those obtained in any previous study, suggesting the sample composition for this study may have comprised a greater proportion smaller, younger fish than earlier studies.

Comparison of the age - mean length relation proposed here with those obtained in previous studies, by different methods and from very different sample sizes, shows greatest difference for older fish (Table 1), again reflecting the lack of larger fish in the samples., and the increasing variance inherent in length-at-age estimates for older fish. As the majority of fish in this study are reprentative of the mid-range of sizes caught by the Australian pole-and-line fishery, it is reasonable to expect their growth rate to be typical of their respective cohorts. Consequently, extrapolated values may also be expected to describe typical growth and length-at-age. Yukinawa's (1970) study was limited by the lesser clarity of bands in scales from larger fish, this effect being proportional to size, the consequence of this is most likely that faster growing individuals could not be aged, and the resulting growth curve was biased by smaller than average, slower growing fish in the upper size range of fish sampled, with a consequently lower L_{∞}.

Table 1. Length-at-age estimates for southern bluefin tuna

	Age in Years								
	1	2	3	4	5	6	7	8	9
Mean Fork Length									
Thorogood	30.6	54.3	75.4	94.5	111.5	126.9	140.6	153.0	164.1
Kirkwood, 1983	33.9	54.7	73.1	89.3	103.5	116.0	127.0	136.7	145.2
Murphy, 1976	24.8	46.0	64.4	80.2	93.9	105.7	115.9	124.7	132.4
Shingu, 1970	28.9	54.2	76.3	95.4	112.1	126.6	139.2	150.1	159.7
Yukinawa, 1970	28.8	52.9	73.9	92.3	108.4	122.4	134.7	145.4	154.9

CONCLUSIONS

The precision of age determination offered by reading otoliths is of significant value to studies of the southern bluefin tuna's population dynamics.

Difference between estimates of the parameters of the von Bertalanffy growth equation made in this study and those made in earlier studies can be attributed to samples of differing size range and distribution, and possibly biased by fishing strategy.

Much research has been done on the northern bluefin tuna (*Thunnus thynnus*), a closely related species (Iwai, Nakamura and Matsubara, 1965) demonstrating the superiority of otoliths over other structures for age determination (Nichy and Berry, 1976; Caddy and Butler, 1976; Butler, Caddy, Dickinson and Hunt, 1977; Hurley and Isles, 1982). Whilst scales, vertebrae and fin spines showed readable banding in young fish, banding was unclear in older fish; otoliths showed clear banding for fish to 30 years of age. A similar phenomenon may be reasonably expected for the southern bluefin tuna.

ACKNOWLEDGEMENTS

Thanks must go to the fishermen and staff of processing companies, particularly of the Heinz cannery, Eden, who allowed me to sample, usually at their inconvenience. I also thank Dr Garth Murphy, Dr Jacek Majkowski, Mr Kevin Williams and Mr Bill Hearn of the CSIRO Division of Fiseries Research, for their assistance and encouragement whilst I was with the Division. Lastly, I thank Dr W. J. R. Lanzing of The University of Sydney, for his patient support whilst waiting for this work to be written up.

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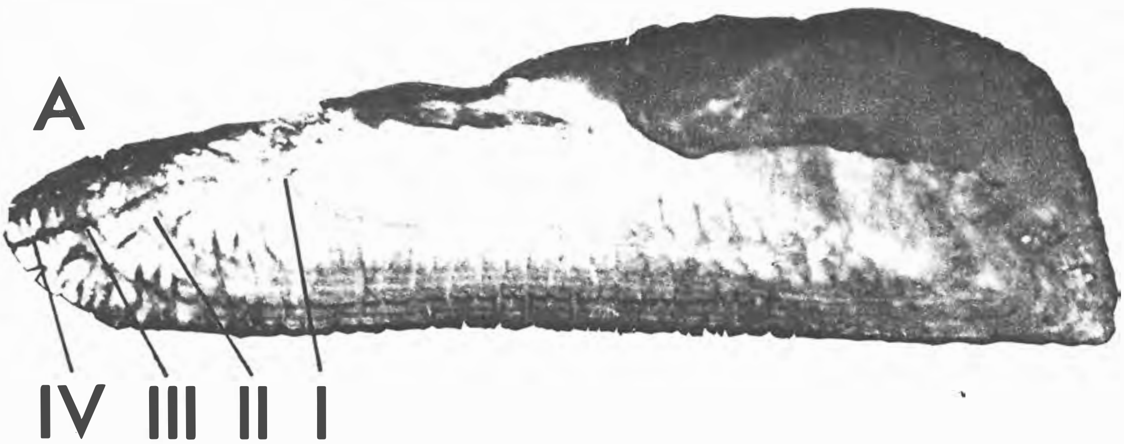
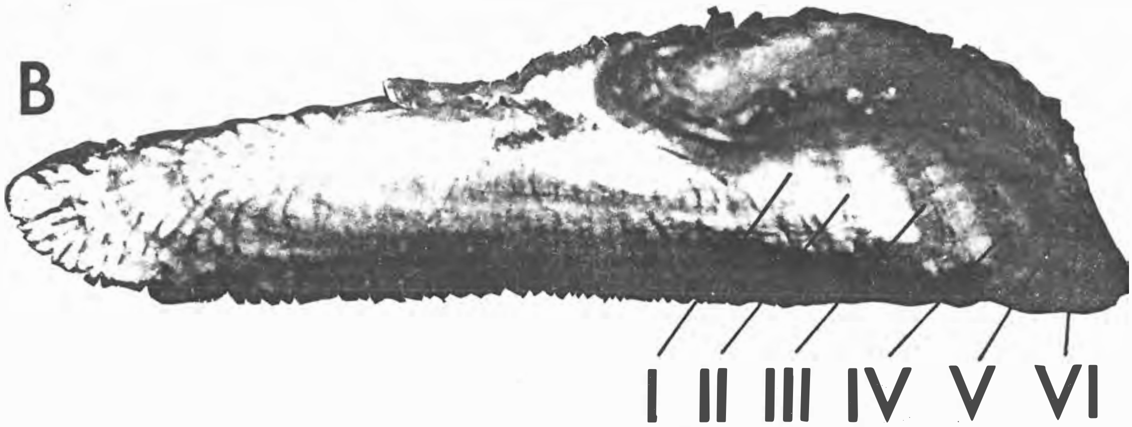
LIST OF FIGURES

Figure 1a & b.	Burnt and mounted sagittal otoliths from southern bluefin tuna of 86 cm (a), and 128 cm (c), showing 4 and 6 bands respectively.
Figure 2.	Otolith length (rostrum to post-rostrum plotted against fish fork-length.
Figure 3.	Mean otolith marginal increment plotted by month for 2, 3, and 4 band fish. Error bars represent one standard deviation from the mean.
Figure 4	The relations between age, fork-length and weight of southern bluefin tuna.


A
IV III II I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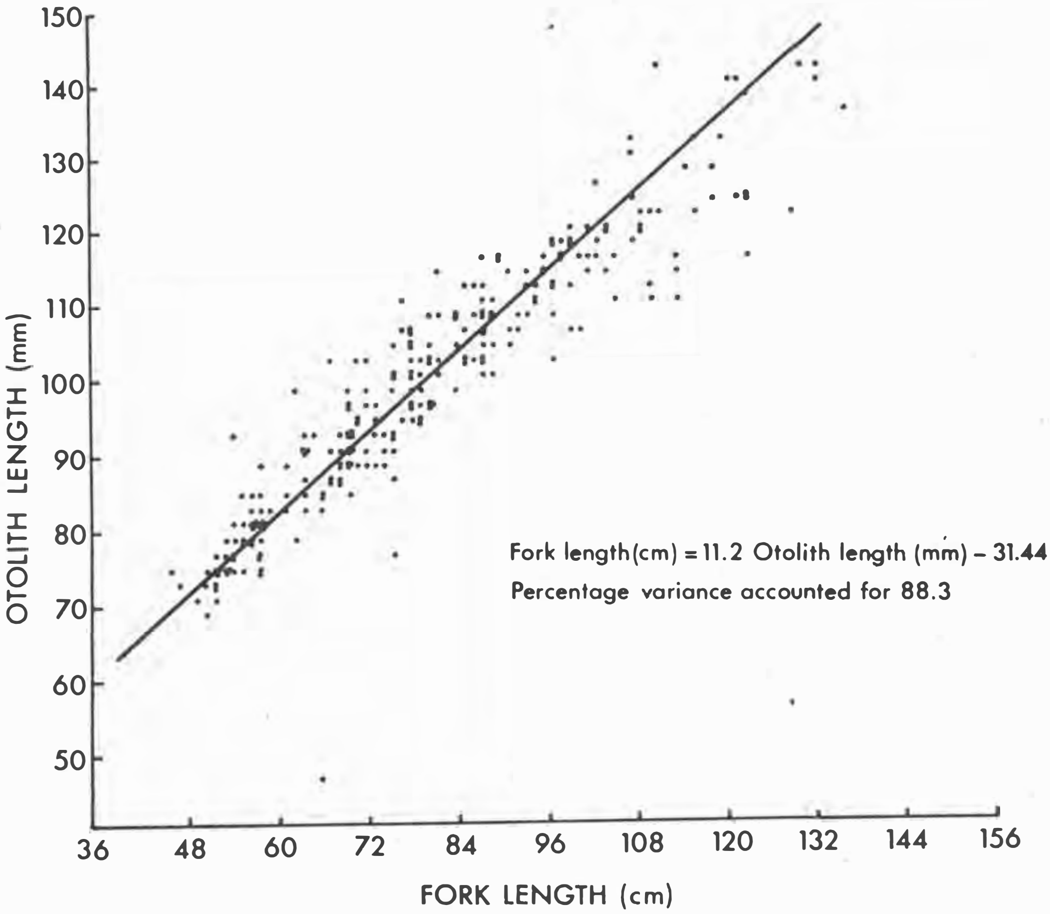
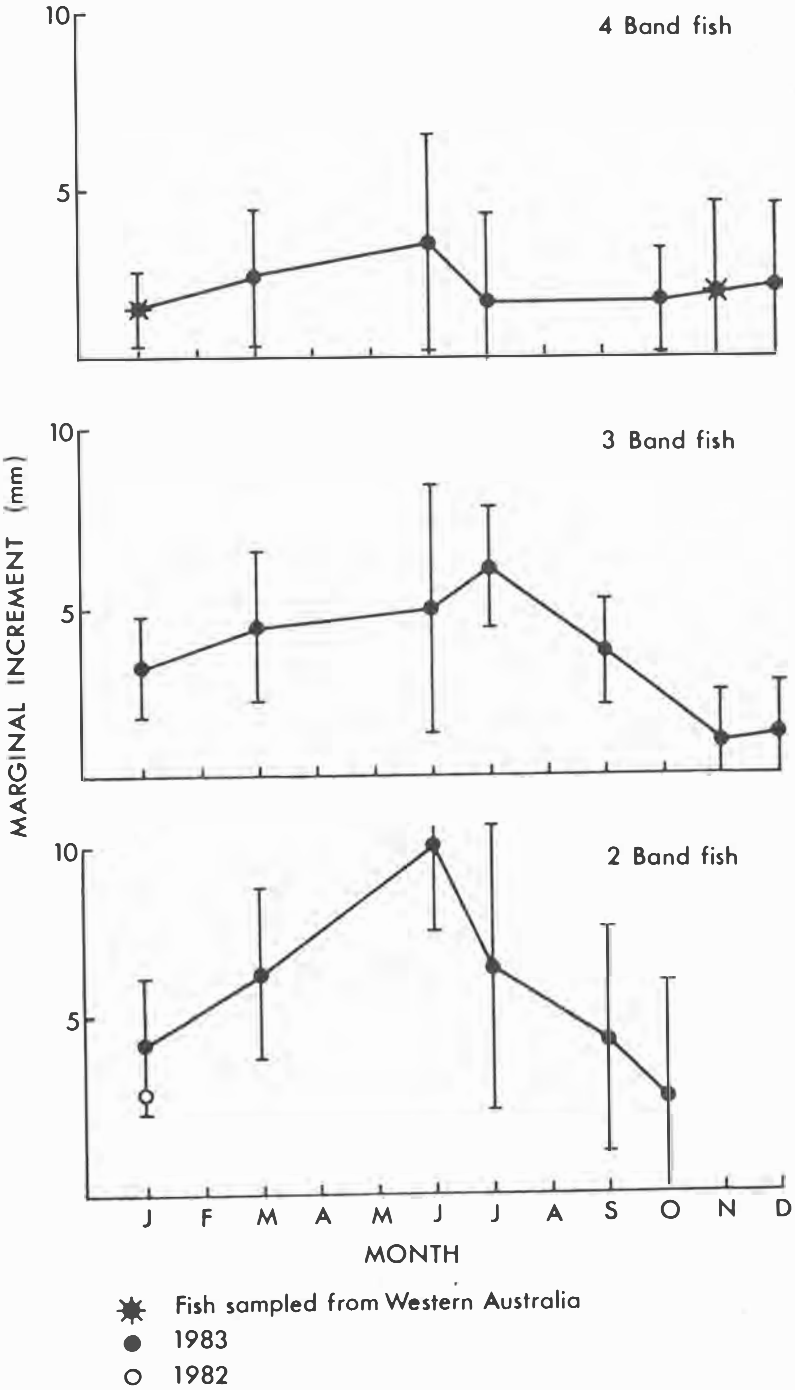
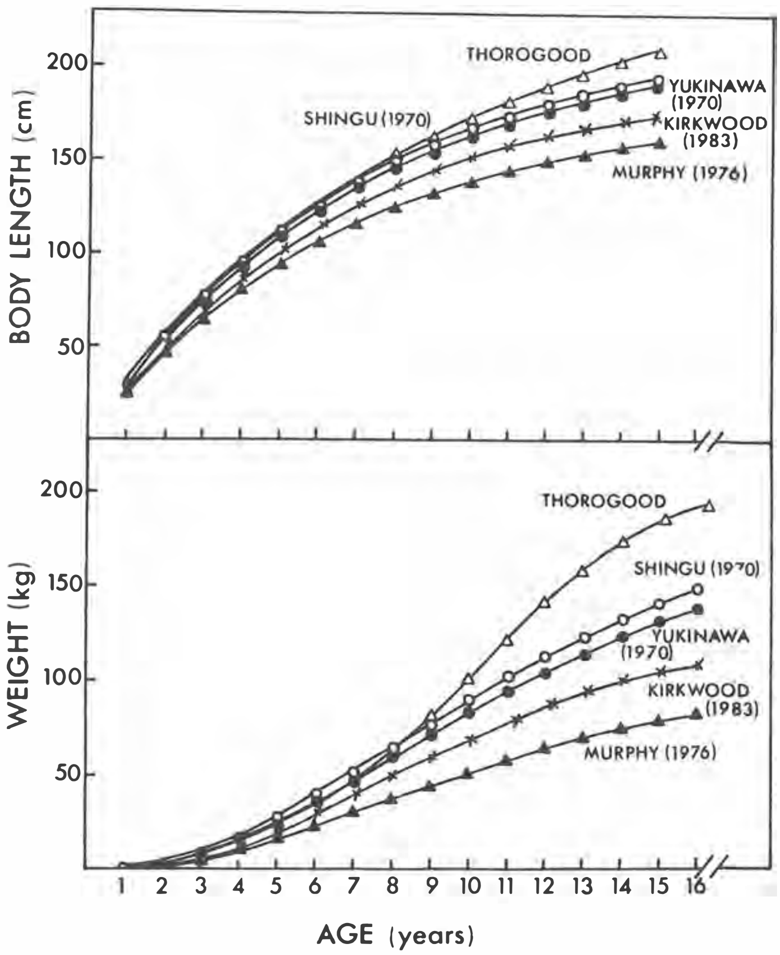


150
140
130
120
110
100
90
80
70
60
50
OTOLITH LENGTH (mm)
36
48
60
72
84
96
108
120
132
144
156
FORK LENGTH (cm)
Fork length(cm) = 11.2 Otolith length (mm) – 31.44
Percentage variance accounted for 88.3


4 Band fish
3 Band fish
2 Band fish
MARGINAL INCREMENT (mm)
10
5
J F M A M J J A S O N D
MONTH
Fish sampled from Western Australia
1983
1982



	l_∞	k	t_o
THOROGOOD	261.3	0.108	-0.157
KIRKWOOD (1983)	207.6	0.128	-0.394
MURPHY (1976)	180.8	0.146	0.011
SHINGU (1970)	225.5	0.14	-0.011
YUKINAWA (1970)	209.7	0.135	0.040

THE DETERMINATION OF AGE AND GROWTH RATE OF SOUTHERN BLUEFIN TUNA USING OTOLITHS

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Introduction

Recent studies[1] have revealed annual banding in the otoliths (ear bones) of the southern bluefin tuna (Thunnus maccoyii). This banding allows the fisheries biologist to determine the age and growth rate of individual fish, precisely and quickly.

There are a number of reasons why fisheries biologists rely heavily on age and growth rate studies if they are to advise on the best ways to manage a resource. Both the life expectancy of a fish and it's production of offspring are related to age, and consequently provide the basis for fisheries analysis using population dynamics modeling. These models allow the fisheries biologist to predict the impact of alternate fishing stategies and management regimes. Age and growth rate studies can also provide information relating to the age structure of a stock, the timing and frequency of spawning, response to the environment such as a change in population density, and annual variation in the survival of young. Accurate estimates of growth rate are essential for determining recruitment to the fishery and likely production.

There are several different methods of age and growth determination available to the fisheries biologist. Not unexpectedly the size of a fish gives a fair indication of it's age. For young southern bluefin tuna, up untill about the age of seven, length is a reliable indicator of age. By measuring a large number of fish and plotting their length against time a number of peaks become apparent[2]. These peaks represent the most commonly occuring length for fish born in a particular year. By following the progression of peaks over time (sampling each month for example), the average growth rate of fish in each year class can be determined. Greek fishermen first used this method of ageing tuna over 2000 years ago.

***** Figure 1 Here *****

However, whilst it's easy to guess the age of a child by his height, this method doesn't work for adults (a 20 year old man is roughly the same height as a 60 year old man). So it is with the southern bluefin tuna, about the time they begin to mature (around 6 years of age) their growth rate slows dramatically. This has the effect of causing the peaks to become indistinct and eventually overlap so that one year class can't be discriminated from another.

A second method used to determine the growth rate of southern bluefin tuna has been to tag fish, recording the date and the fish's length[3]. If the fish is recaptured and again measured, the growth of the fish over the period between tagging and recapture can be accurately determined. The problems inherant to this type of study are firstly that the fish must be caught twice, and secondly the time lag between beginning the study and getting any worthwhile results. As only fish to 4+ years of age have been tagged, it will be many years before we are able to say anything about the growth of southern bluefin in old age, that is if any tagged fish both survive that long and are recaptured.

So, the methods available to date, to determine the age and growth rate of southern bluefin tuna are limited; age-from-length by a decline in the growth rate of mature fish, and growth rate from tagging studies by the long wait for results. A direct method of age estimation is needed that is both accurate and reliable for the entire age range of the stock.

Annual banding in bony structures

Annual banding in bony structures, such as scales, fin spines, vertebrae, and otoliths has been used to determine the age and growth rate of many species of fish. Banding, analygous to that seen in a sawn tree stump, represents changes in the rate of growth and associated metabolic processes, in response to changes in the environment. Environmental factors that have been shown to influence the growth rate of fish include temperature, day length, and food intake. Not all bony structures show clear banding in all fish, in one species scales may produce the clearest banding, in another otoliths. Studies to find a suitable stucture for the southern bluefin tuna have been conducted by both the CSIRO, and Japanese and New Zealand fisheries agencies. Scales were examined and considered unreliable by the late Stan Hynd (CSIRO). Banding in scales was considered reliable for immature southern bluefin tuna only, by Japanese researchers in the late '60s[4]. Most recently fin spines have been examined by New Zealand scientists.

After examining a range of stuctures, and experimenting with a variety of methods designed to reveal or enhance banding, such as burning and staining, banding was found to be clearest and most easily read in otoliths. Cleaned otoliths are lightly burned to highlight the variation in the proportion of calcium to protein deposited in their structure. Clear banding can be easily revealed in otoliths for the size range of fish available from the Australian fishery (up to 8 years of age).

***** Figure 2a and b Here *****

When do the bands form ?

In order to determine that banding was annular, otoliths were sampled from fish of varying sizes over a 13 month period. By measuring and plotting the amount of otolith growth since the last complete band, it was possible to show the time of band formation and the relative growth rate throughout the year.

***** Figure 3 Here *****

A clear peak can been seen around the period June - July, indicating a rapid increase in growth rate coinciding with the onset of spring. Rapid growth continues over the summer months, declining in winter.

Age - length relation

The age - length relation derived from otolith banding is plotted in Figure 4, with growth curves determined in earlier studies using different methods shown for comparison[5,6]. 3

***** Figure 4 Here *****

Future Studies

Although otoliths have been unavailable from fish greater than 150 cm, similar research conducted in Canada on northern bluefin tuna (Thunnus thynnus) has shown that yearly banding in otoliths remained readable for fish in excess of 20 years of age[7,8,9]. As part of a current FIRTA sponsored project (see Australian Fisheries **** your ref. here ****) it's planned to collect the otoliths of larger, older southern bluefin tuna through the cooperation of Australian, Japanese and New Zealand fishermen and scientists.

Acknowledgements

I am particularly grateful to the skippers and crew of the southern bluefin tuna boats that have allowed me to sample their catch, usually suffering great inconvenience, over the past years. I would also like to thank the shore personnel and cannery staff, without whose help this study would not have been possible.

This reseaerch was initiated whilst I was with the CSIRO Division of Fisheries Research.

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John Thorogood is currently principal investigator of two FIRTA projects, one dealing with aspects of the reproductive biology of the southern bluefin tuna, the other with otolithic ageing of mature southern bluefin tuna. Currently at The University of Sydney, the author has spent a number of years working on the biology of the southern bluefin tuna with the CSIRO Division of Fisheries Research.

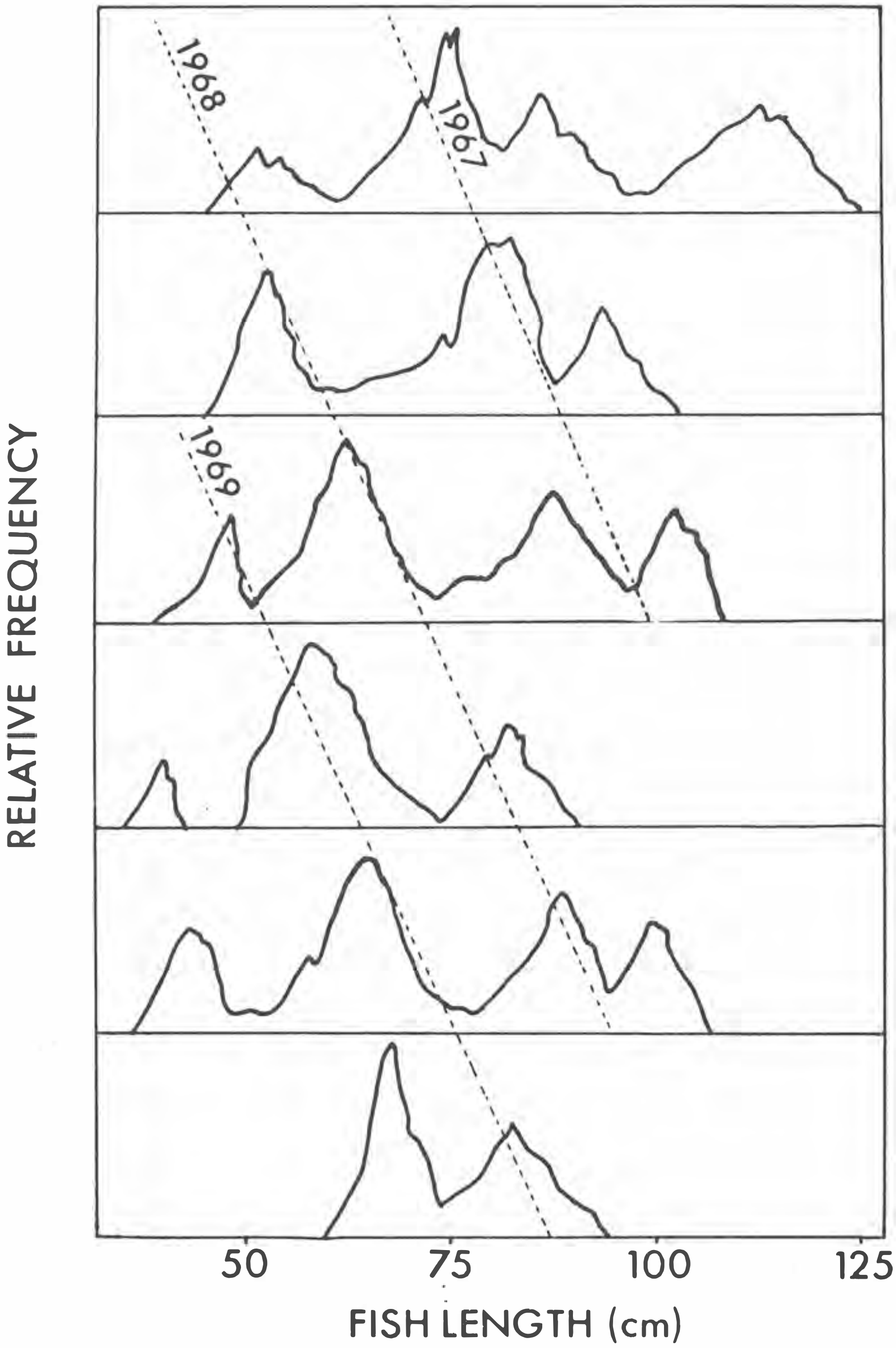
List of Figures

Figure 1. Size composition of the 1970 Australian southern bluefin tuna catch, plotted at bimonthly intervals. Oblique broken lines indicate the growth of year-classes spawned in 1967, 1968 and 1969.

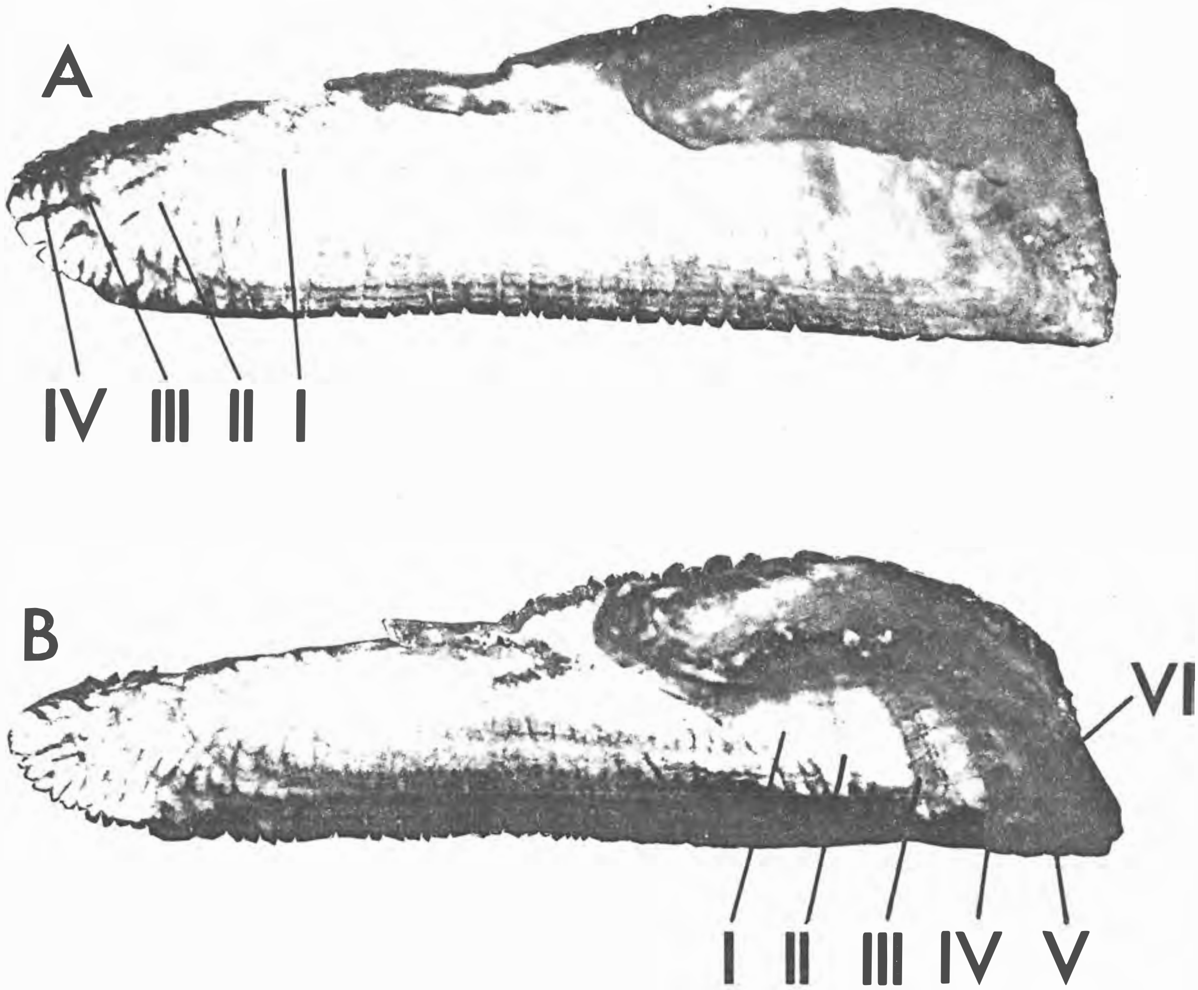
Plate 2a, b. Otoliths from an 86 cm (a) and an 128 cm (b) southern bluefin tuna, lightly burnt to reveal four and six bands respectively.

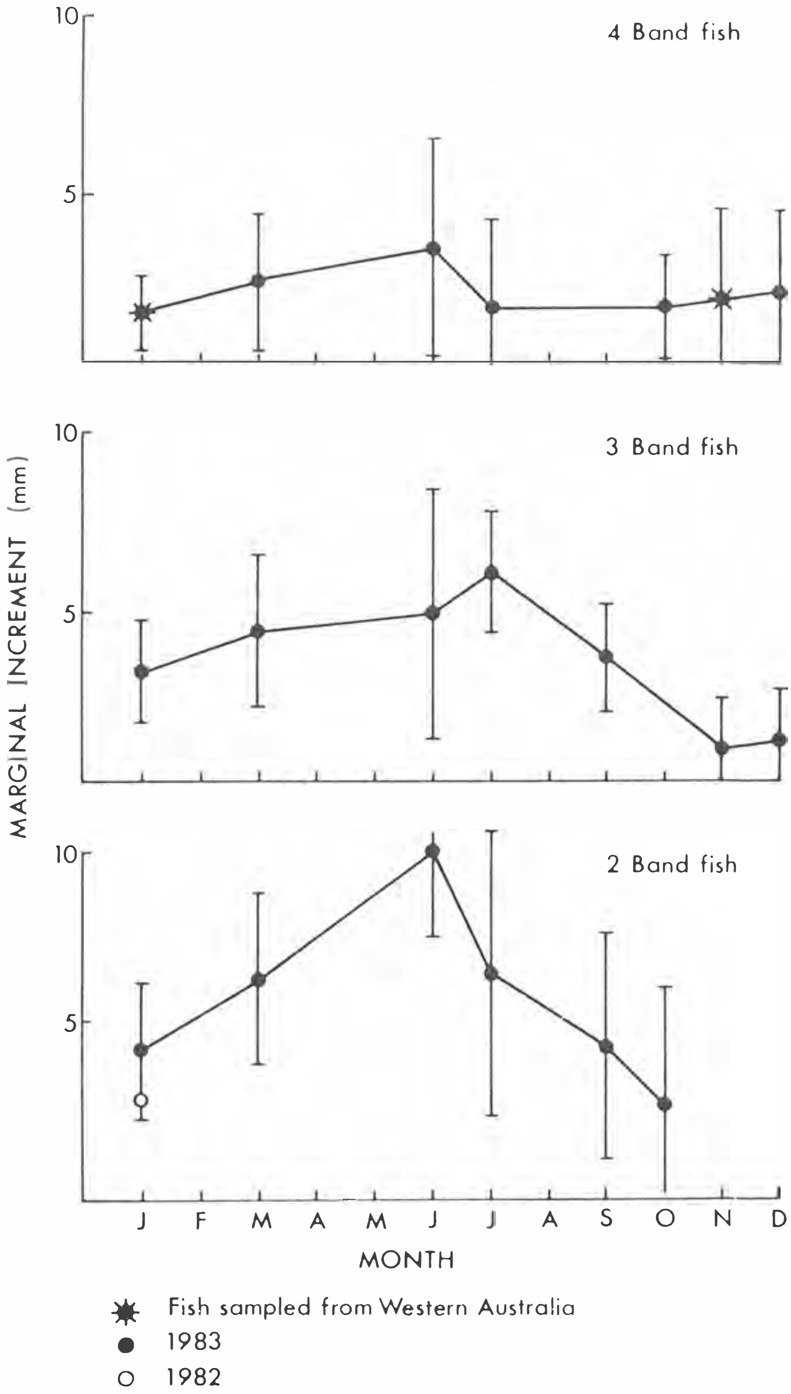
Figure 3. Otolith marginal growth plotted by month for two, three, and four year old southern bluefin tuna. Error bars represent one standard deviation from the mean.

Figure 4. Age - length relationships for southern bluefin tuna, derived from length - frequency analysis (Shingu, 1970), banding in scales (Yukinawa, 1970), tag - recapture (Murphy and Majkowski, 1981), and banding in otoliths.

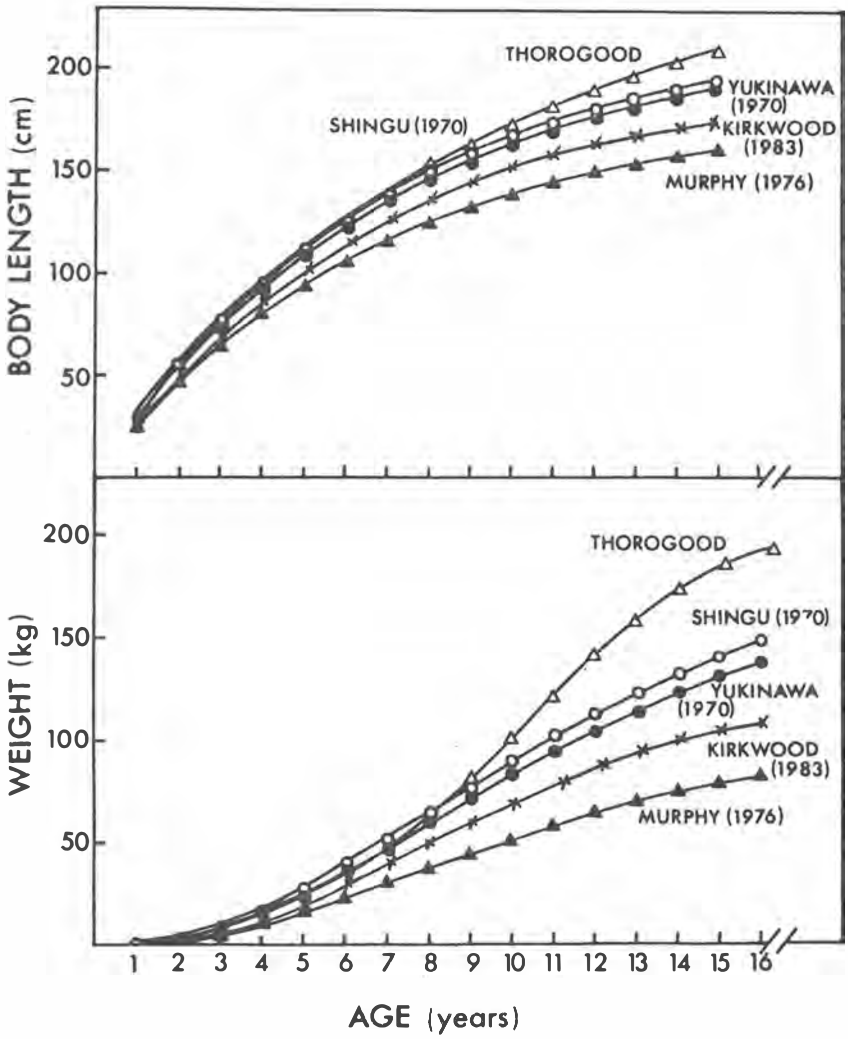


1968
1967
1969
RELATIVE FREQUENCY
50
75
100
125
FISH LENGTH (cm)


A
IV
III
II
I
B
VI
I
II
III
IV
V



4 Band fish
3 Band fish
2 Band fish
MARGINAL INCREMENT (mm)
10
5
J F M A M J J A S O N D
MONTH
Fish sampled from Western Australia
1983
1982



THOROGOOD
YUKINAWA (1970)
SHINGU (1970)
KIRKWOOD (1983)
MURPHY (1976)
BODY LENGTH (cm)
200
150
100
50
THOROGOOD
SHINGU (1970)
YUKINAWA (1970)
KIRKWOOD (1983)
MURPHY (1976)
WEIGHT (kg)
200
150
100
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
AGE (years)

A NEW TECHNIQUE FOR SAMPLING THE OTOLITHS OF SASHIMI - GRADE SCOMBRID FISHES

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ABSTRACT

A technique involving the use of a rechargeable drill fitted with a hole saw attachment for the removal of otoliths is described. This technique causes little damage to the fish and consequently is suitable for tuna and similar fish destined for the Japanese sashimi market.

INTRODUCTION

The use of otoliths for the age determination of fishes, and in particular scombrids such as the commercially important tunas is widely practiced (eg. Caddy and Butler, 1976; Nichy and Berry, 1976; Laurs and Nichimoto, 1979; Wild and Foreman, 1982). Traditionally, otoliths have been removed from the fish after the head has been removed or at least partly severed from the trunk. The recent trend towards supplying fish to the Japanese sashimi market has severely restricted the sampling of otoliths from tunas, southern bluefin (Thunnus maccoyii), yellowfin (T. albacares), and bigeye (T. obesus), caught in Australian and New Zealand waters. To achieve the maximum market price sashimi tuna must appear intact and undamaged.

In this paper a technique is described that enables otoliths to be sampled with little damage to the fish.

MATERIALS and METHODS

Tunas destined for the Japanese sashimi market are 'dressed' immediately upon capture. In this process the gill cover (operculum) from both sides is removed and the gills and associated tissue removed from the back of the buccal cavity (see Marek, 1985). The posterior region of the skull is thus revealed and accessable.

Using a rechargable drill fitted with a hole saw attachment of approximately 4cm diameter a core may be taken from the region of the skull known to contain the otoliths (Figure 1). The diameter of hole saw used may be varied to suit the size of the fish, and reduced with experience. Whilst an arbor is needed to hold the hole saw in position initially, it is removed as soon as a clear 'track' is cut by the saw. In large fish, where it may not be possible to gain the necessary depth with the saw to remove the otoliths with the core, otoliths may be removed from their capsules using fine forceps, via the hole made with the hole saw. A screw driver or similar tool is used to crack loose the core from underlying bone. After removal of the otoliths the core is replaced in it's original position, leaving little indication of sampling. The sampling operation takes less than a minute with practice.

Tuna that are air-freighted packed in ice, rather than being frozen on board ship may not have their gill covers removed. This resticts ease of access to the skull, but should not prevent a core being taken.

Otolithic banding can be revealed using the burning technique of Thorogood (submitted).

RESULTS and DISCUSSION

Intact otoliths are able to be quickly sampled from tunas and similar fishes in a manner that produces no apparent damage to the fish and that is generally acceptable to both the fisherman and the Japanese market.

This technique for otolith removal is currently being used to sample Australian southern bluefin tuna, destined for the Japanese sashimi market and whole export to Europe. The technique would seem applicable to any large species of fish where market presentation prevents conventional sampling techniques.

ACKNOWLEDGMENTS

I thank Mark Wilson for his inspiration, Albert Caton for his faith and David Burford for his willingness to allow me to practice on fish at the Sydney Fish Markets during the early stages of this work.

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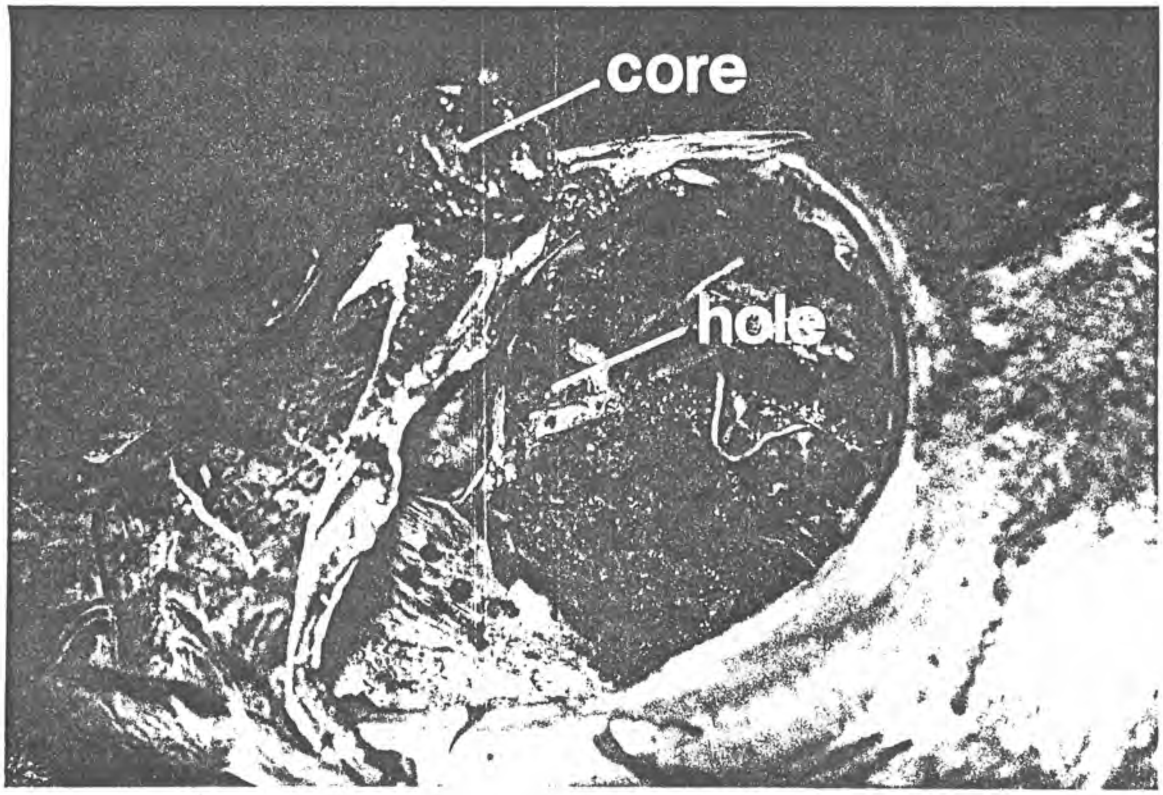
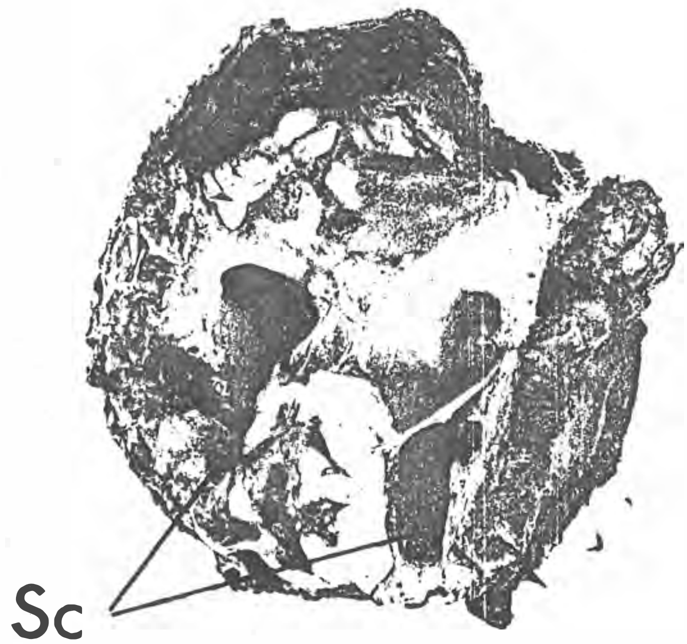
Figure 1. A yellowfin tuna (Thunnus albacares) showing gill cover removed (standard sashimi preparation) and a 4 cm core removed from the posterior region of the skull.

Figure 2. The core showing the saccullar canals from which the otoliths have been removed. Otoliths on the right have been cleaned of their tissue capsule. Note asteriscus and lapillus below the sagitta


core
hole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