International Commission for ⬛ the Northwest Atlantic Fisheries

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DRAFT

Report of the Ageing Workshop at Vigo, Spain
October-November 1975

Introduction

Differences in the age compositions of some fish species as sub-
mitted by various countries to ICNAF were apparent at the Assessments
Subcommittee Meeting at Woods Hole. Because accurate age determinations
are essential in analytical assessments of fish stocks, an ageing workshop
was set up to ascertain if there were in fact differences between age
determinations of readers of different countries and if so, if these
differences were important. This document describes the proceedings of the
workshop which took place in Vigo, Spain.

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Time and Place

The meeting was held at the Instituto de Investigaciones Pesqueras, Vigo, Spain. Two species were to be examined.

Cod

The cod workshop was carried out as scheduled during October 20-25, 1975, with the participation of experts from U.S.A., Canada, Poland, F.R.G., Portugal and Spain. Because of illness, the Soviet expert was unable to attend before November 3, at which time he had the opportunity to study part of the samples examined in the workshop.

Silver Hake

Silver hake experts from U.S.A. and Canada were present during the October 20-25 period, but because of illness, the Soviet expert was unable to attend at this time. In view of the recommendations made by STACRES at its Annual Meeting in June in relation to the ageing workshop (Redbook 1975, p. 20), which emphasizes that "countries fishing those stocks should participate in the workshop and that participants should include the persons who actually do the age reading", and taking into account that due to unfortunate and unavoidable circumstances, Soviet and Canadian silver hake experts were not present for the week of November 3-7, it was agreed to exchange points of view with relation to techniques, but the major problem, namely that experts from countries interested in these stocks meet and discuss the interpretation of otoliths in relation to ageing problems, could not be solved at this time, so that the need of such a meeting still exists, and it should be left to the interested countries to decide where, when and if such a meeting is to be held.

Organization of the Work

Two samples of cod otoliths were examined as follows:

ICNAF DIVISION	Sample 1 (Spanish)	Sample 2 (Canadian)
2J		49
3K	55	46
3L	106	49
3NO		49
3O	52	49
3Ps	52	49
4Vn	51	
5Z	52	

Each reader was provided with a microscope for use throughout the whole workshop. the otoliths were read in a darkened room. The otoliths were embedded in clay and arranged in trays each containing about 25 specimens so that no delay was experienced in obtaining samples.

There was insufficient time for most readers to read all the otoliths available.

On October 20, Sample 1 was read by those participants who had arrived by that date. On the following day, after discussion by all participants, it was decided to carry on with Sample 2 because this sample included photographs and slides of the otolith sections. After these otoliths had been read, time was available to study in detail about 60 slides and the various interpretations of age were noted and discussed.

Results

Sample 1

Agreement between Pairs of Readers

Table 1 shows the percentage agreement between readers by ICNAF Division and in total. Agreements between readers ranged from 0 (readers 3, 9 in Division 3Ps) to 77% (readers 8, 9 in Division 3Ps). Agreement between pairs of readers for all Divisions combined ranged from 8% (readers 1, 3) to 63% (readers 8, 9). An agreement of 76% was reached by readers 5 and 8 but this was for Division 5Z only. the average agreement between pairs of readers was as follows:

DIVISION	NO. OF PAIRS OF READERS	AVERAGE PERCENTAGE AGREEMENT BETWEEN PAIRS
3K	3	53
5Z	10	51
3Ps	28	42
4Vn	11	42
3L	24	34
30	9	23

This grouping would imply that the otoliths most difficult to interpret were those of 30 and 3L.

Taking all Divisions combined, the percentage agreement between pairs of readers is shown in Table 2. Pairs of readers with agreements better than 50% were (1,2), (1,5), (2,10), (5,8), (8,9), (8,10). Reader 2 has little bias with respect to the group as a whole; readers 1, 4, 5, 8 and 9 under-read the group while readers 3, 6, 7 and 10 tend to over-read the group.

Agreement with the Modal Age

A mode was derived for each specimen from the ages estimated by the various readers, except in those areas (about 20%) in which no clear mode was evident. The ages of each reader were compared to the mode and the anomalies (estimated age-modal age) are listed in Table 3 by reader and Division. The mean age and standard error of the anomalies by Division and reader were calculated. With respect to the modal age the deviation of the mean age from 0 gives an indication of bias, while the standard error gives a measure of consistency.

Table 4 shows the means and standard errors by Division and reader. This table may be compared with the plots of the data of Table 3 (Figures 1-8). In Division 3K, agreement with the mode was good by all 3 readers. In Division 3L (1973), agreement was generally good but readers 1 and 4 tended to under-read while reader 7 showed some tendency to over-read. In Division 3L (1974), agreement was good, although reader 7 showed a tendency to over-read the mode. In Division 30, agreement was fair. Reader 3 over-read. Reader 2 tended to under-read. In Division 3Ps, agreement was excellent, although readers 3 and 7 over-read the mode. In Division 4Vn, agreement was excellent; reader 1 tended to under-read. In Division 5Z, agreement was excellent.

The mean ages of the anomalies are shown in Table 5 by reader and Division. The agreement with the mode for all Divisions combined averaged about 65%. For all Divisions combined, agreement was good, except that reader 3 over-read the mode and reader 7 tended to over-read.

Sample 2

Modal ages were derived for this sample as for the previous one. The anomalies from the mode by reader and Division are listed in Table 6, while the means and standard errors of the anomalies by Division and reader are shown in Table 7. Table 7 may be compared with the plots of the data of Table 6 (Figures 9-15).

In Division 2J readers 11 and 17 under-read, and reader 16 over-read the mode. Readers 2 and 13 over-read to a lesser extent. In Division 3K, readers 1, 2 and 16 tended to over-read, and readers 4, 7, 14 and 15 tended to under-read. In Division 3L, readers 16 and 17 over-read and 4 and 7 under-read. In Divisions 3NO, readers 2, 16 and 17 over-read; readers 4 and 7 under-read. In Division 30 reader 16 over-read and reader 7 under-read. In Division 3Ps, reader 2 over-read and reader 17 under-read.

Taking all Divisions combined, reader 16 consistently over-read the mode; reader 2 showed a tendency to over-read and readers 4 and 7 a tendency to under-read. The agreement overall was about 60%.

Examination of Photographs

About 60 otoliths were examined by the group by means of slides and the various interpretations suggested were noted on the photographs appended. Some otoliths offered no difficulty and agreement was unanimous, for example: 3L 55, 3L 268, 2J 58, 2J 85.

Difficulties were encountered in determining the first annulus. The following were considered typical first year annuli: 3Ps 37, 3Ps 104, 3Ps 155. Often a check occurs in the opaque zone before the first annulus is laid down as in 3Ps 127, and in some cases, for example, 3Ps 101 and 3L 189, it was difficult to agree if a ring was a check or the first annulus. Compounding the difficulty, otoliths cut off centre may show a deformed first annulus such as the figure 8 shape in 3Ps 192.

It appeared that the second annulus might often be characteristically clear or bright, for example 3L 268, 3Ps 104.

The major problem was in determining which rings were splits or checks. The different interpretations of splits and checks were the major reasons for disagreements. Some otoliths, such as 2J 12, showed many splits. In otoliths 3L 134 and 2J 58 it was agreed that a definite check occurred in the opaque zone before the second annulus and that 3L 189 showed a definite check before the third annulus. Definite splits were present in the second annulus of otoliths 3Ps 45 and 2J 58 and in the third annulus in 3L 102 and 2J 85. Doubtful checks and splits were common, for example in 3NO 27, 3L 6 and 3L 183.

A problem was also encountered in determining whether the type of edge was opaque or hyaline: 3L 183, 3Ps 101, 3L 268. In a number of cases it was difficult to determine if there were 1 or 2 years at the edge, for example: 3Ps 37, 30 65, 2J 300, 3L 189 and 3NO 71.

An analysis of these ageing data is being attempted at the Newfoundland Biological Station to determine if the differences noted above are significant. Serious differences between pairs of readers are evident but the differences between readers and modal ages are much less severe.

Discussion

The participants at the workshop considered that, because of obvious differences between readers, there was a need for a description of the problems encountered in the age determination of cod and guidelines to assist in resolving these problems. Several of the problem areas were discussed:

a) Nuclueus and determination of the first annulus

b) The effect of cutting the otolith "off-centre" - the figure 8
                                                    effect
                                             - small 1st
                                               annulus

c) Otolith edge - recognition of the type of edge (Hyaline or
                   opaque)
                 - seasonal deposition of opaque and hyaline
                   material

d) Splits and checks - and how these may be distinguished from
                        annuli

e) Peculiarities in the otoliths from specific areas - for
                   example, a small first annulus in 4Vn, a
                   very strong check before the second annulus
                   in 5Z

Recommendations

1. That STACRES request papers dealing with the interpretation of ages of cod including:

   a) validation of ages

   b) seasonal deposition of material at the edge of the otolith

   c) effects of cutting otoliths "off-centre"

   d) peculiarities in the otoliths of specific areas

2. That STACRES request whatever further action is necessary to ensure discrepancies in age composition data be eliminated as far as possible.

Table 1. Percentage agreements between pairs of readers of sample 1 by ICNAF Division.

READER	ICNAF DIV.	READER									
		1	2	3	4	5	6	7	8	9	10
1	3K								42	51	
	3L			9	35				9	26	9
	30										
	3Ps		56	8	52			13	66	66	48
	4Vn		28		58			35	35		
	5Z		68		37	51			45		
	TOTAL		55	8	44	51		22	42	50	32
2	3L				47			41	49	48	46
	30			4					17	38	
	3Ps	56		50	38			31	57	57	61
	4Vn	28			48			35	55		
	5Z	68			45	47			45		
	TOTAL	55		29	45	47		36	48	50	54
3	3L	9			12				42	48	20
	30		4				25		10	6	
	3Ps	8	50		15			46	12	0	15
	4Vn										
	5Z										
	TOTAL	8	29		14		25	46	18	15	18
4	3L	35	47	12				27	30	37	23
	30										
	3Ps	52	38	15				15	77	69	65
	4Vn	58	48					39	43		
	5Z	37	45			45			48		
	TOTAL	44	45	14		45		30	44	45	35
5	3L										
	30										
	3Ps										
	4Vn										
	5Z	51	47		45				76		
	TOTAL	51	47		45				76		
6	3L										
	30				25				21	33	
	3Ps										
	4Vn										
	5Z										
	TOTAL				25				21	33	

Table 1. (cont'd).

READER	ICNAF DIV.	READER									
		1	2	3	4	5	6	7	8	9	10
7	3L		41		27				33	36	41
	3O										
	3Ps	13	31	46	15				18	22	29
	4Vn	35	35		39				51		
	5Z										
	TOTAL	22	36	46	30				34	29	35
8	3K	42								67	
	3L	9	41	42	30			33		57	49
	3O		17	10			21			57	
	3Ps	66	57	12	77			18		77	63
	4Vn	35	55		43			51			
	5Z	45	45		48	76					
	TOTAL	42	48	18	44	76	21	34		63	54
9	3K	51			·				67		
	3L	26	48	48	37			36	57		38
	3O		38	6			33		57		
	3Ps	66	57	0	69			22	77		58
	4Vn										
	5Z										
	TOTAL	50	50	15	45		33	29	63		45
10	3L	9	46	20	23			41	49	38	
	3O										
	3Ps	48	61	15	65			29	63	58	
	4Vn										
	5Z										
	TOTAL	32	54	18	35			35	54	45	

Table 2. Percentage agreements between pairs of readers of sample 1. Bias between readers is shown in parentheses and equals percentage over-read minus percentage under-read.

READER	>60	51-60	41-50	31-40	<30	AV. BIAS	AV. AGREEMENT
1		2 (-26) 5 (49)	4 (17) 8 (-24) 9 (-22)	10 (-68)	3 (-84) 7 (-71)	-28	38
2		1 (26) 10 (-23)	4 (29) 5 (45) 8 (2) 9 (12)	7 (-17)	3 (-67)	1	46
3			7 (-30)		1 (84) 2 (67) 4 (78) 6 (50) 8 (65) 9 (83) 10 (42)	55	22
4			1 (-17) 2 (-29) 5 (-23) 8 (-30) 9 (-21)	10 (-51)	3 (-78) 7 (-42)	-30	38
5	8 (-16)	1 (-49)	2 (-45) 4 (23)			-22	55
6				9 (59)	3 (-50) 8 (54)	21	26
7			3 (30)	2 (17) 8 (37) 10 (33)	1 (71) 4 (42) 9 (67)	42	33
8	5 (16) 9 (21)	10 (-23)	1 (34) 2 (-2) 4 (30)	7 (-37)	3 (-65) 6 (-54)	-18	44
9	8 (-21)		1 (22) 2 (-12) 4 (21) 10 (-44)		3 (-83) 6 (-59) 7 (-67)	-30	-41
10		2 (23) 8 (23)	9 (44)	1 (68) 4 (51) 7 (-33)	3 (-42)	19	39

Table 3. Anomalies from the modes of otolith sample 1 by reader and by ICNAF Division.

READER	ICNAF DIV.	<-3	-3	-2	-1	0	1	2	3	>3	TOTAL
1	3K			2	9	29	5	1			46
	3L(73)		1	1	8	4	1				15
	3Ps				8	22	1				31
	4Vn			1	10	12					23
	5Z					28	8	2			38
	TOTAL		1	4	35	95	15	3			153
2	3L(73)				2	16		1			19
	3L(74)				11	31	4				46
	3O			2	5	7	1				15
	3Ps				1	32	10				43
	4Vn					27	10	2			39
	5Z				2	25	11				38
	TOTAL			2	21	138	36	3			200
3	3L(73)					12	2				14
	3O					5	13	12	3	4	37
	3Ps				1	3	19	2			25
	TOTAL				1	20	34	14	3	4	76
4	3L(73)		1	7	5	3					16
	3L(74)				15	30	1				46
	3Ps					20	5				25
	4Vn			1	7	28	3	1			40
	5Z			2	11	24	4				41
	TOTAL		1	10	38	105	13	1			168
5	5Z			3	1	37					41
6	3O				1	11	5	2			19
7	3L(73)				1	10	4	3	1		19
	3L(74)				2	9	7	1			19
	3Ps					10	21	9	2	1	43
	4Vn				8	27	3	2			40
	TOTAL				11	56	35	15	3	1	121
8	3K					40	8				48
	3L(73)				3	27	3	3			36
	3L(74)				2	37	7	1			47
	3O				3	30	5				38
	3Ps			2	3	39	1				45
	4Vn				2	31	6	1			40
	5Z				4	31	5				40
	TOTAL			2	17	235	35	5			294
9	3K				2	45	1				48
	3L(73)				5	31					36
	3L(74)				10	35	2				47
	3O		1	1	3	32	1				38
	3Ps				5	39	1				45
	TOTAL		1	1	25	182	5				214
10	3L(73)				3	23	6	2	2		36
	3L(74)					28	11				39
	3Ps				1	33	8	3			45
	TOTAL				4	84	25	5	2		120

Table 4. Mean age and standard error by ICNAF Division and
reader with respect to the mode of otolith sample 1.

ICNAF DIV.	READER	$\bar{x}$	$S_{\bar{x}}$	TOTAL READ	% AGREEMENT
3K	1	- .13	.11	46	63
	8	.17	.054	48	83
	9	- .021	.036	48	94
3L 1973	1	- .80	.24	15	27
	2	.00	.13	19	84
	3	.14	.097	14	86
	4	-1.38	.22	16	19
	7	.63	.23	19	53
	8	.17	.12	36	75
	9	- .14	.059	36	86
	10	.36	.16	36	64
3L 1974	2	- .15	.082	46	67
	4	- .30	.075	46	65
	7	.37	.17	19	47
	8	.15	.074	47	79
	9	- .17	.070	47	74
	10	.28	.073	39	72
3O	2	- .53	.22	15	47
	3	1.68	.19	37	14
	6	.42	.18	19	58
	8	.05	.075	38	79
	9	- .18	.11	38	84
3Ps	1	- .23	.089	31	71
	2	.21	.071	43	74
	3	.88	.12	25	12
	4	.20	.082	25	80
	7	1.14	.14	43	23
	8	- .13	.075	45	87
	9	- .09	.053	45	87
	10	.29	.093	45	73
4Vn	1	- .52	.12	23	52
	2	.36	.094	39	69
	4	- .10	.11	40	70
	7	- .025	.11	40	68
	8	.15	.084	40	78
5Z	1	.32	.093	38	74
	2	.24	.088	38	66
	4	- .27	.11	41	59
	5	- .17	.085	41	90
	8	.025	.076	40	78

Table 5. Mean age with respect to the mode of otolith sample 1
by reader and ICNAF Division

READER	3K	3L(73)	3L(74)	3O	3Ps	4Vn	5Z	TOTAL	TOTAL % AGREEMENT	TOTAL READ
1	- .13	- .80			- .23	- .52	.32	- .16	62	153
2		0	- .15	- .53	.21	.36	.24	.085	69	200
3		.14		1.68	.88			1.13	26	76
4		-1.38	- .30		.20	- .10	- .27	- .27	63	168
5							- .17	- .17	90	41
6				.42				.42	58	19
7		.63	.37		1.14	- .025		.55	46	121
8	.17	.17	.15	.05	- .13	.15	.025	.082	80	294
9	- .021	- .14	- .17	- .18	- .09			- .12	85	214
10		.36	.28		.29			.31	70	120

Table 6. Anomalies from the modes of otolith sample 2 by
reader and ICNAF Division.

READER	ICNAF DIV.	<-3	-3	-2	-1	0	1	2	3	>3	TOTAL
1	2J			2	9	17	6	1			35
	3K				5	11	8	5	2		31
	3L				3	24	10	1			38
	3NO				2	27	1	4	2		36
	3O			1	7	25	8	1			42
	3Ps				3	35	5				43
	TOTAL			3	29	139	38	12	4		225
2	2J		1	1	3	20	13	1			39
	3K				3	9	14	10	1		37
	3L				5	24	12	2	1		44
	3NO			1	2	17	10	8	2		40
	3O			2	2	24	9	3	2		42
	3Ps				1	19	24	1			45
	TOTAL		1	4	16	113	82	25	6		247
3	2J	1	1	3	11	22	1				39
	3K				7	19	9	1			36
	3L		1		3	31	8	1	1		45
	3NO			1	1	32	12				46
	3O				3	34	5				42
	3Ps				8	33	1				42
	TOTAL	1	2	4	33	171	36	2	1		250
4	2J			3	7	22	5				37
	3K	1	1	3	13	18	1				37
	3L		2	8	12	18	4				44
	3NO		1	4	16	20	2				43
	3O			2	12	29		1			44
	3Ps			3	2	41					46
	TOTAL	1	4	23	62	148	12	1			251
5	2J	1	1	1	2	6	1				12
	3K			1	4	20	7	2	1		35
	3L				6	22	14	1			43
	3NO				2	20	6				28
	3O			1	2	29	9	2	2		45
	3Ps				1	44		1			46
	TOTAL	1	1	3	17	141	37	6	3		209
7	2J	1		4	11	21	2	1			40
	3K		1	4	12	13	5				35
	3L		2	4	15	22					43
	3NO		1	2	20	22					45
	3O		2	7	16	19	1				45
	3Ps			1	8	37					46
	TOTAL	1	6	22	82	134	8	1			254
8	2J				2	30	3	3	2		40
	3K	1		1	3	22	6	4			37
	3L				2	29	9	3	2		45
	3NO				4	35	5	2			46
	3O			2	11	25	7	1			46
	3Ps				2	40	4				46
	TOTAL	1		3	24	181	34	13	4		260

Table 6. (cont'd).

READER	ICNAF DIV.	<-3	-3	-2	-1	0	1	2	3	>3	TOTAL
9	2J				3	29	3	2	3		40
	3K	1			3	26	5	1		1	37
	3L			1	3	30	10	1			45
	3NO				2	37	4	3			46
	3O			1	6	24	12	2	1		46
	3Ps				1	43	1	1			46
	TOTAL	1		2	18	189	35	10	4	1	260
11	2J		3	8	10	13	4	1			39
	3K			1	8	22	1	1	1		34
	3L			1	6	33	3	1	1		45
	3NO	1	1	1	10	27	3	2			45
	3O		1	5	8	30	1				45
	3Ps		1		2	43					46
	TOTAL	1	6	16	44	168	12	5	2		254
12	2J	1		2	7	23	4	1			38
	3K				3	24	9	1			37
	3L			1	7	31	6				45
	3NO		1	1	3	32	7				44
	3O			3	3	36	3	1			46
	3Ps				3	39	2				44
	TOTAL	1	1	7	26	185	31	3			254
13	2J					14	10	3			27
	3K				6	17	5	4	1		33
	3L				5	20	3	1			29
	3NO				2	26	2				30
	3O				5	19	2	2			28
	3Ps				7	35	3			1	46
	TOTAL				25	131	25	10	1	1	193
14	2J			2	5	28	2	3			40
	3K		1	5	7	22	2				37
	3L				9	27	6	3			45
	3NO				7	29	9	1			46
	3O				2	23	3	1		1	30
	3Ps				1	42	2	1			46
	TOTAL		1	7	31	171	24	9		1	244
15	2J				10	22	5	3			40
	3K	1	1	4	11	16	3	1			37
	3L		1	1	8	31	2	2			45
	3NO	1	1	2	12	28	2				46
	3O		1	1	7	32	3			1	45
	3Ps				2	41	3				46
	TOTAL	2	4	8	50	170	18	6		1	259
16	2J					12	16	5	2		35
	3K		1			1	13	9	4	6	34
	3L					9	14	8	5	4	40
	3NO					11	15	4	7	2	39
	3O					18	12	4	2	6	42
	3Ps					34	7	1	3		45
	TOTAL		1			85	77	31	23	18	235
17	2J			6	12	9	4		3		34
	3K		2	5	6	12	4	1	3		33
	3L				8	7	7	3	3	3	31
	3NO			1	6	11	8	4	2		32
	3O		1	4	9	6	9	6			35
	3Ps			1	15	21	4	3			44
	TOTAL		3	17	56	66	36	17	11	3	209

Table 7. Mean age and standard error by ICNAF Division and reader with respect to the mode of otolith sample 2.

ICANF DIV.	READER	$\bar{x}$	$S\bar{x}$	TOTAL READ	% AGREEMENT
2J	1	- .14	.15	35	49
	2	.18	.15	39	51
	3	- .59	.15	39	56
	4	- .22	.13	37	59
	5	- .83	.42	12	50
	7	- .48	.16	40	53
	8	.33	.14	40	75
	9	.33	.15	40	73
	11	- .74	.19	39	33
	12	- .24	.16	38	61
	13	.59	.13	27	52
	14	- .025	.13	40	70
	15	.025	.13	40	55
	16	.91	.14	35	34
	17	- .32	.24	34	26
3K	1	.61	.21	31	35
	2	.92	.16	37	24
	3	.11	.12	36	53
	4	- .68	.16	37	49
	5	.23	.16	35	57
	7	- .51	.17	35	37
	8	.054	.24	37	59
	9	.054	.25	37	70
	11	- .12	.15	34	65
	12	.22	.10	37	65
	13	.30	.18	33	52
	14	- .49	.15	37	59
	15	- .62	.22	37	43
	16	1.91	.26	34	3
	17	- .21	.27	33	36
3L	1	.24	.10	38	63
	2	.32	.13	44	55
	3	.16	.13	45	69
	4	- .68	.16	44	41
	5	.23	.11	43	51
	7	- .67	.13	43	51
	8	- .42	.13	45	64
	9	.16	.10	45	67
	11	0	.11	45	73
	12	- .067	.092	45	69
	13	0	.12	29	69
	14	.067	.12	45	60
	15	- .16	.12	45	69
	16	1.53	.20	40	23
	17	.90	.32	31	23
3NO	1	.36	.16	36	75
	2	.70	.17	40	43
	3	.20	.086	46	70
	4	- .58	.13	43	47
	5	.14	.099	28	71
	7	- .60	.10	45	49
	8	.11	.089	46	76
	9	.17	.090	46	80
	11	- .27	.15	45	60
	12	- .023	.11	44	73
	13	0	.068	30	86
	14	.087	.097	46	63
	15	- .46	.13	46	61
	16	1.36	.21	39	28
	17	.44	.22	32	34

C 1

Table 7. (cont'd).

ICNAF DIV.	READER	$\bar{x}$	$S_{\bar{x}}$	TOTAL READ	% AGREEMENT
30	1	.024	.12	42	60
	2	.36	.10	42	57
	3	.048	.068	42	81
	4	- .32	.10	44	66
	5	.33	.13	45	64
	7	- .78	.13	45	42
	8	- .13	.12	46	54
	9	.24	.13	46	52
	11	- .44	.12	45	67
	12	- .087	.10	46	78
	13	.036	.14	28	68
	14	.23	.16	30	77
	15	- .11	.14	45	71
	16	1.23	.24	42	43
	17	.029	.24	35	17
3Ps	1	.047	.067	43	81
	2	.56	.087	45	42
	3	- .17	.067	42	79
	4	- .17	.078	46	89
	5	.022	.049	46	96
	7	- .22	.069	46	80
	8	.044	.053	46	87
	9	.044	.053	46	93
	11	- .11	.071	46	93
	12	- .023	.051	44	89
	13	.022	.13	46	76
	14	.065	.057	46	91
	15	.022	.049	46	89
	16	.40	.12	45	76
	17	- .16	.13	44	48

Table 8. Mean age with respect to the mode of otolith sample 2 by
reader and ICNAF Divisions.

| READER	2J	3K	3L	3NO	3O	3Ps	TOTAL	% AGREEMENT	No. READ
1	- .14	.61	.24	.36	.024	.047	.18	62	225
2	.18	.92	.32	.70	.36	.56	.50	46	247
3	- .59	.11	.16	.20	.048	- .17	.032	68.	250
4	- .22	- .68	- .68	- .58	- .32	- .17	- .44	59	251
5	- .83	.23	.23	.14	.33	.022	.13	67	209
7	- .48	- .51	- .67	- .60	- .78	- .22	- .54	53	254
8	.33	.054	- .42	.11	- .13	.044	.13	70	260
9	.33	.054	.16	.17	.24	.044	.17	73	260
11	- .74	- .12	.00	- .27	- .44	- .11	- .28	66	254
12	- .24	.22	- .067	- .023	- .087	- .023	- .039	73	254
13	.59	.30	.00	.00	.036	.022	.15	68	193
14	- .025	- .49	.067	.087	.23	.065	- .008	70	244
15	.025	- .62	- .16	- .46	- .11	.022	- .21	66	259
16	.91	1.91	1.53	1.36	1.23	.40	1.20	36	235
17	- .32	- .21	.90	.44	.029	- .16	.086	32	209

3K
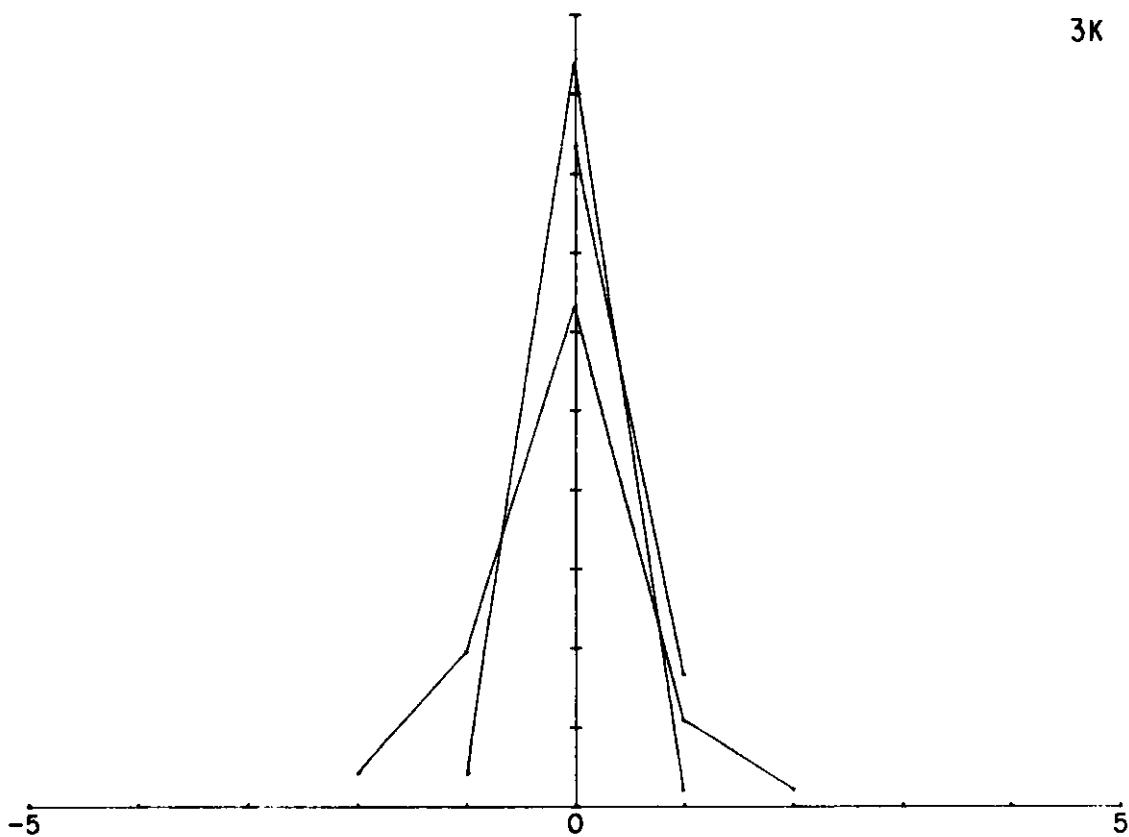
Fig. 1.   Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 3K, Sample 1.
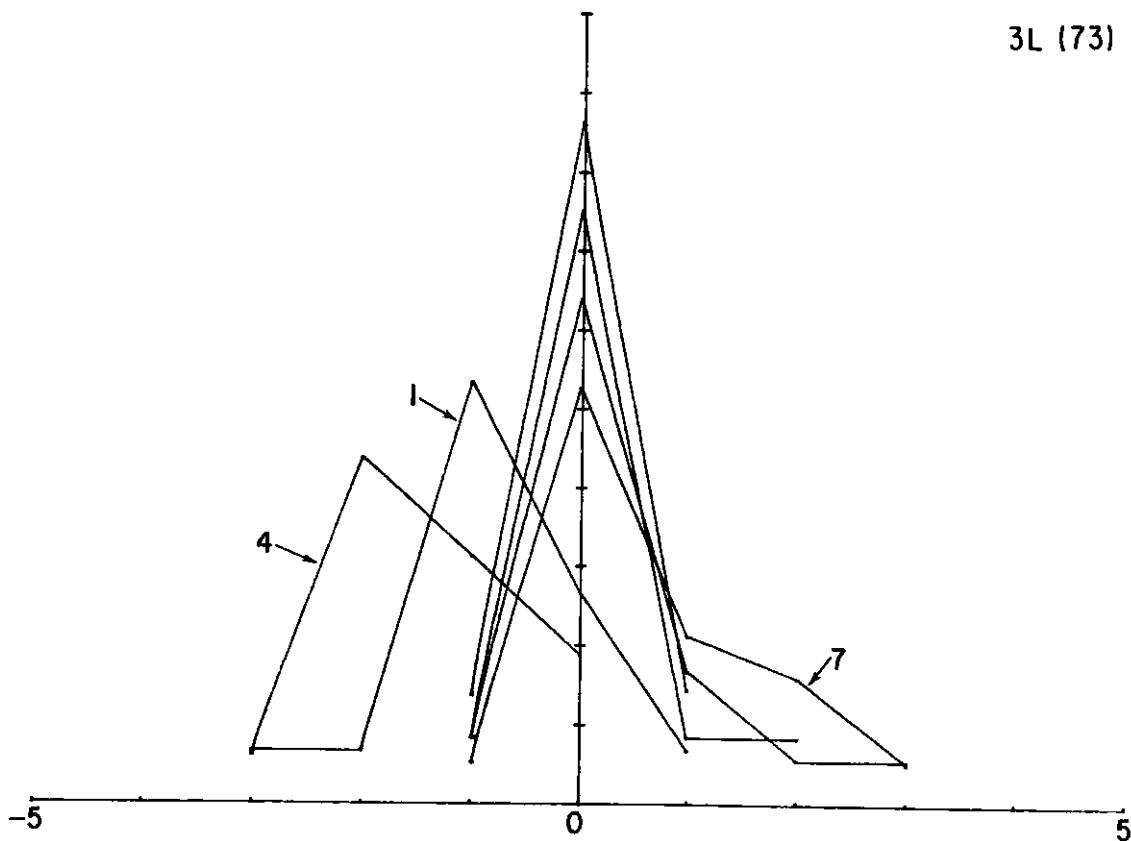
3L (73)

Fig. 2.   Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 3L(73), Sample 1.

C 4
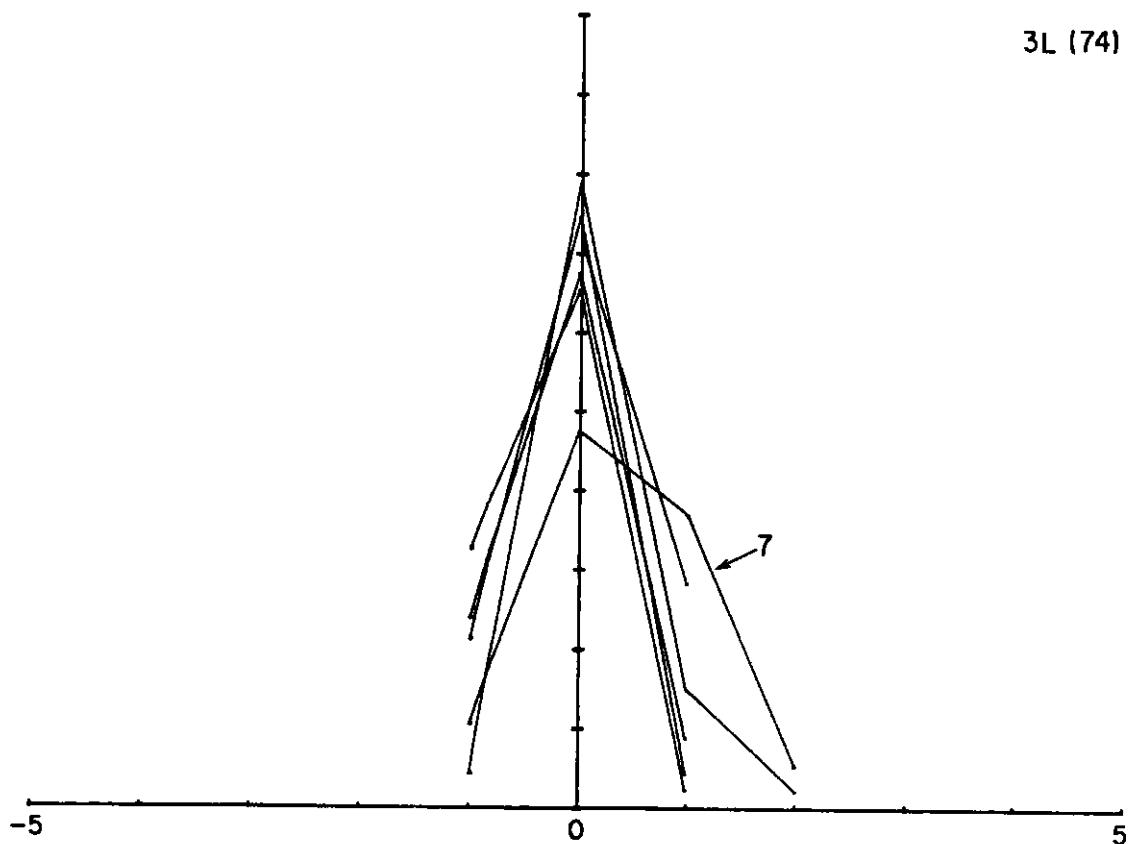
3L (74)

Fig. 3. Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 3L(74), Sample 1.

30
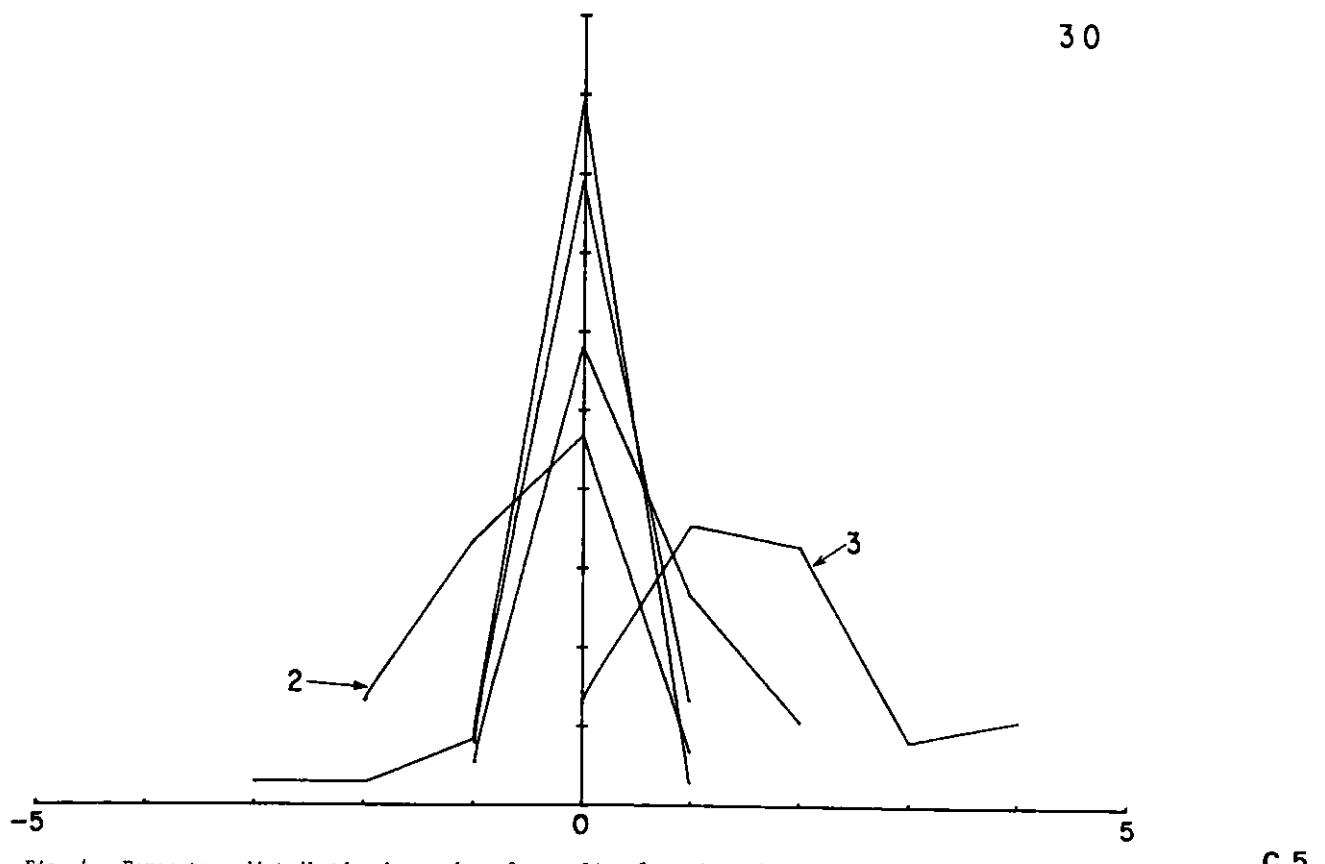
Fig. 4. Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 30, Sample 1.

C 5

3Ps
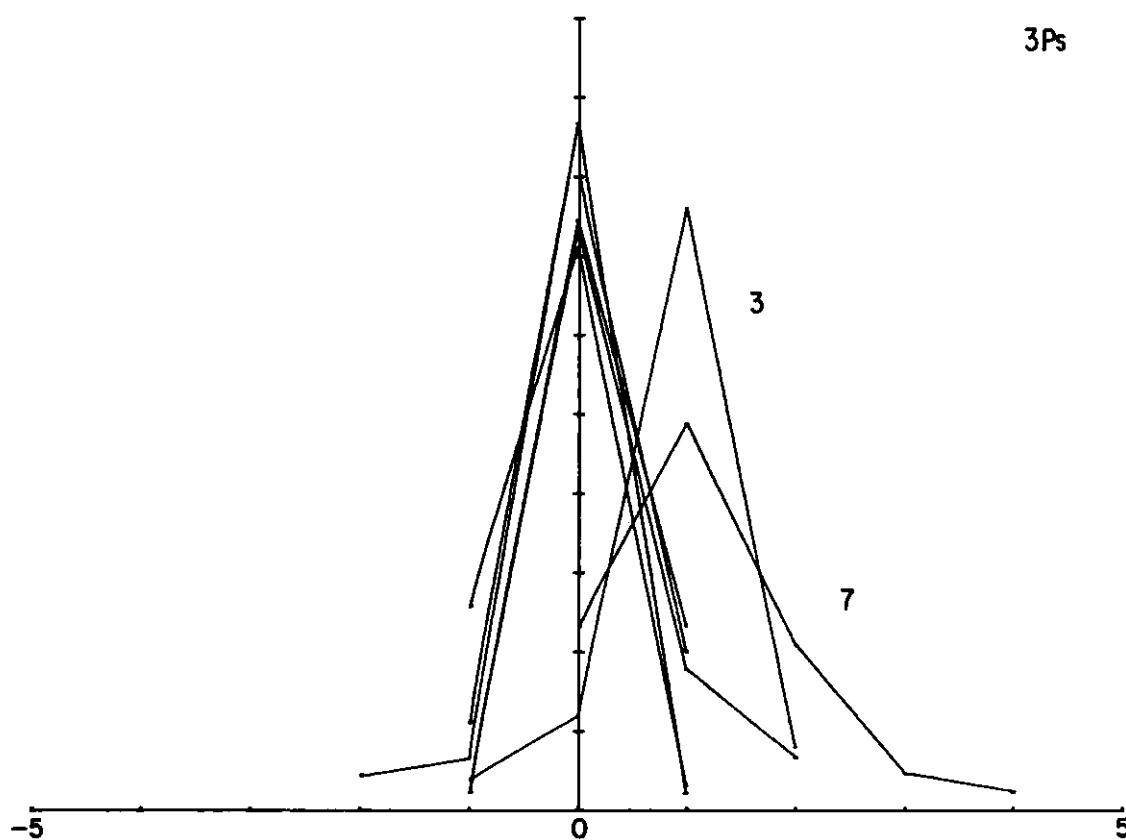
Fig. 5. Percentage distribution by reader of anomalies from the modal age in ICNAF Subdiv. 3Ps, Sample 1.

4Vn
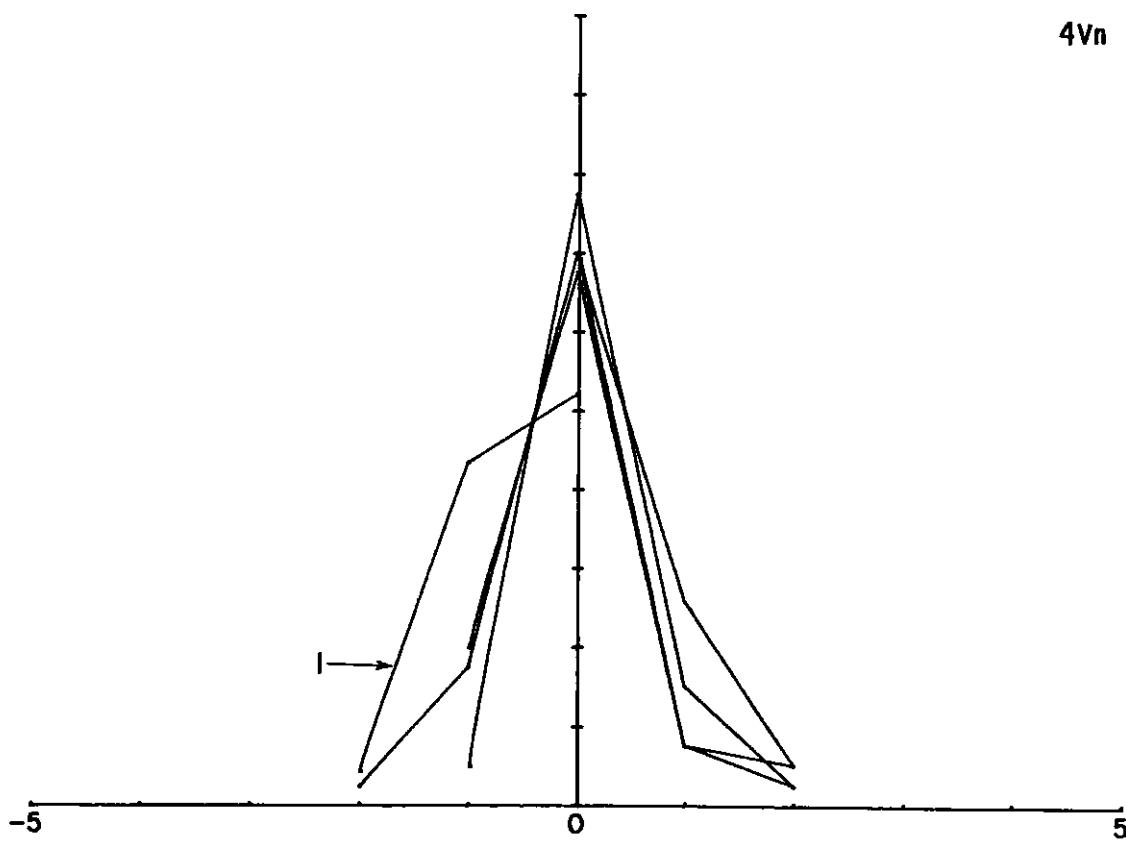
Fig. 6. Percentage distribution by reader of anomalies from the modal age in ICNAF Subdiv. 4Vn, Sample 1.

C 6

5Z
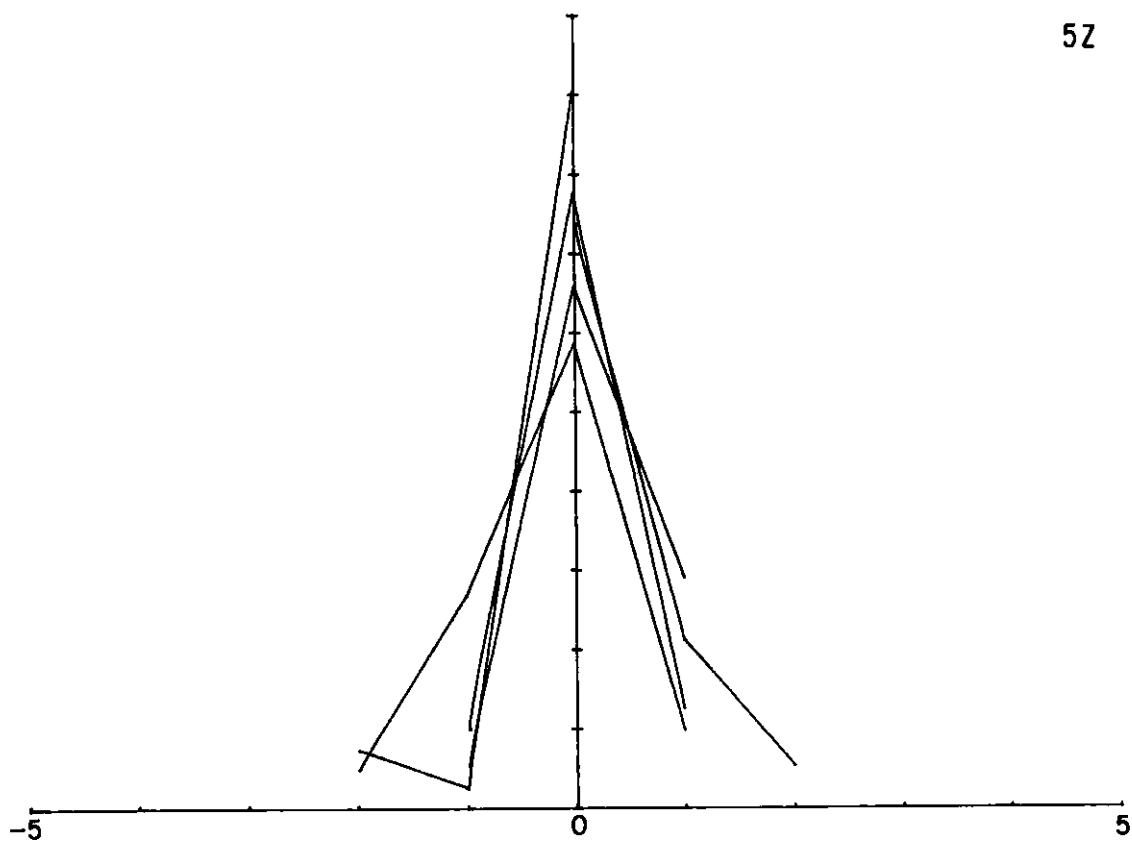
Fig. 7. Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 5Z, Sample 1.

ALL DIVISIONS COMBINED
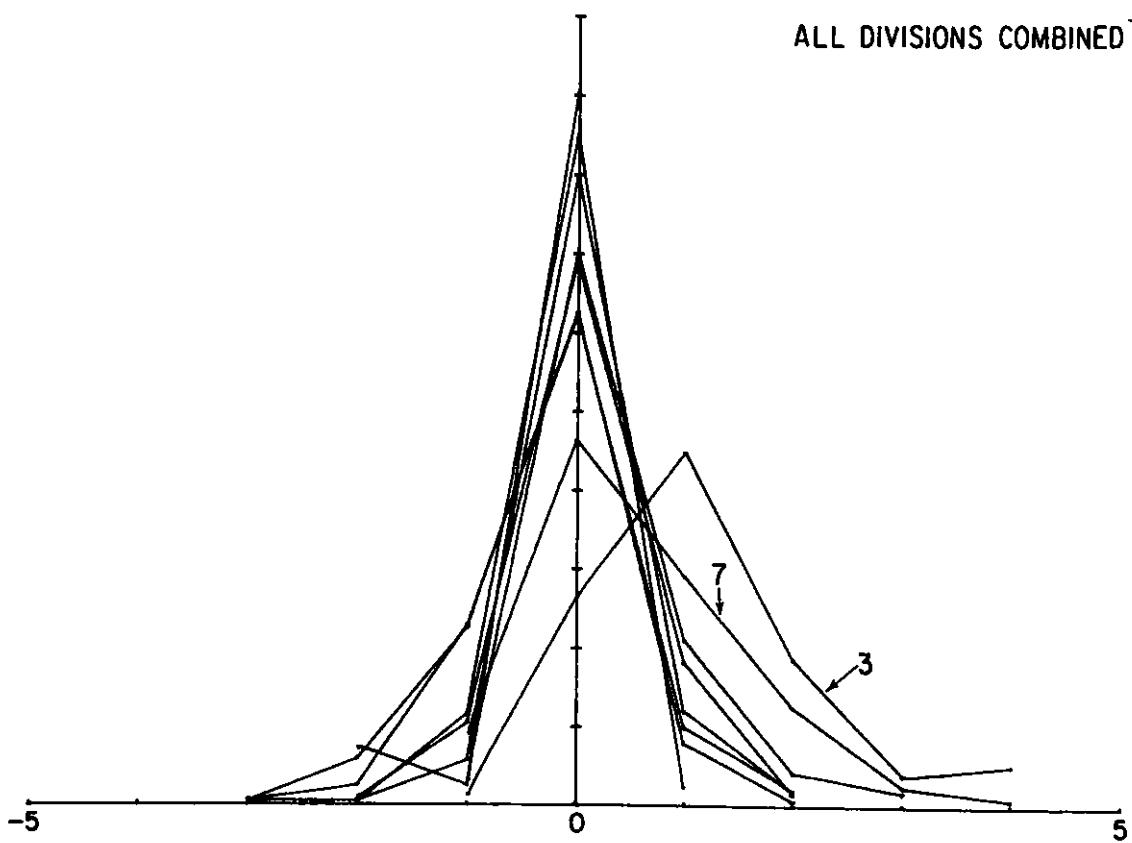
Fig. 8. Percentage distribution by reader of anomalies from the modal age in all ICNAF Divisions combined, Sample 1.

C 7
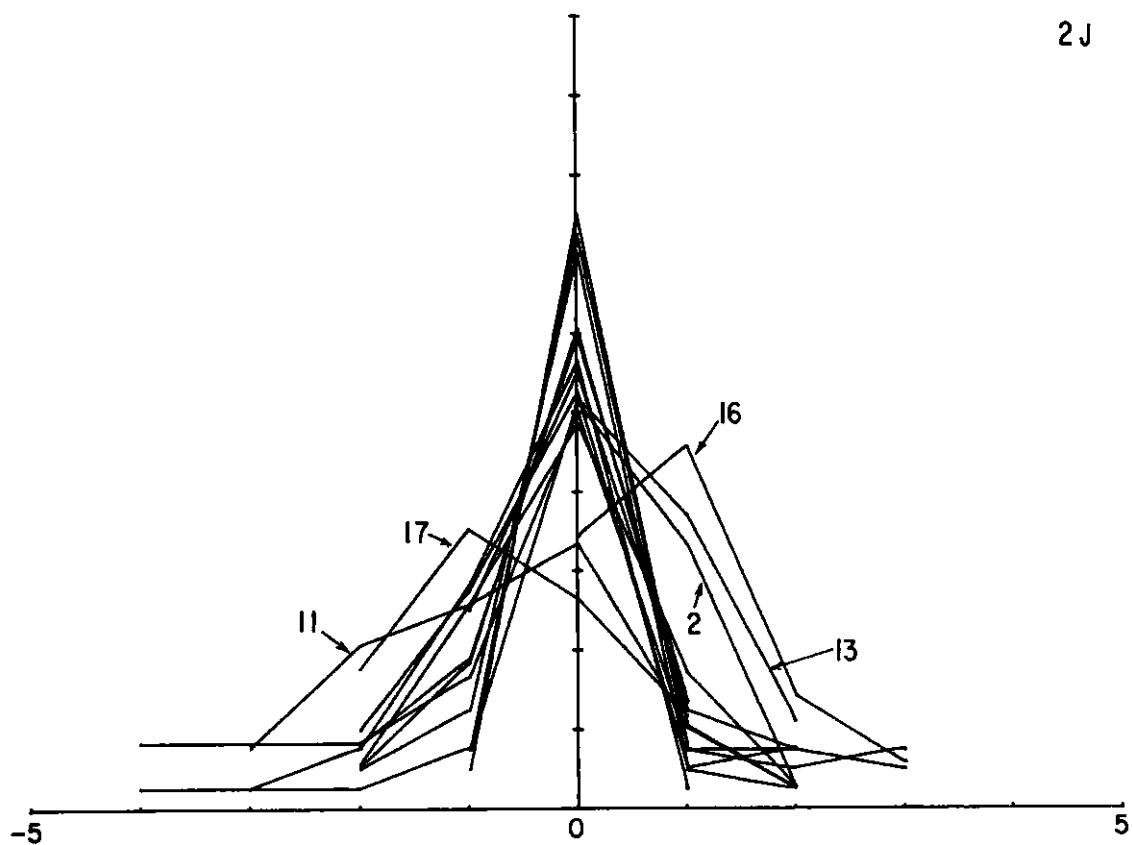
Fig. 9. Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 2J, Sample 2.
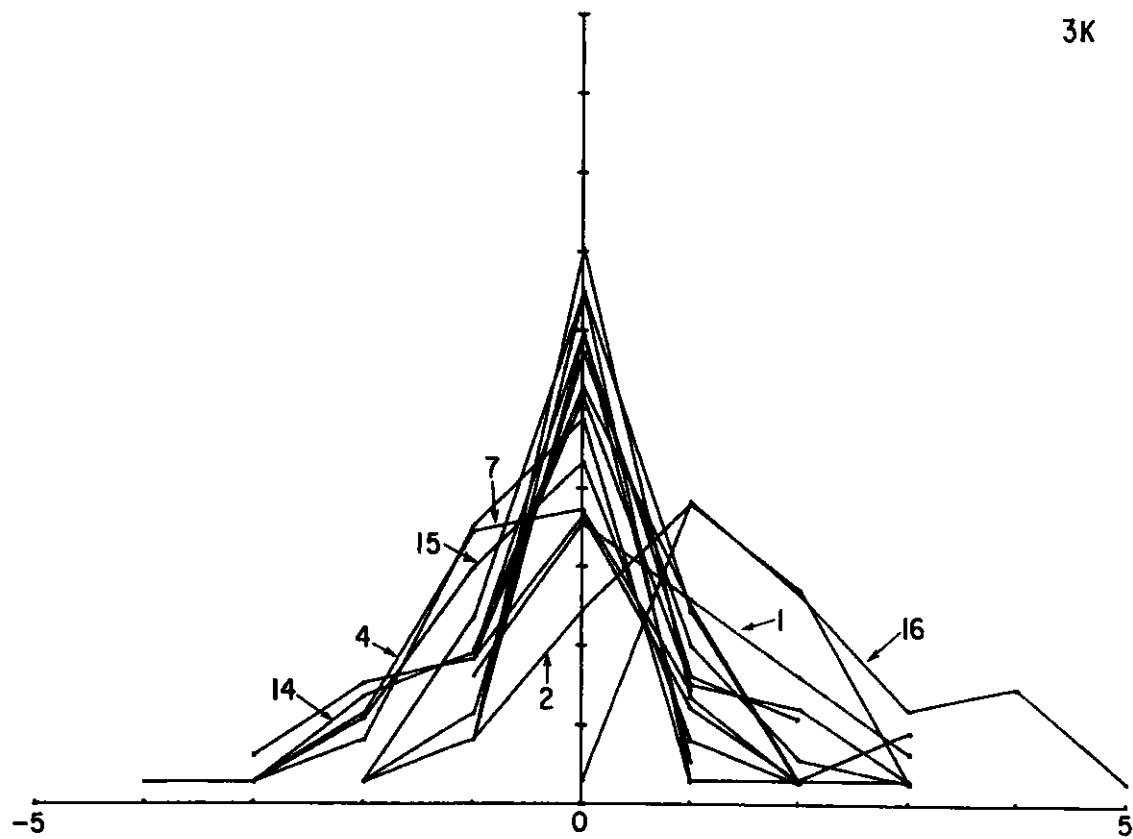
Fig. 10. Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 3K, Sample 2.

3L
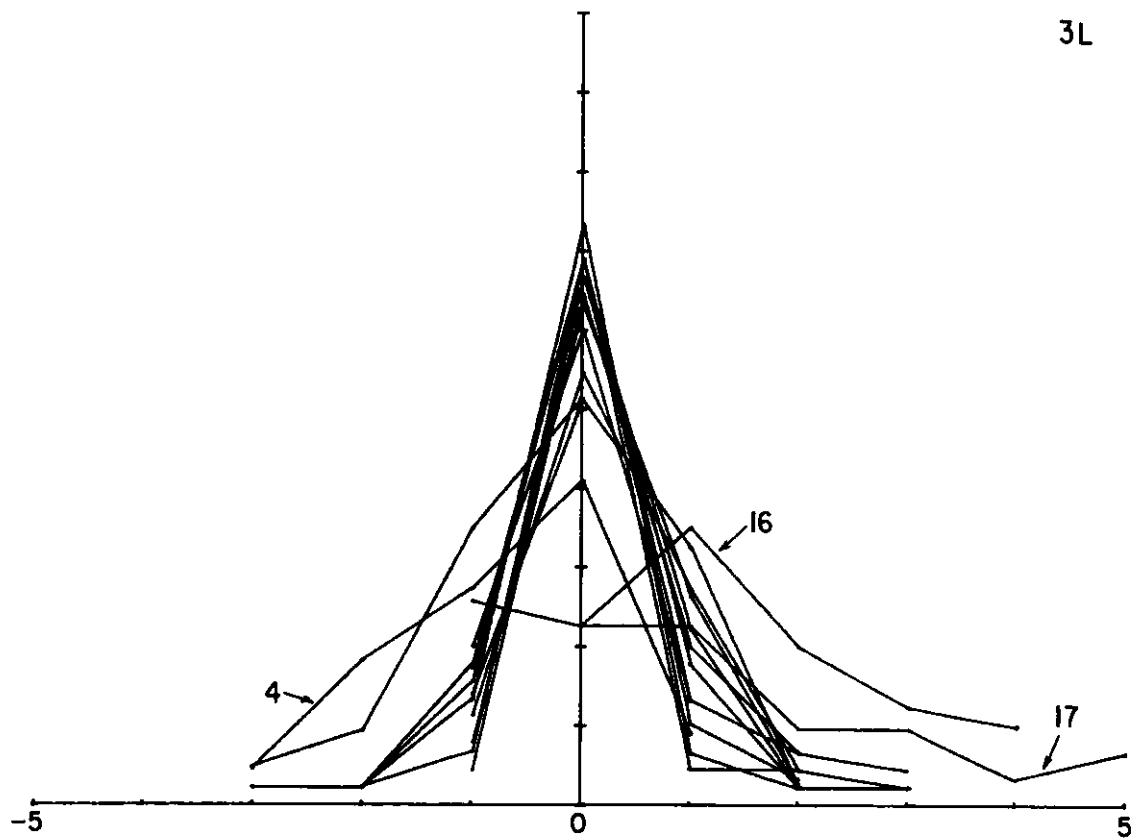
Fig. 11.   Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 3L, Sample 2.

3NO
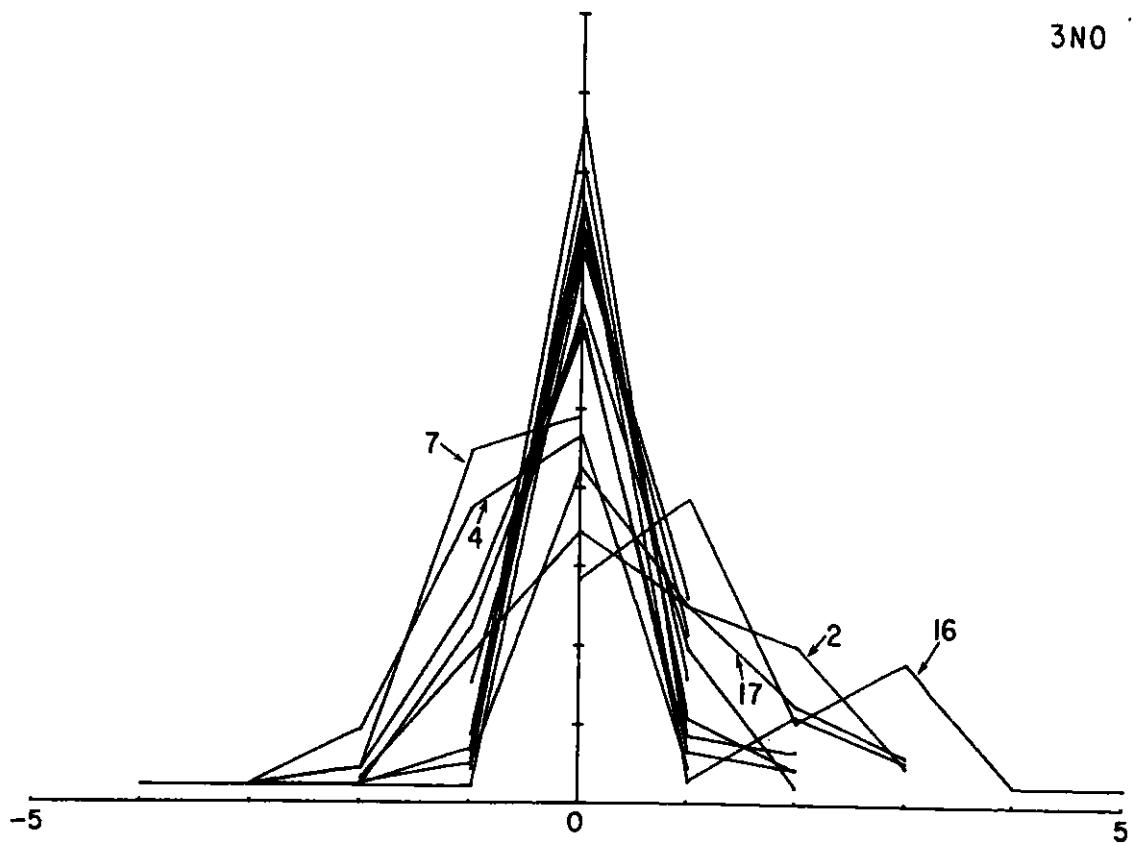
Fig. 12.   Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 3NO, Sample 2.
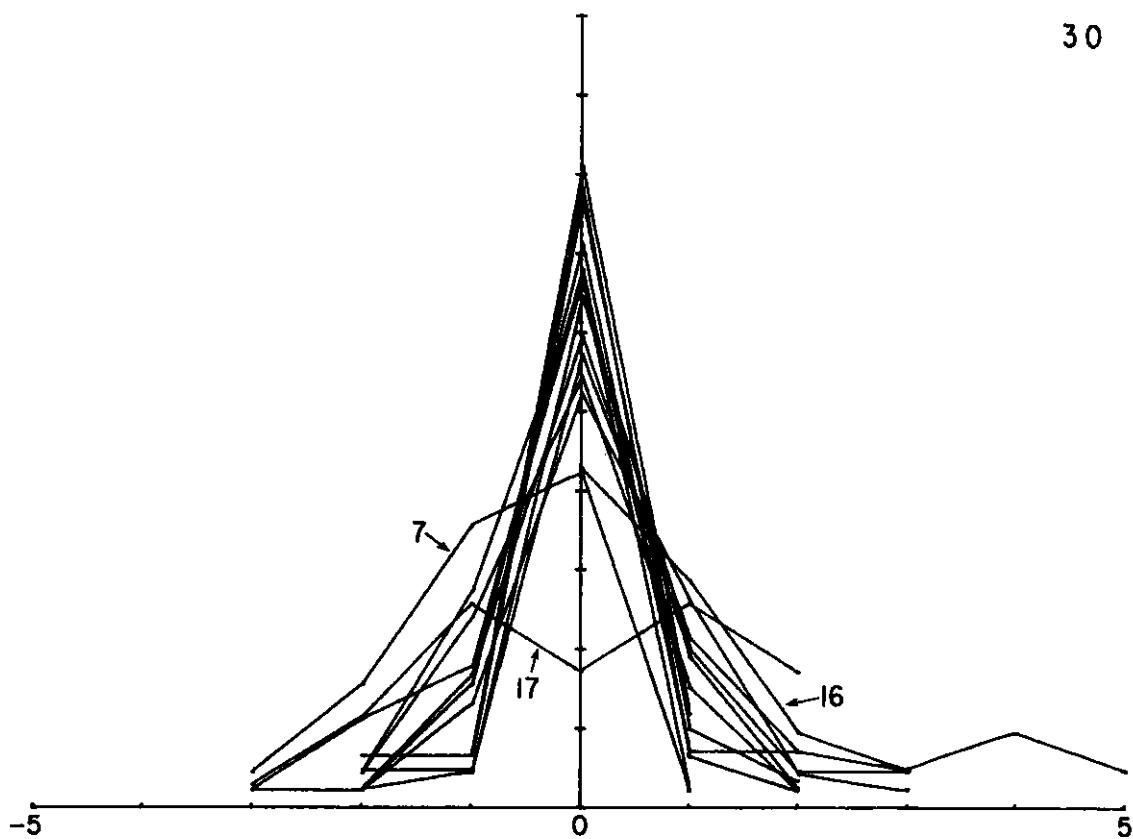
Fig. 13. Percentage distribution by reader of anomalies from the modal age in ICNAF Div. 30, Sample 2.
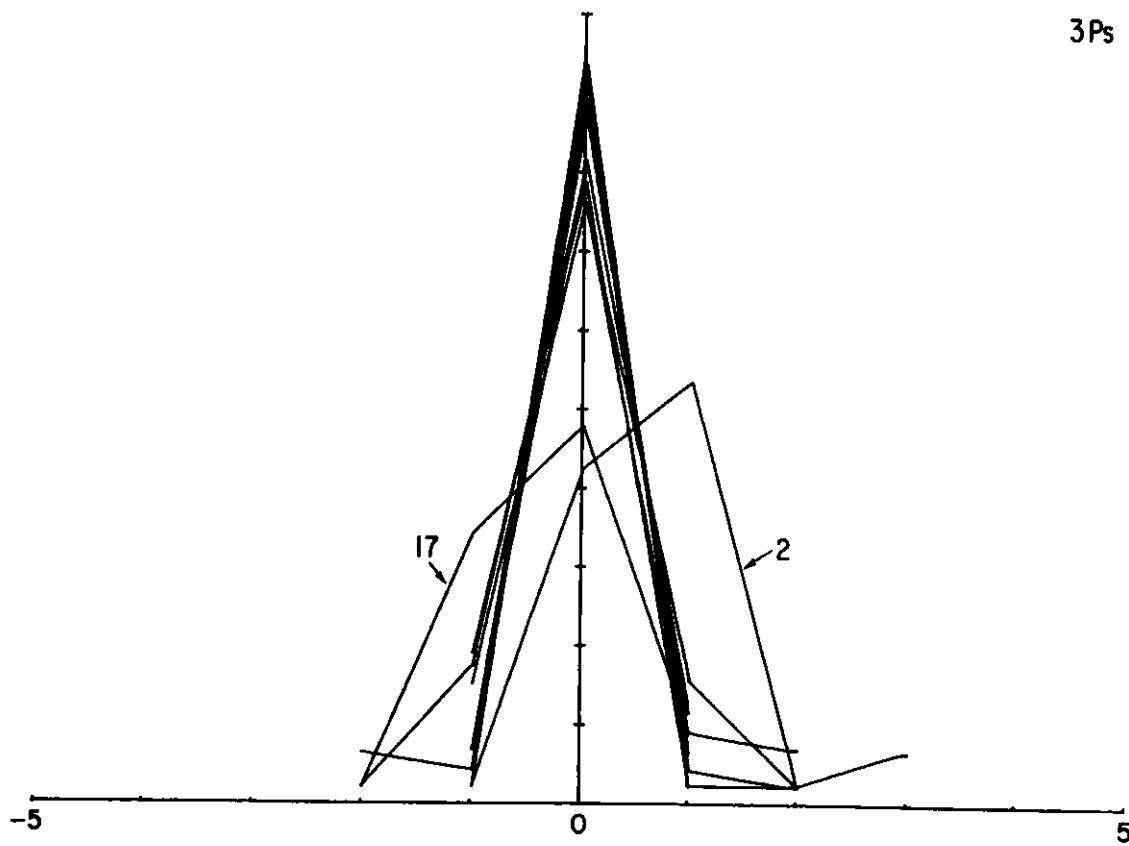
Fig. 14. Percentage distribution by reader of anomalies from the modal age in ICNAF Subdiv. 3Ps, Sample 2.
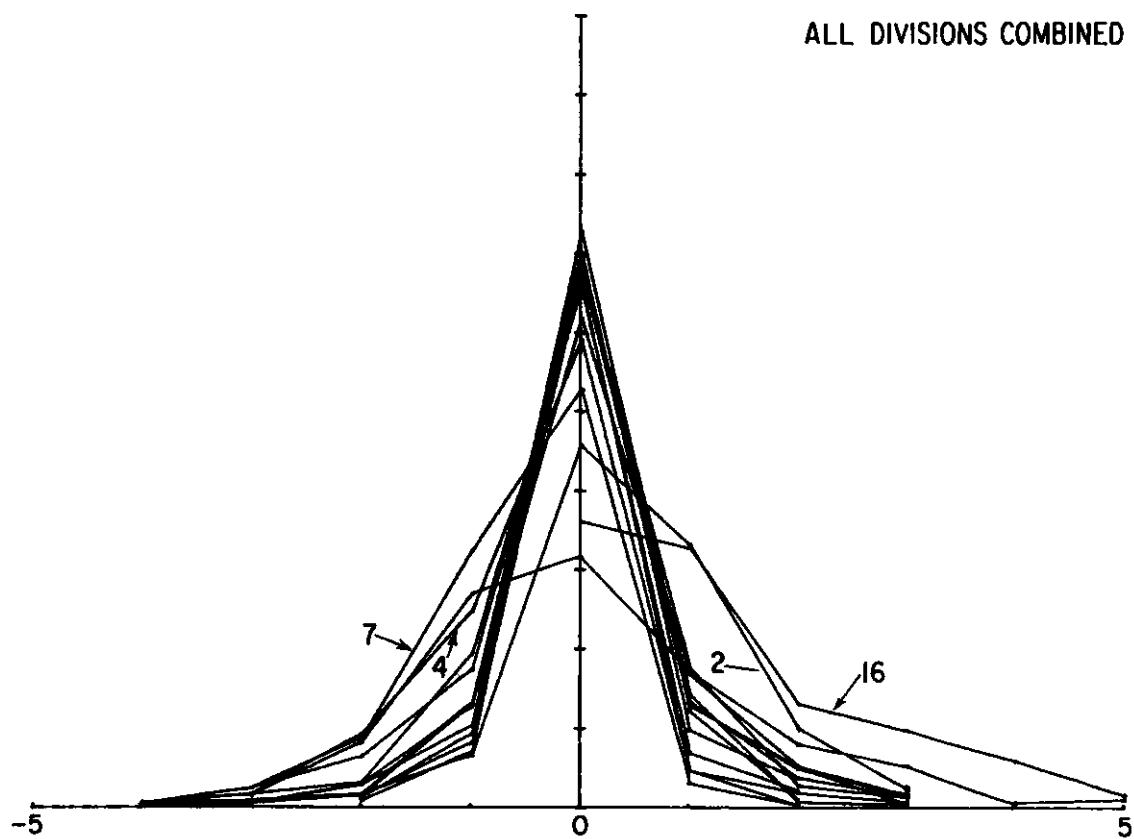
Fig. 15. Percentage distribution by reader of anomalies from the modal age in all ICNAF Divisions
combined, Sample 2.

DIVISION 2J

2J-1

2J-2

2J-12
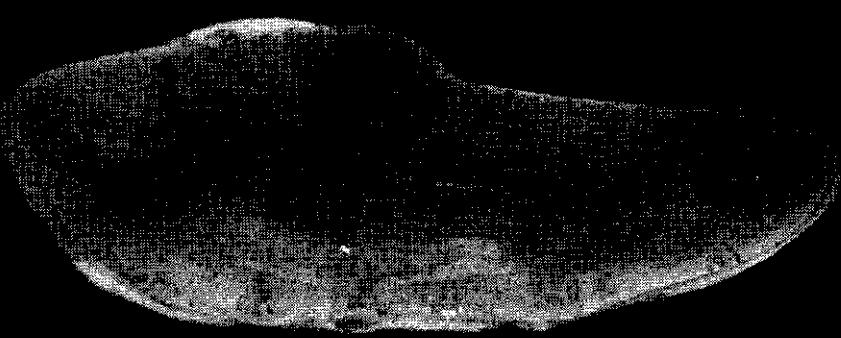
2J-13
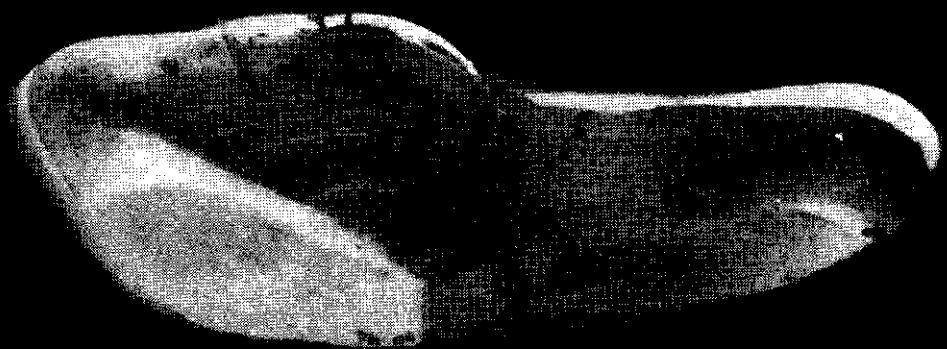
C 12
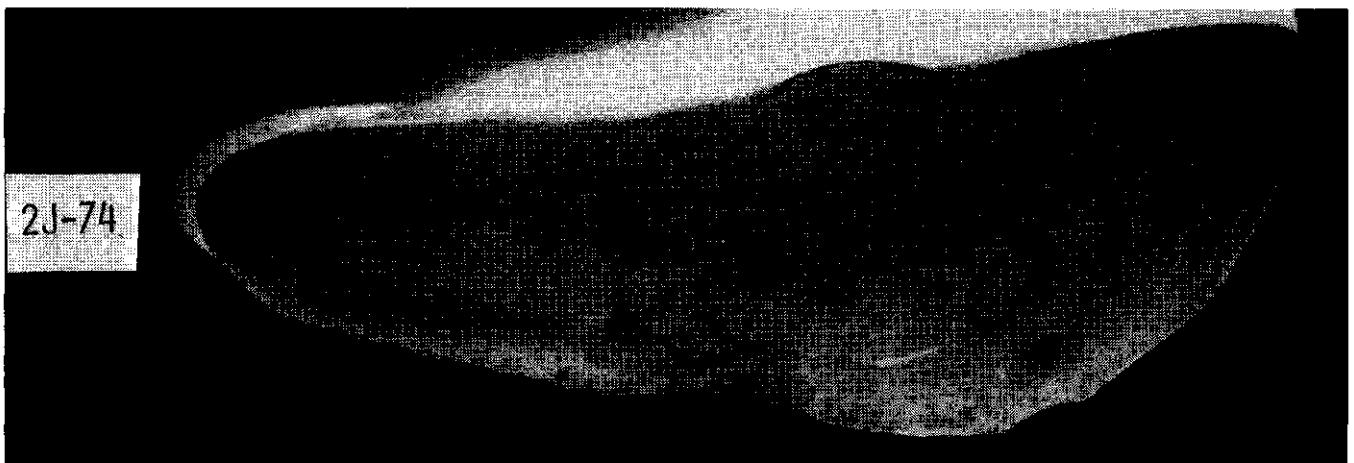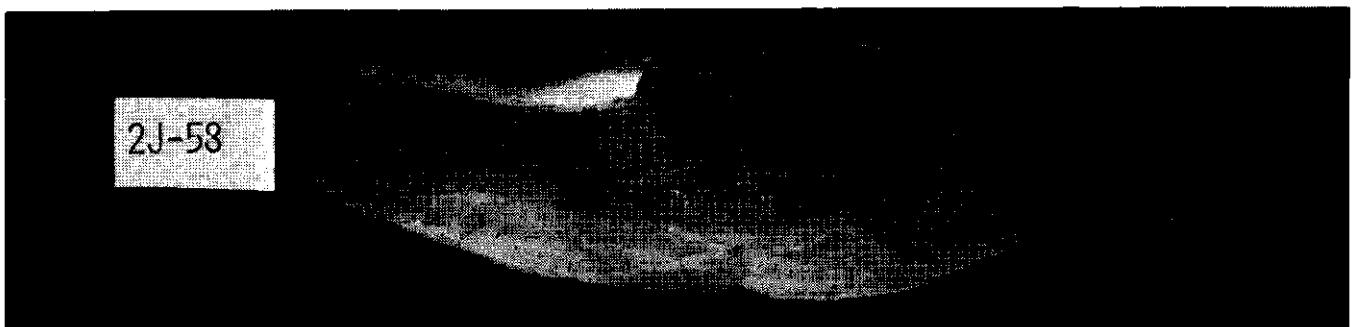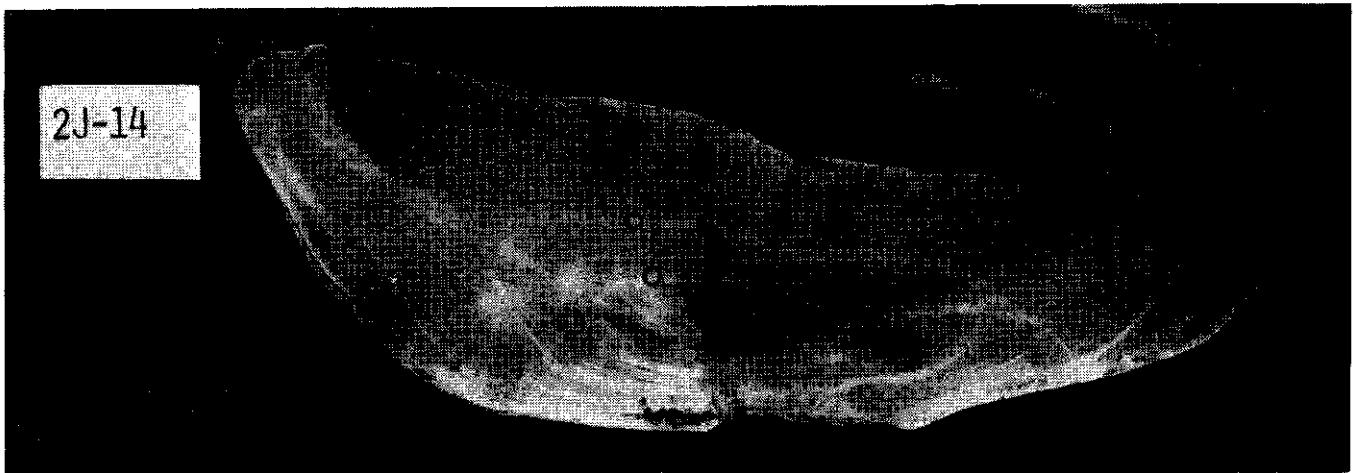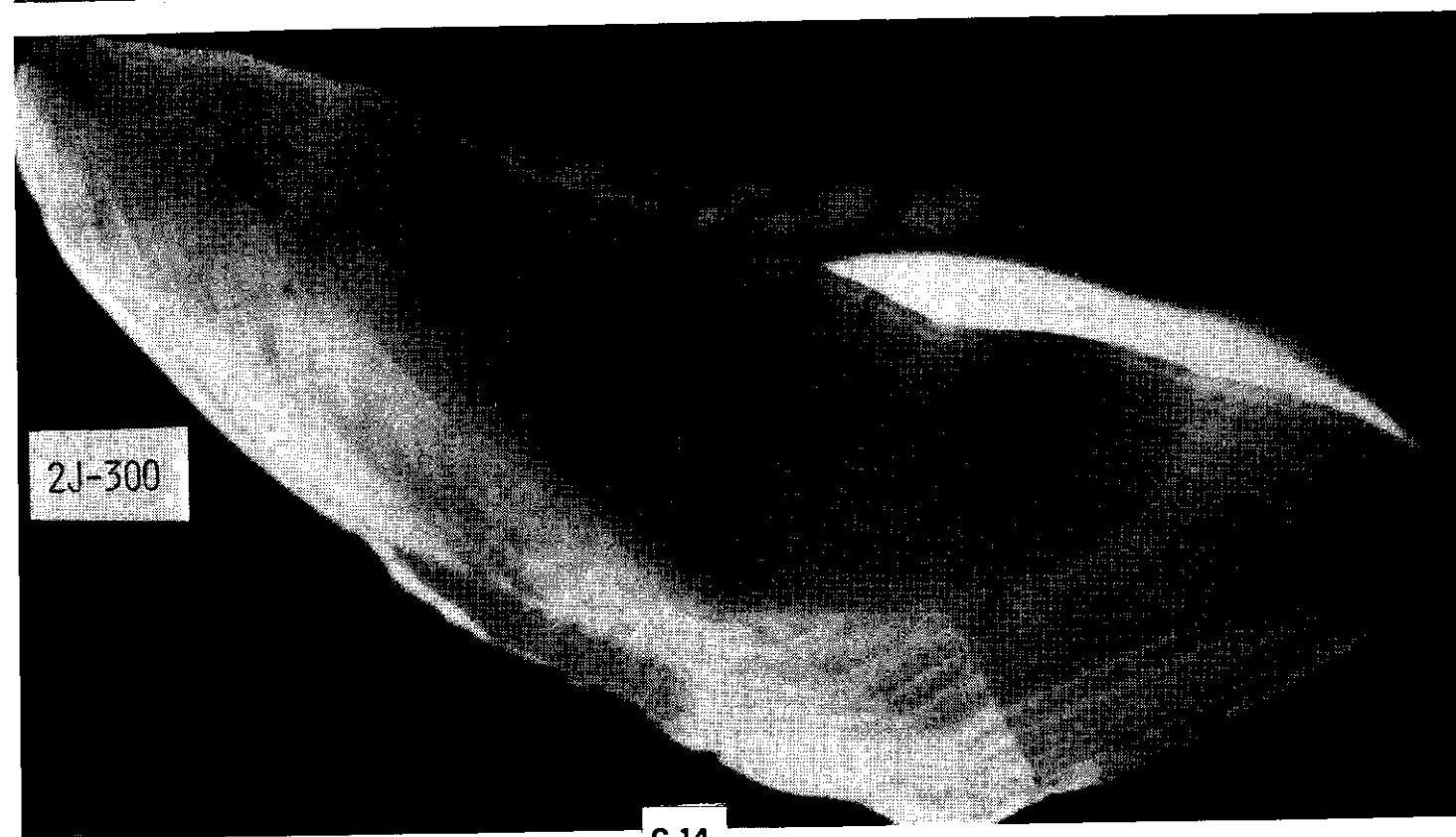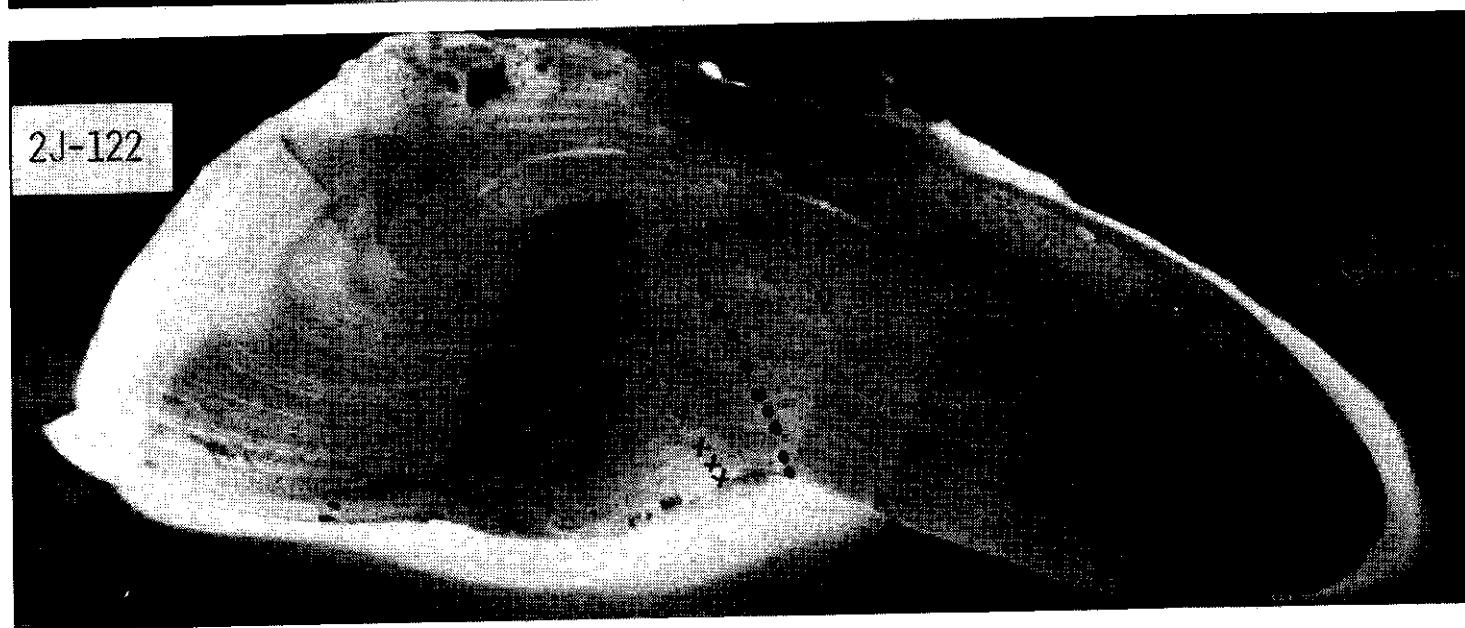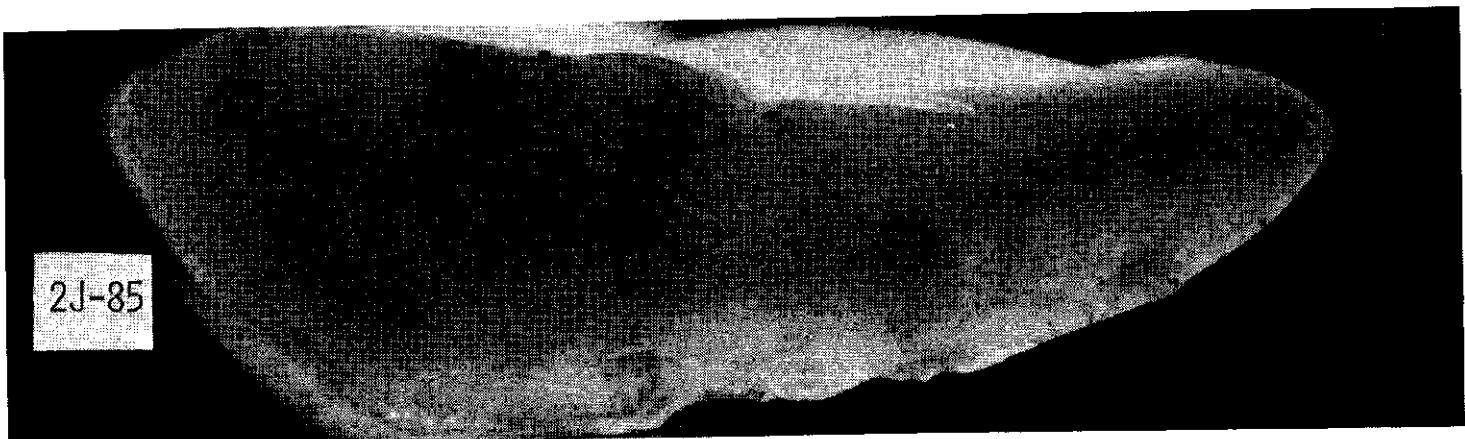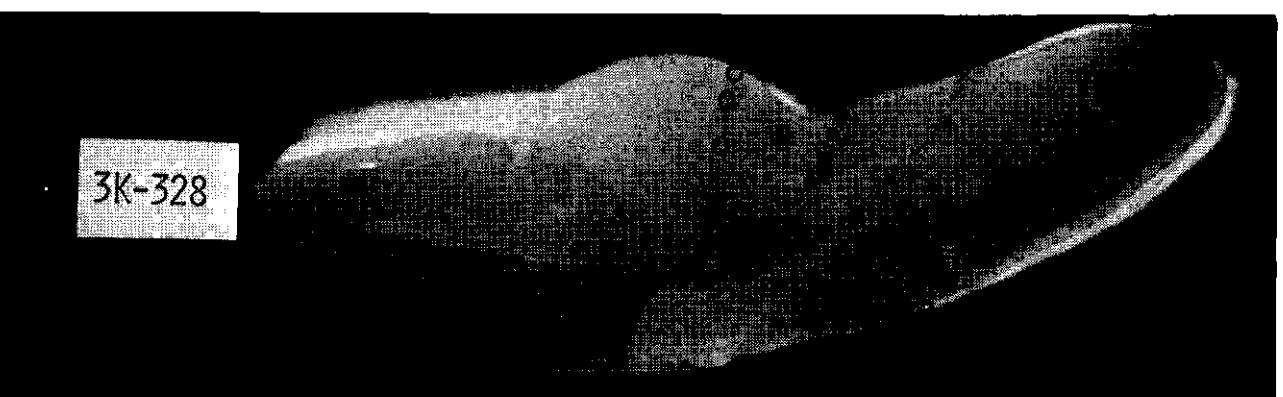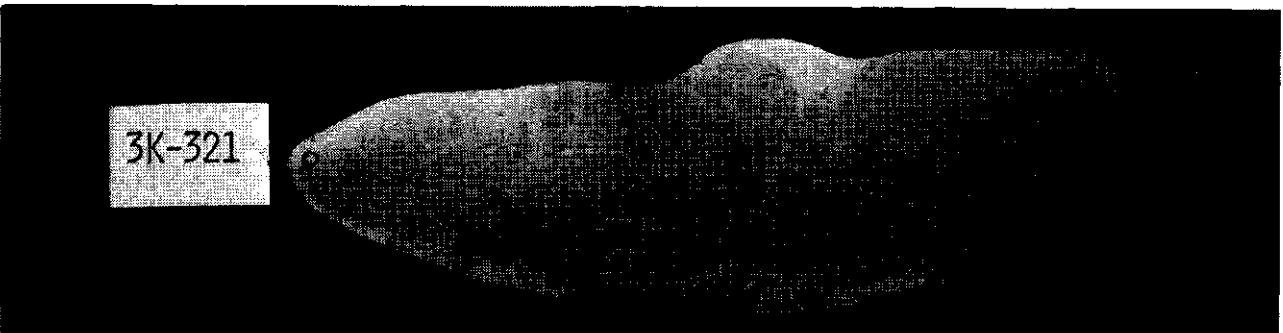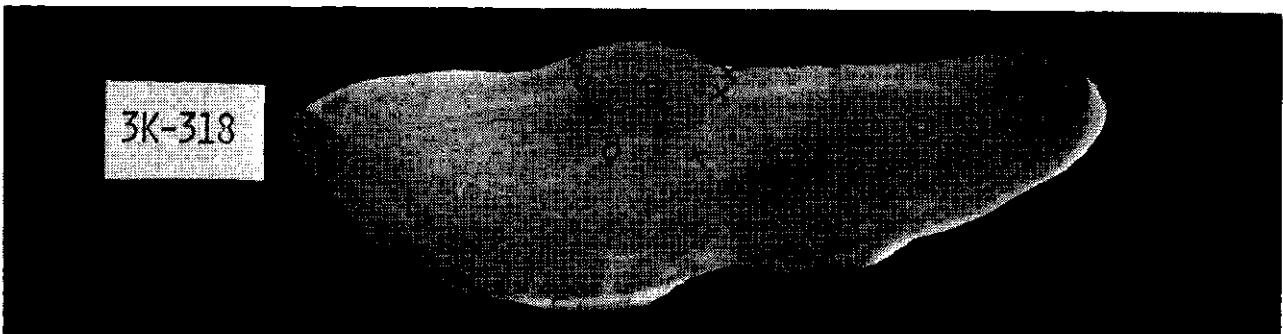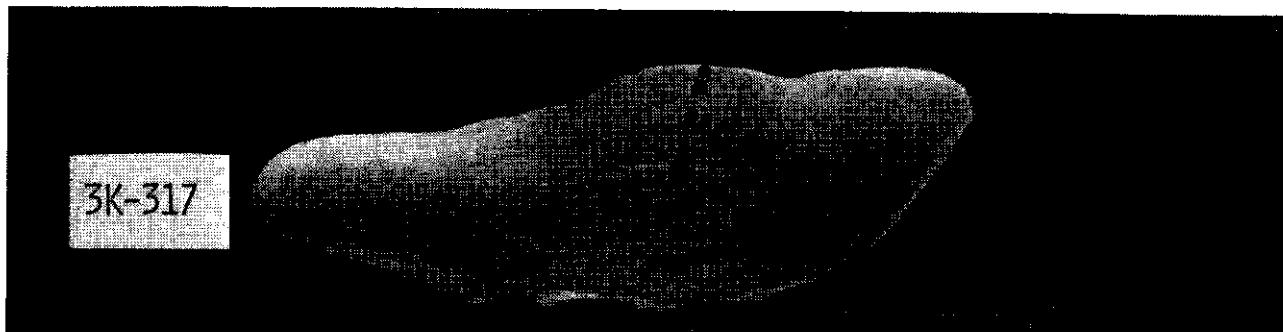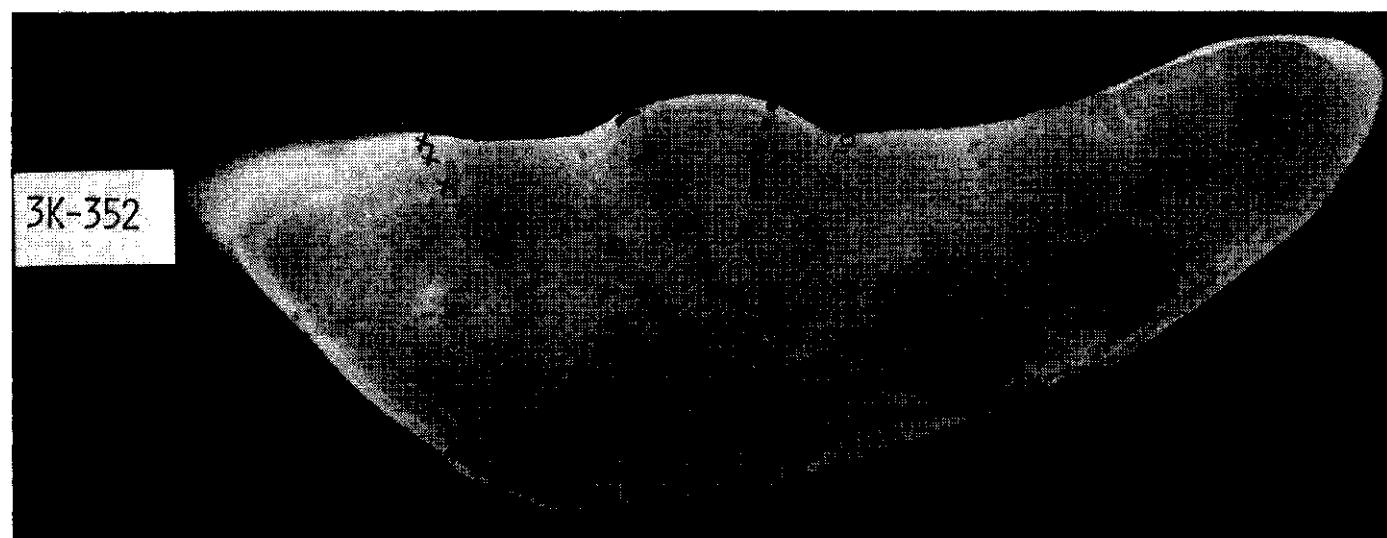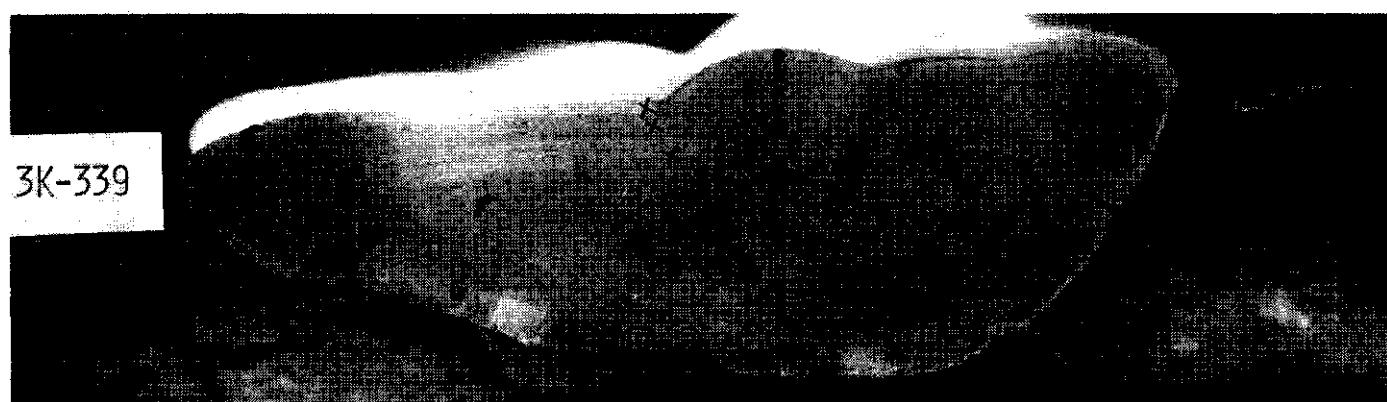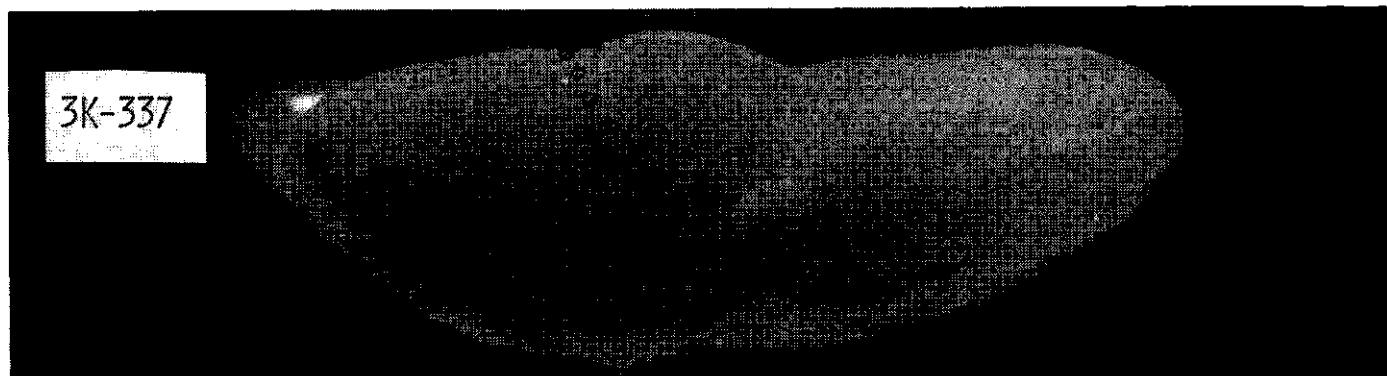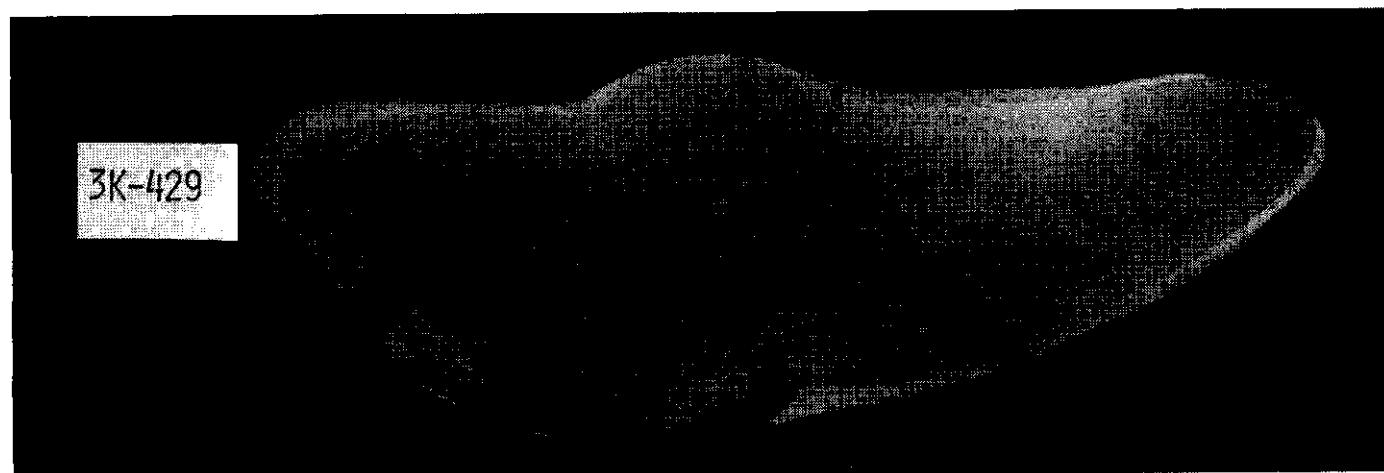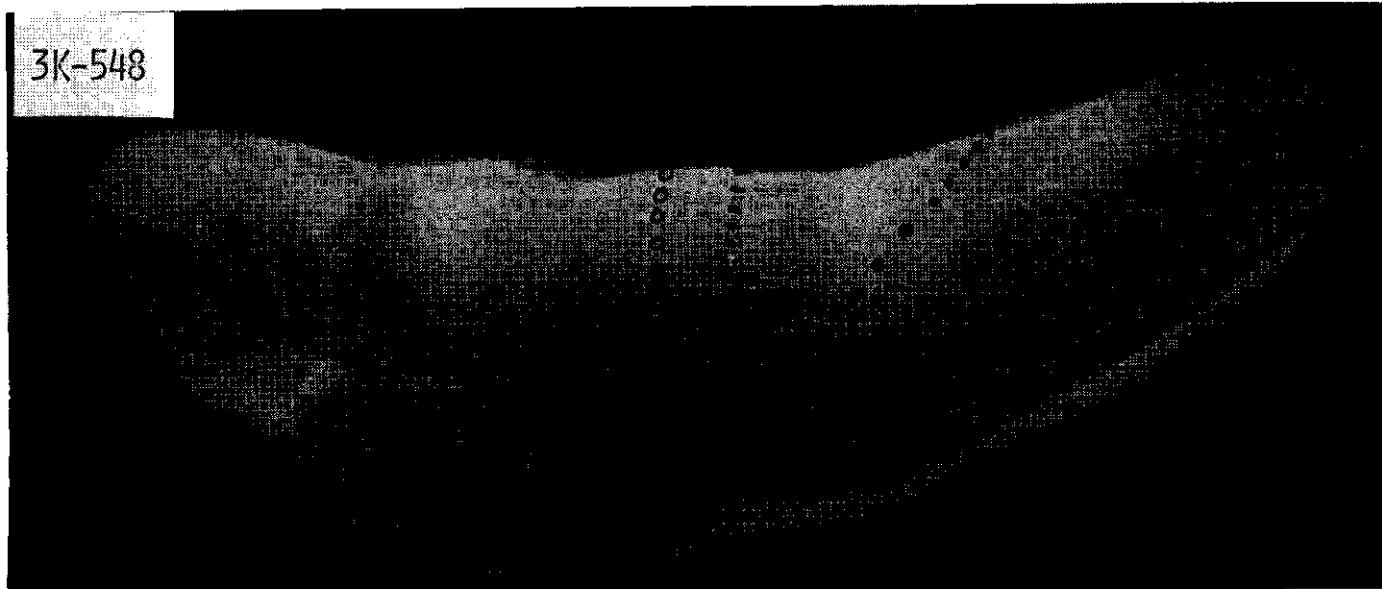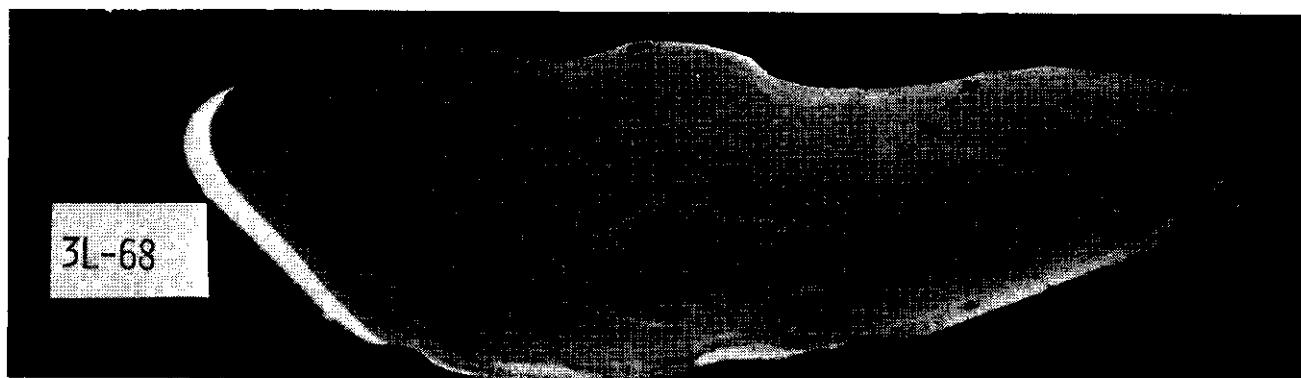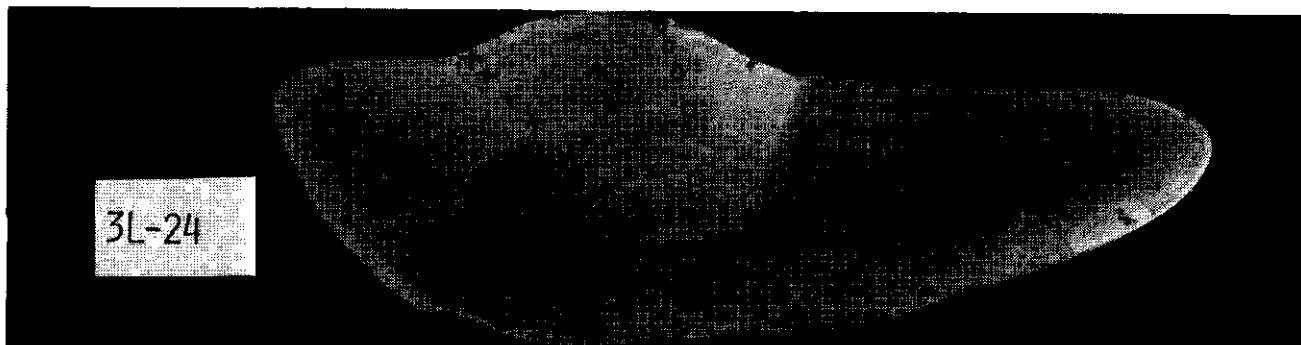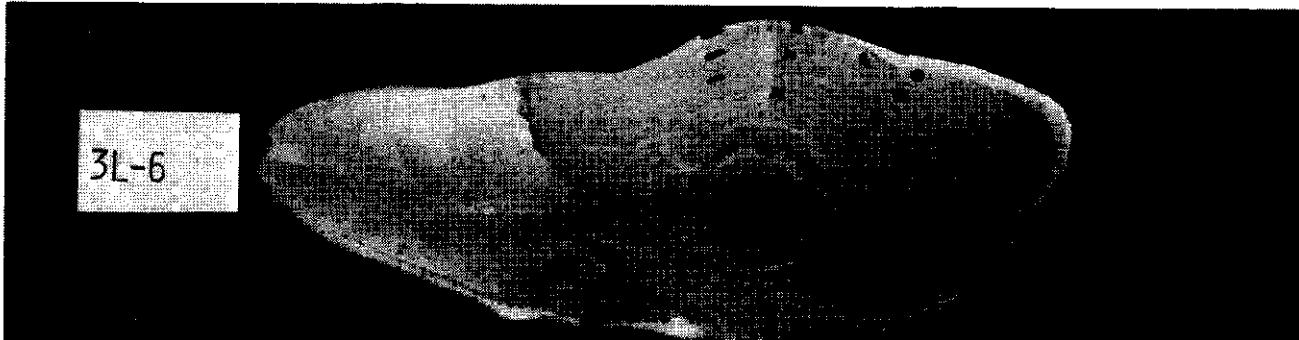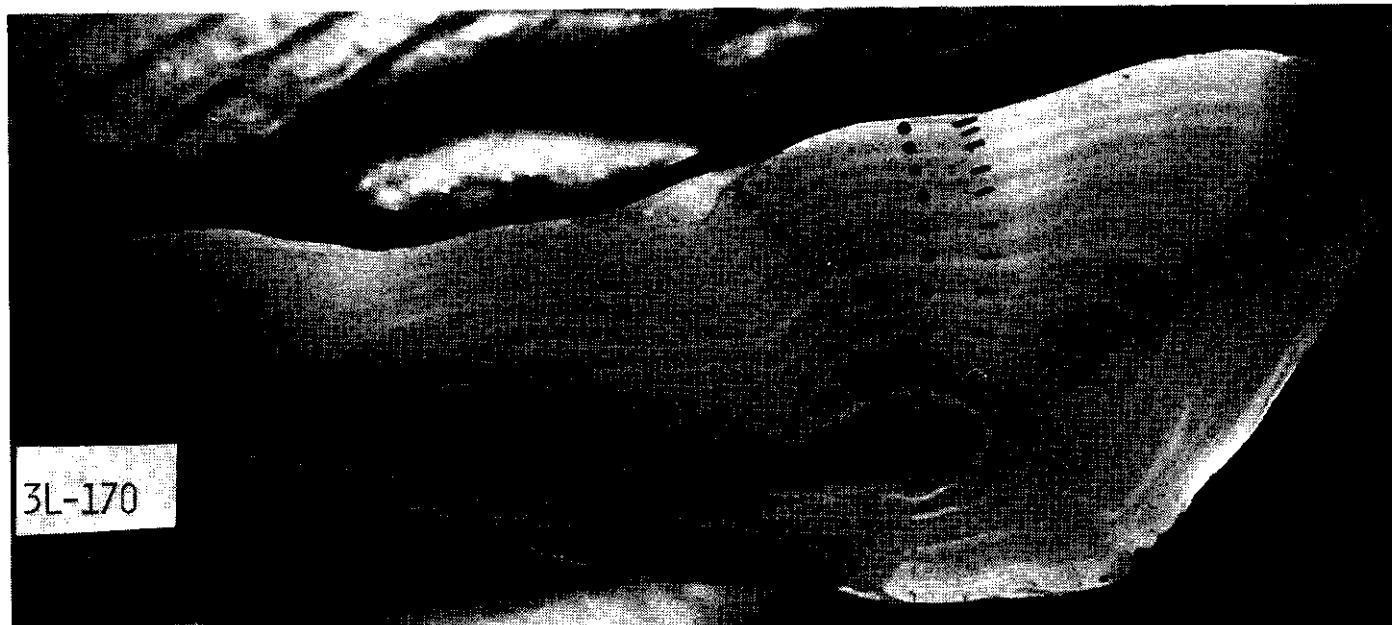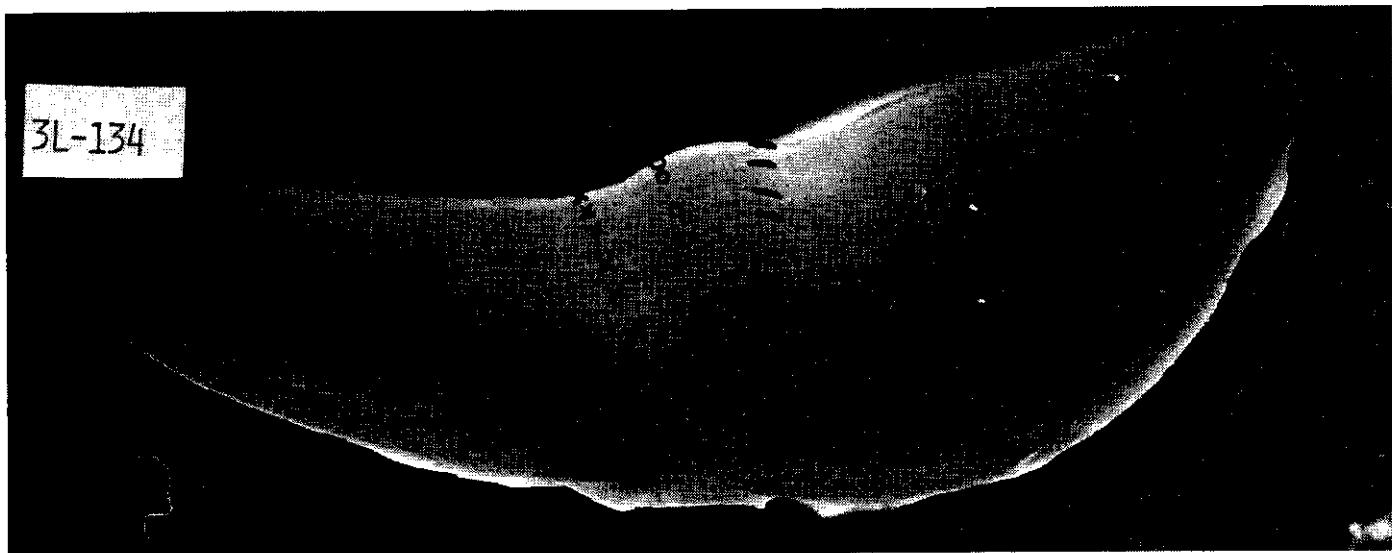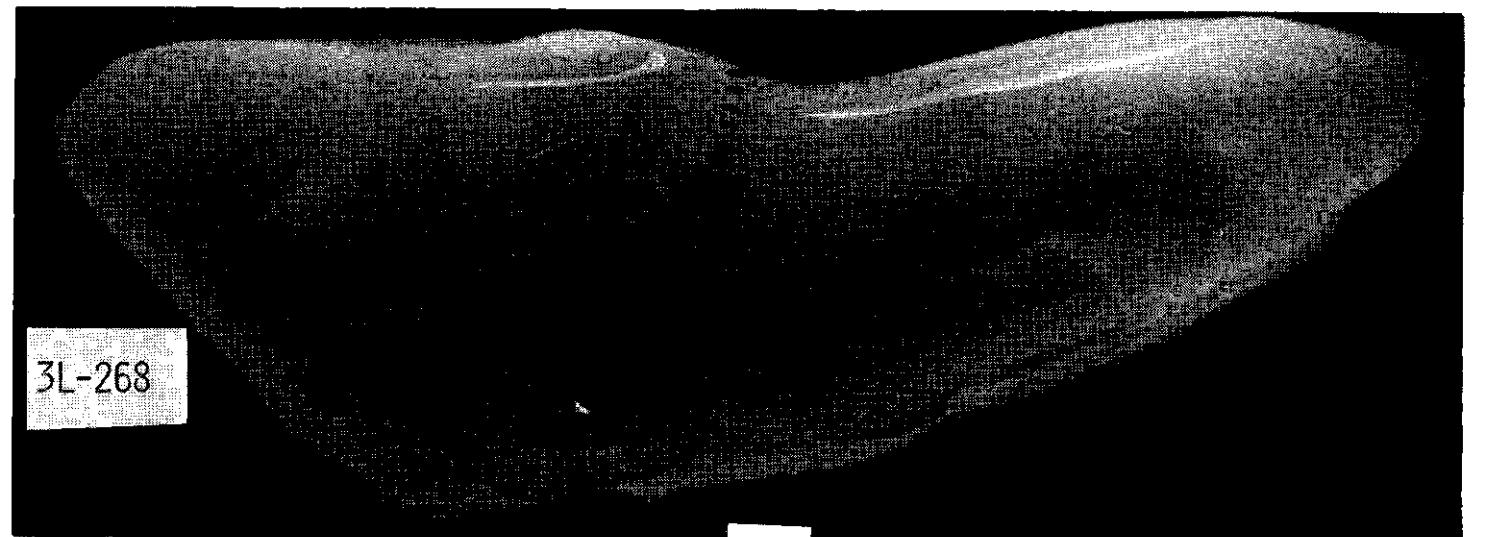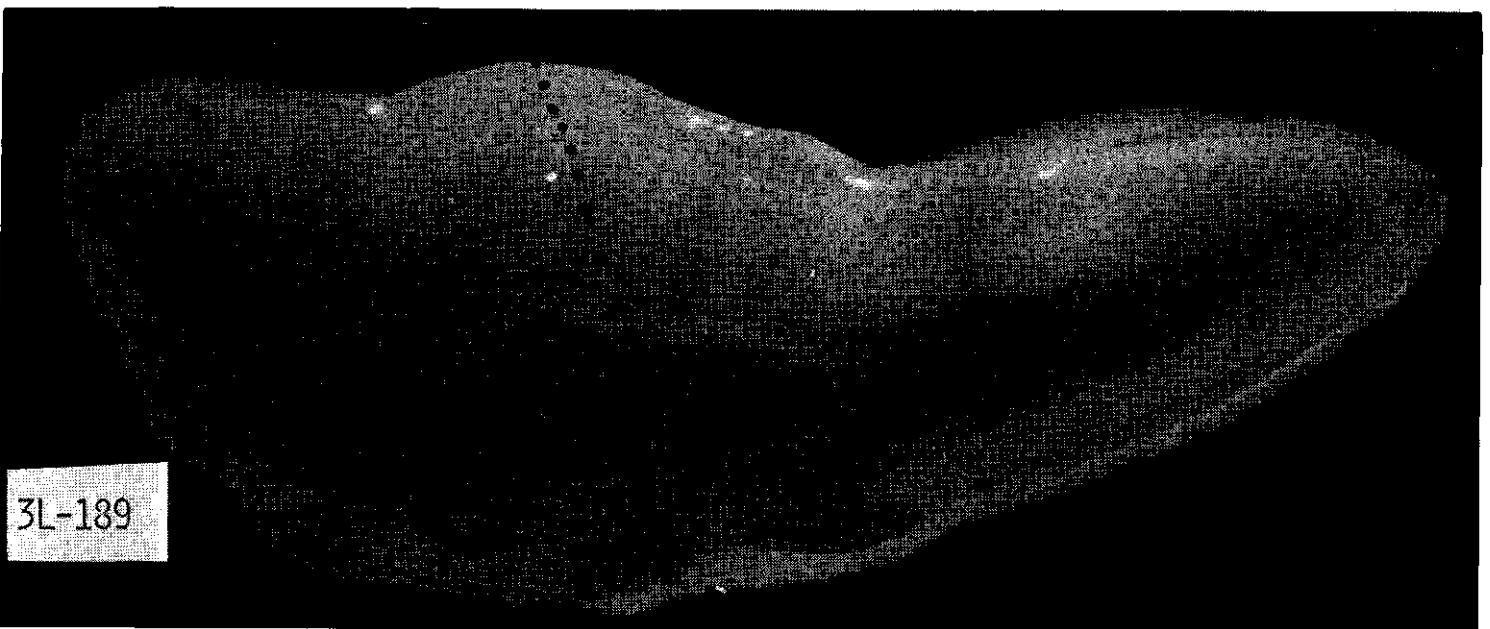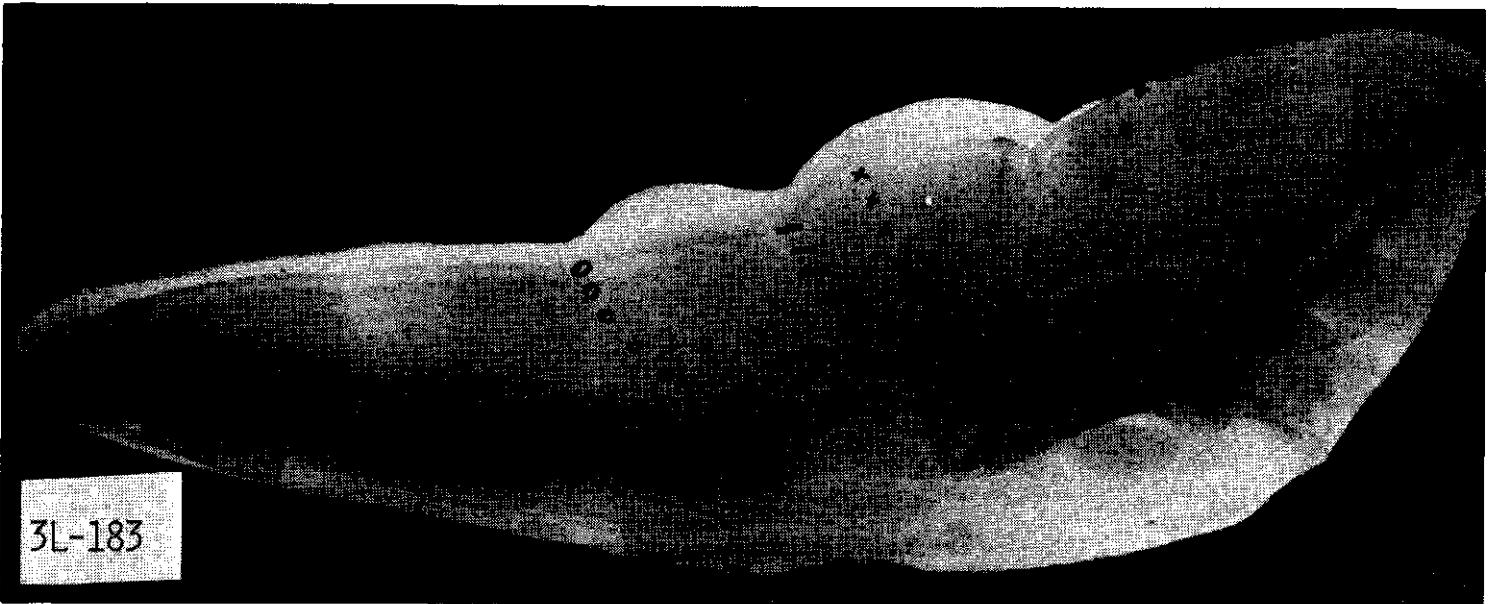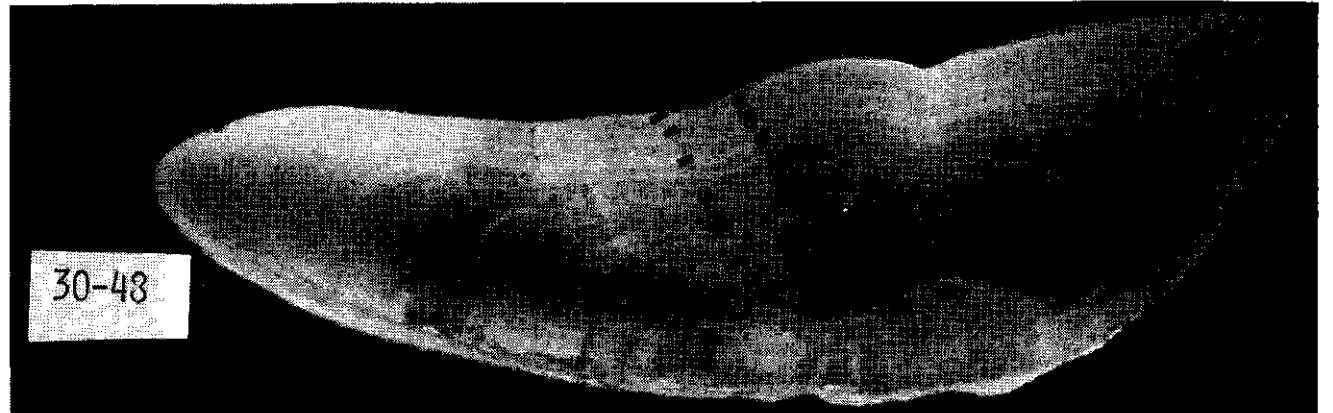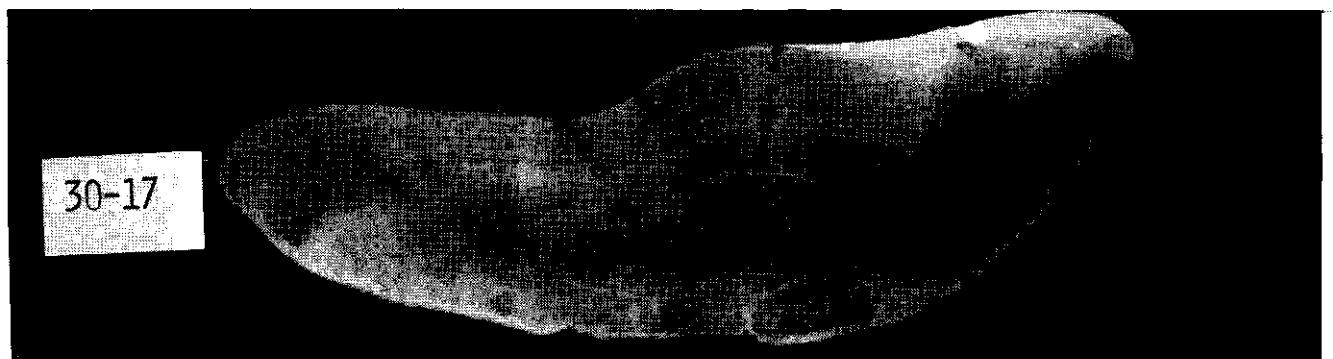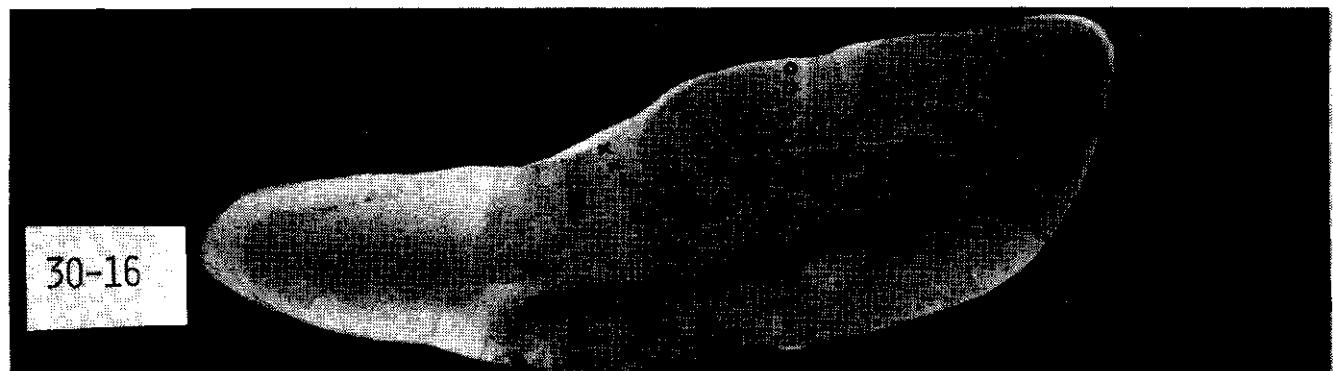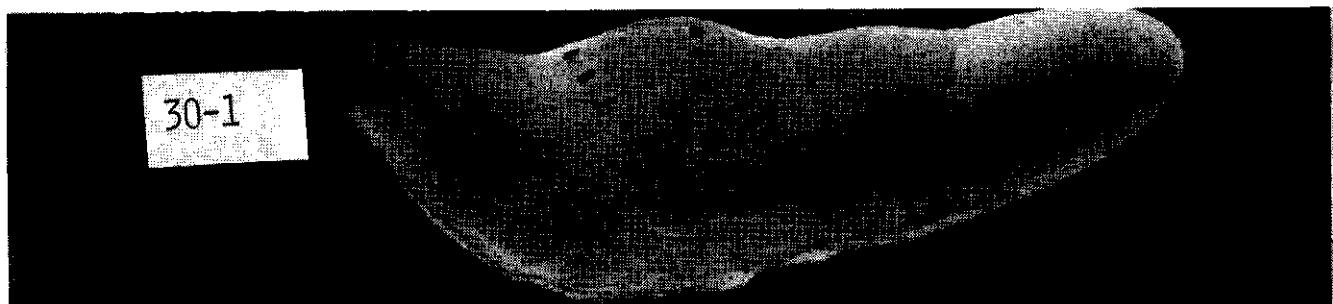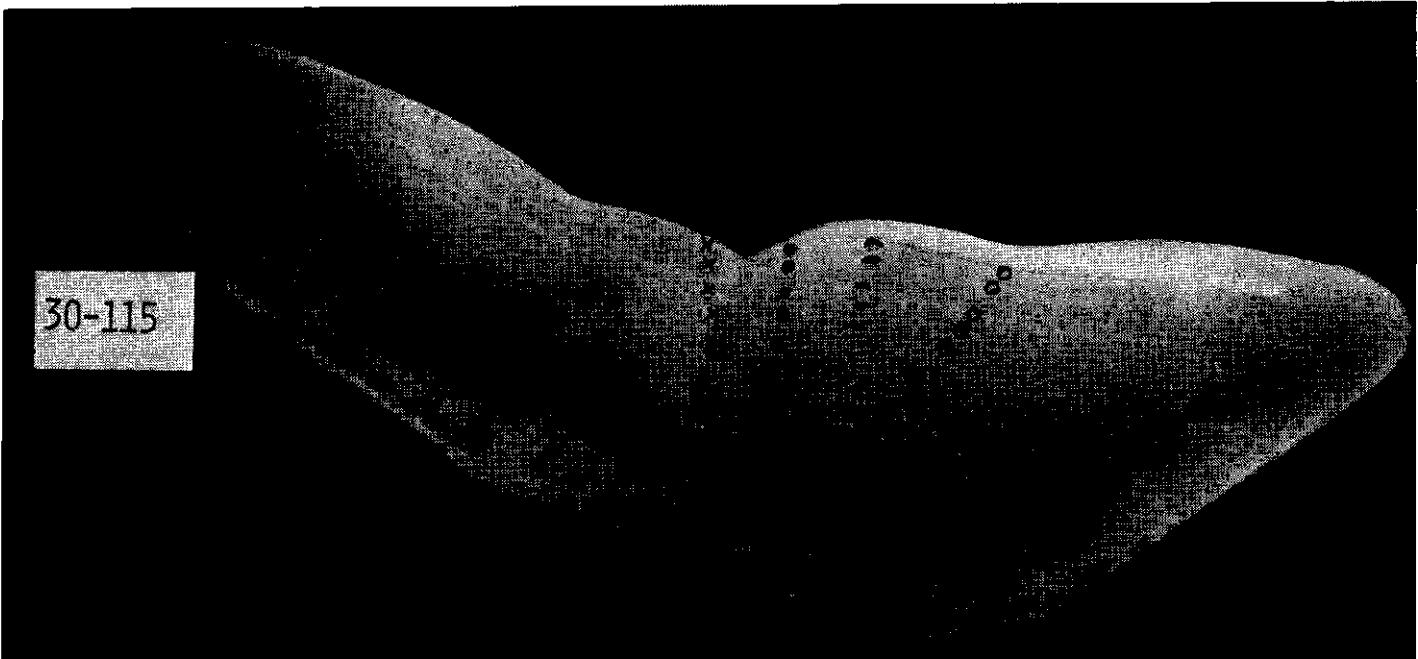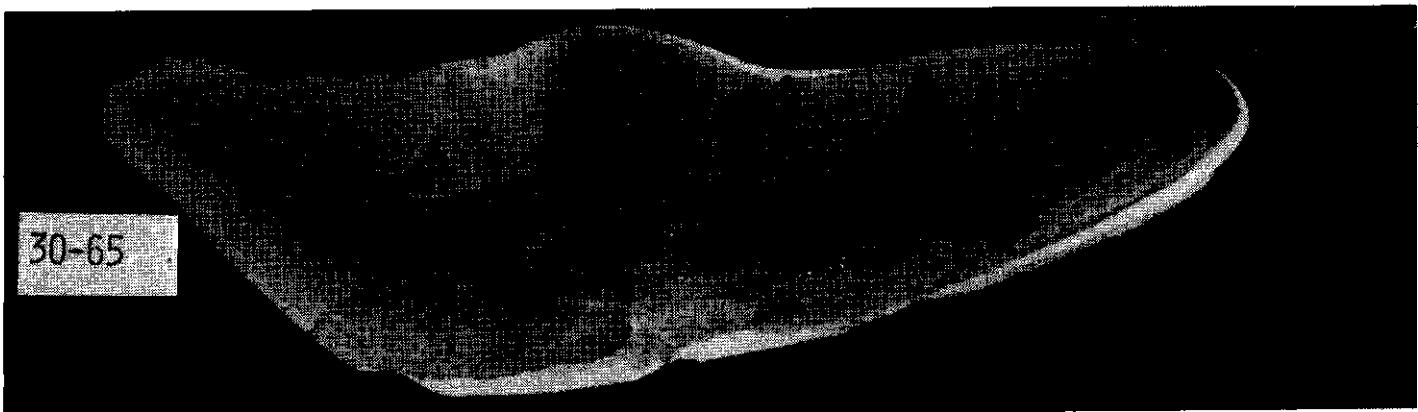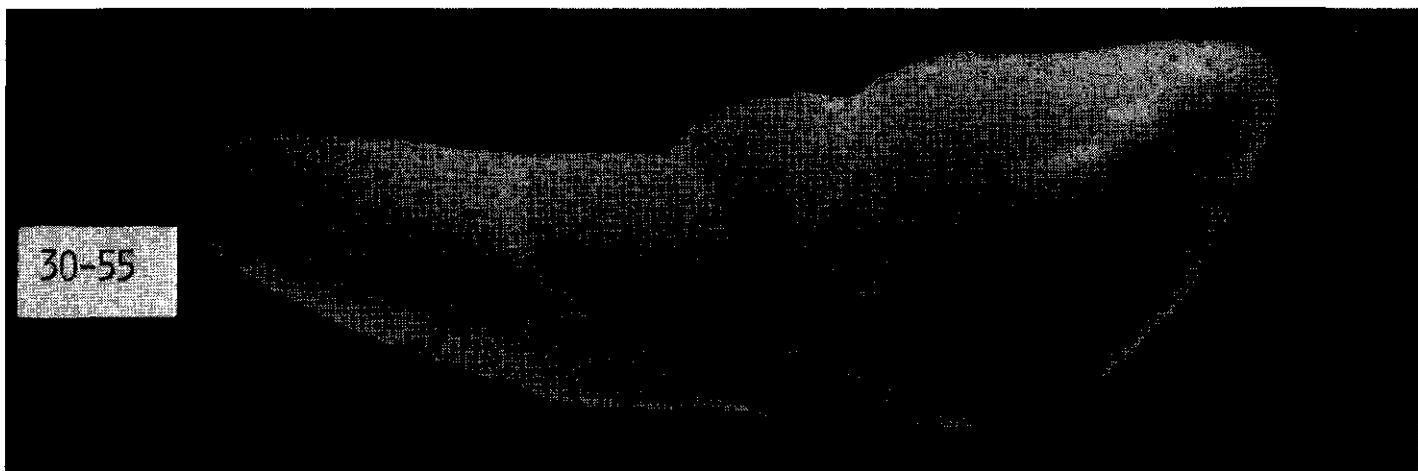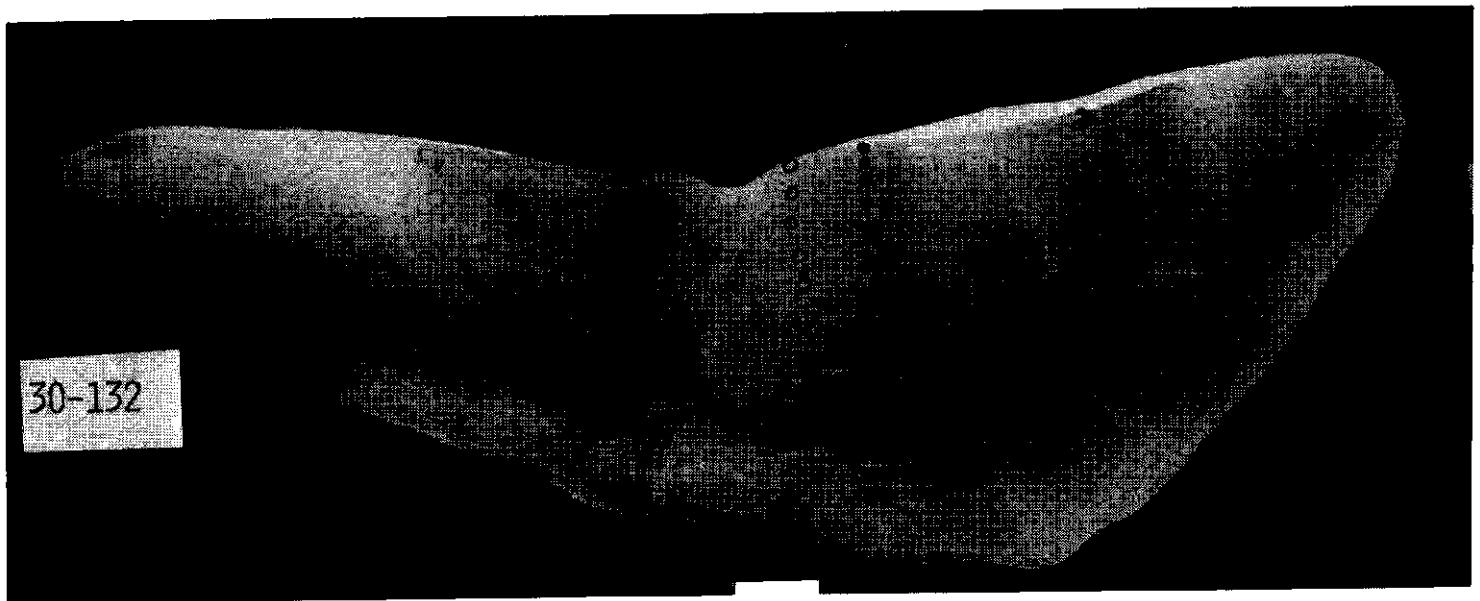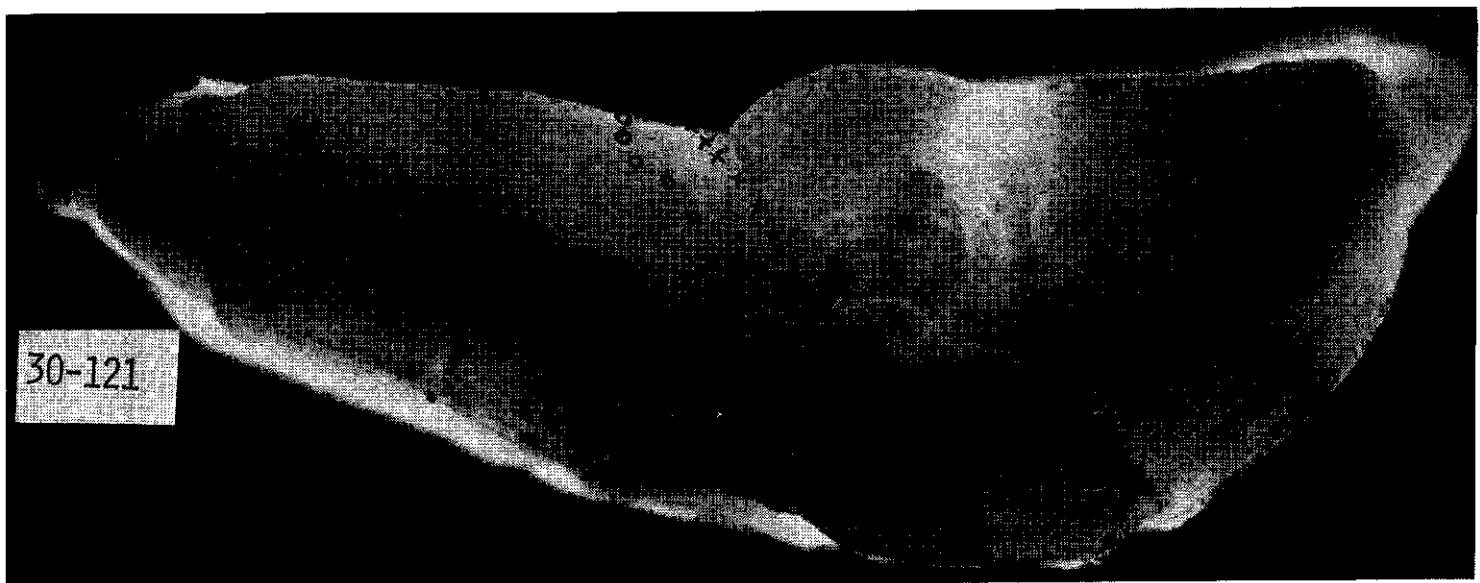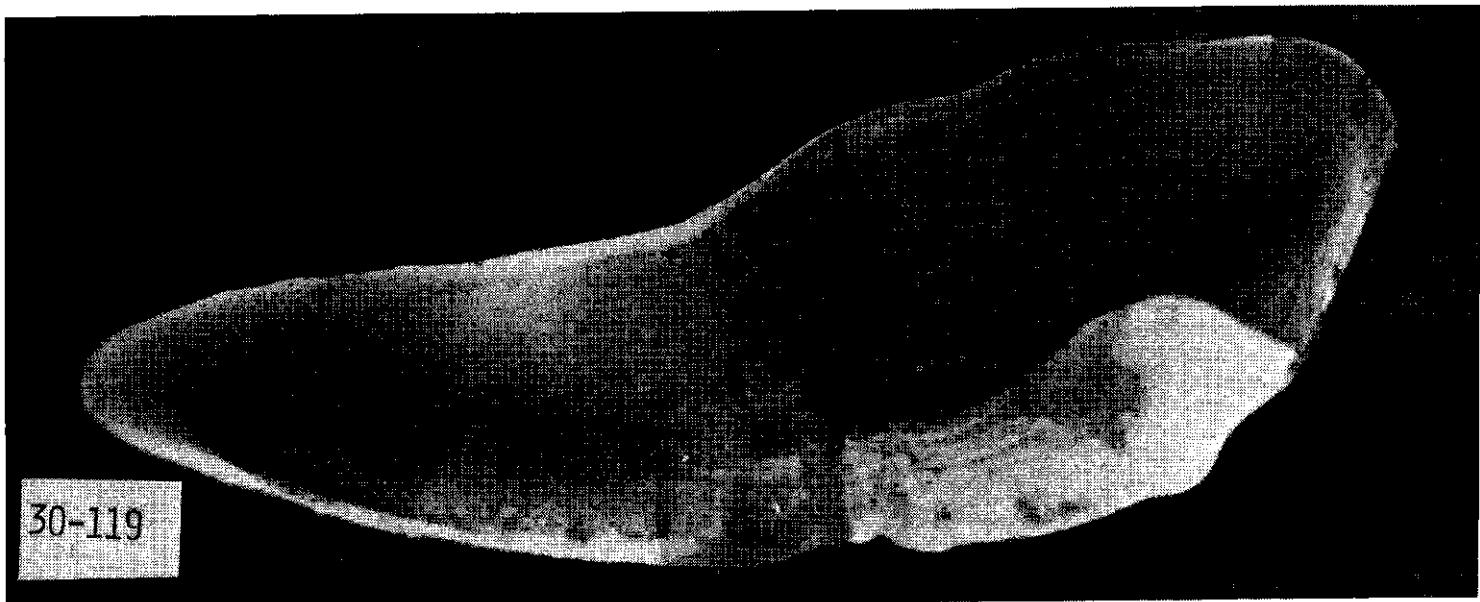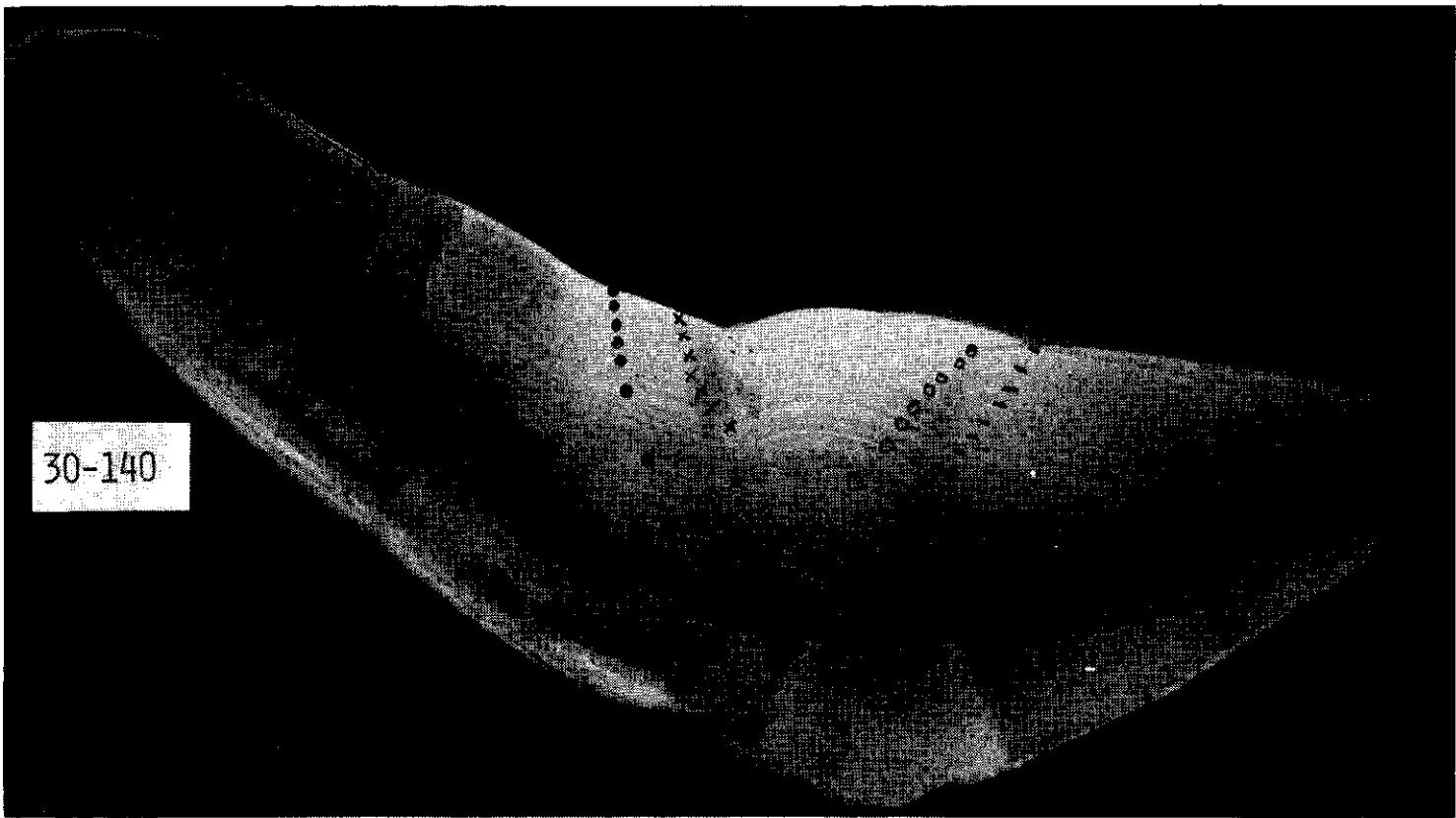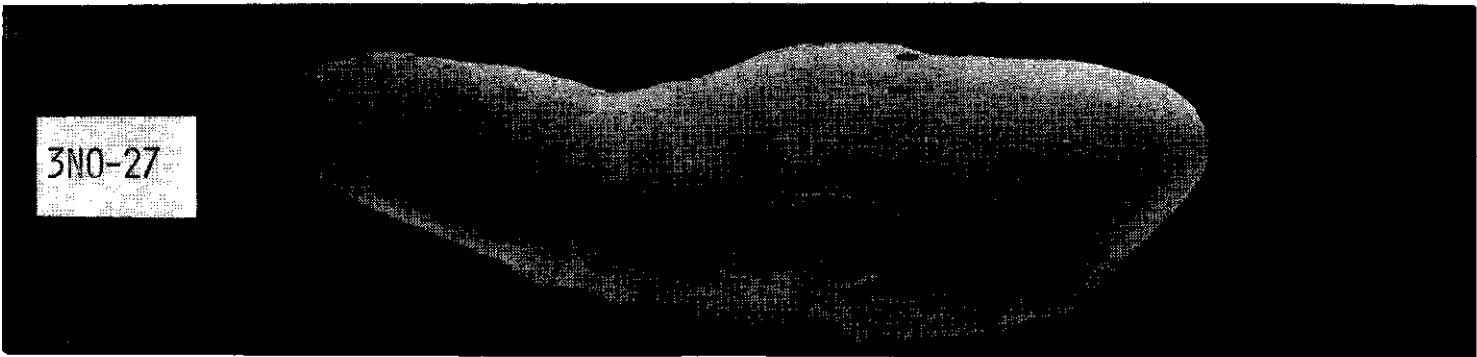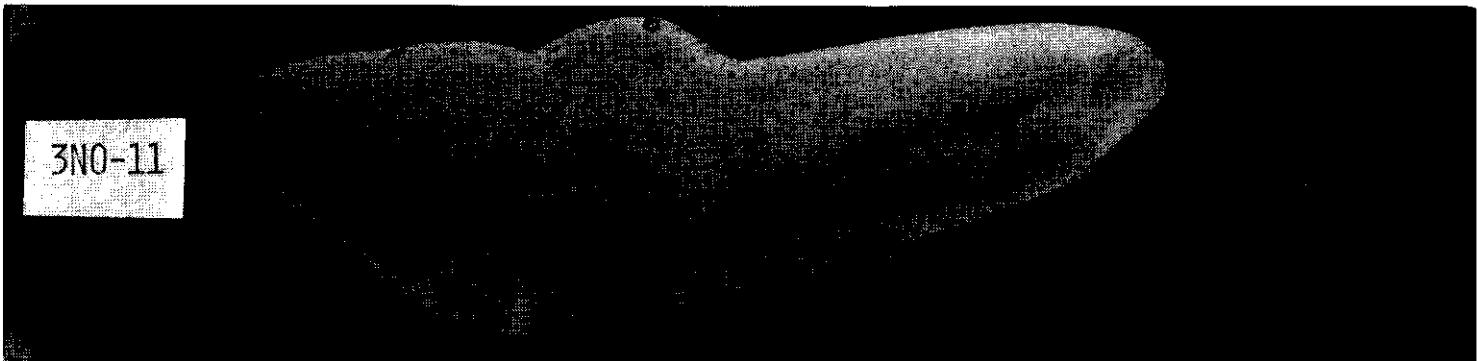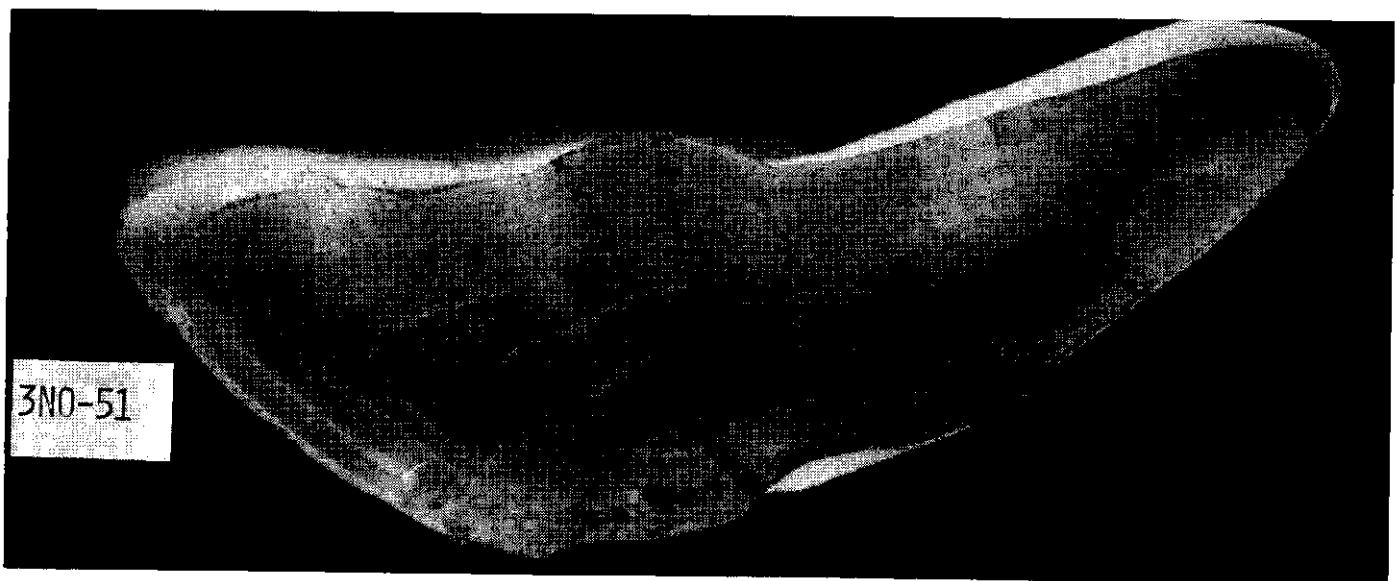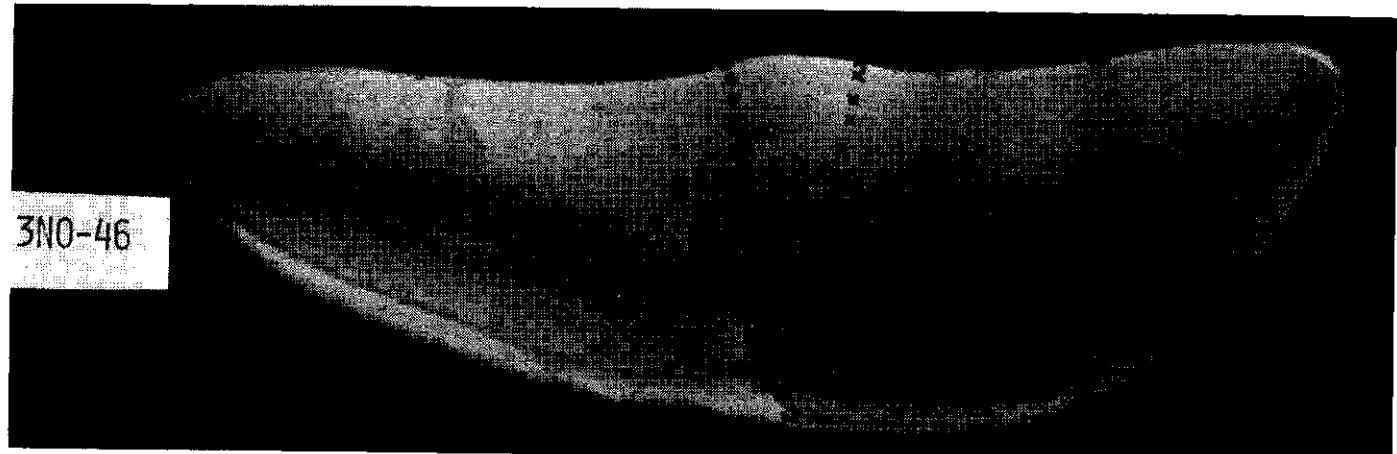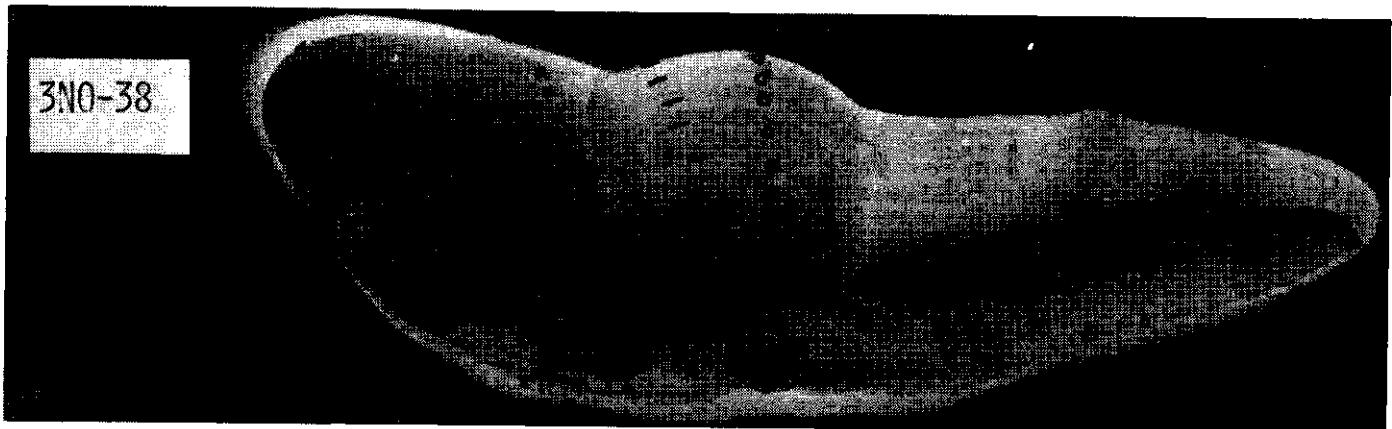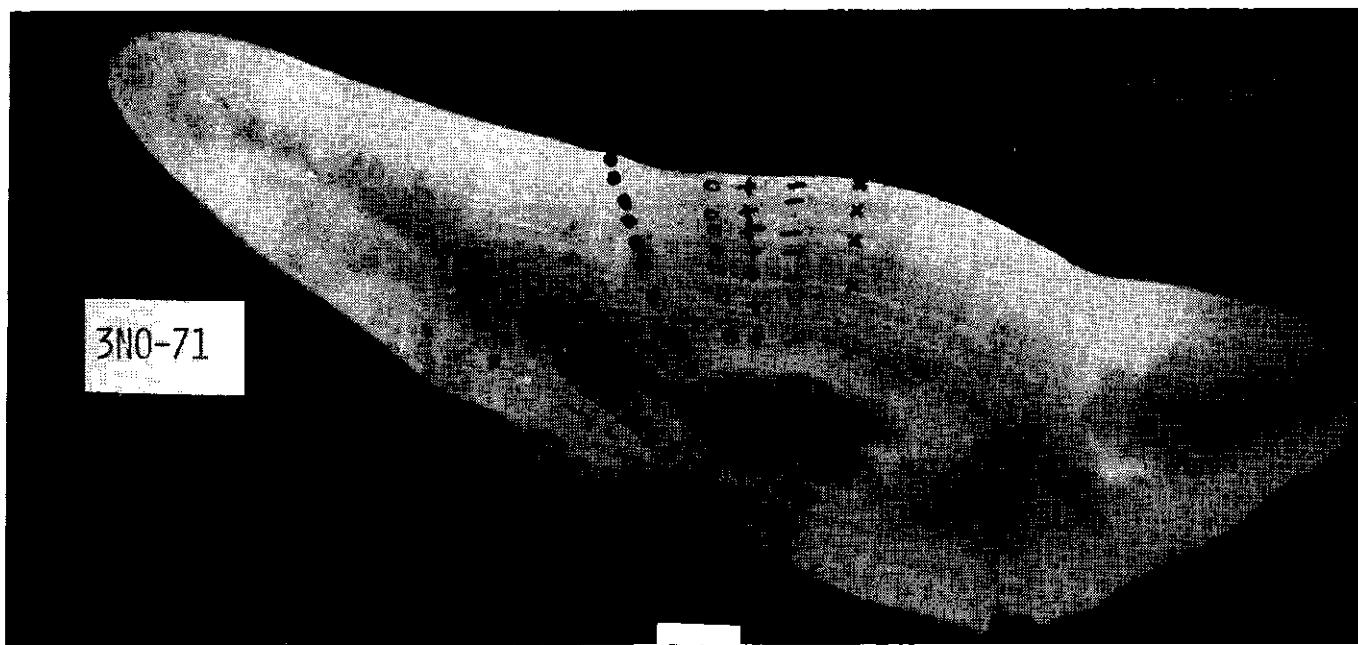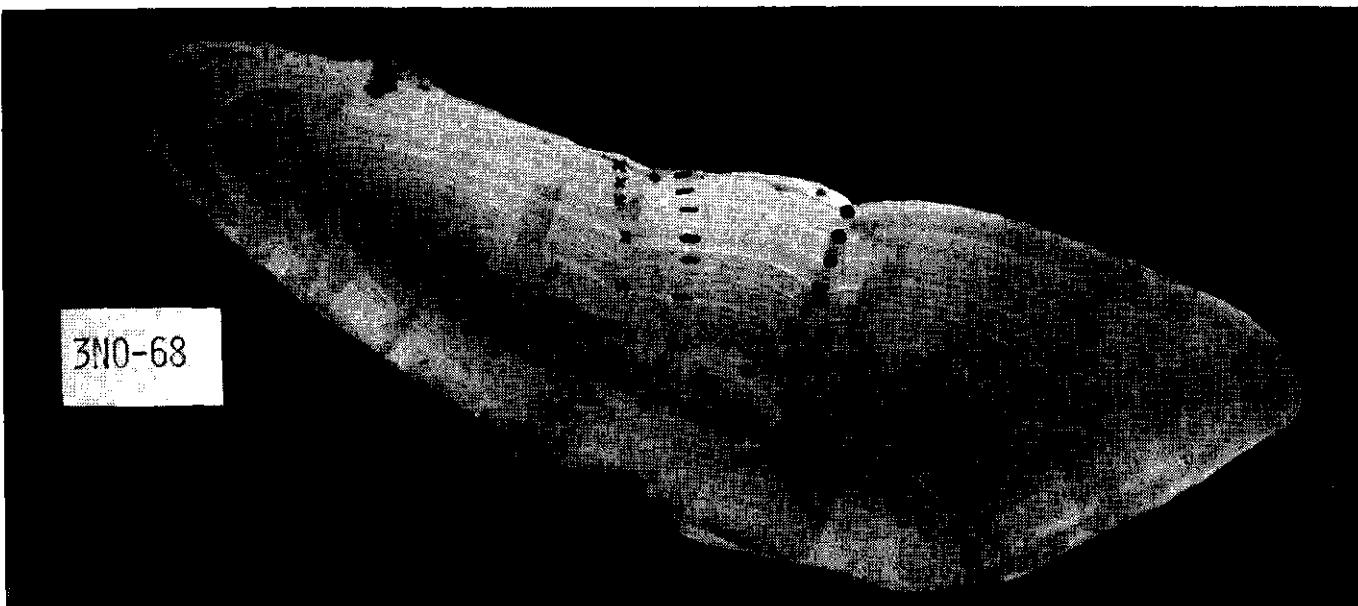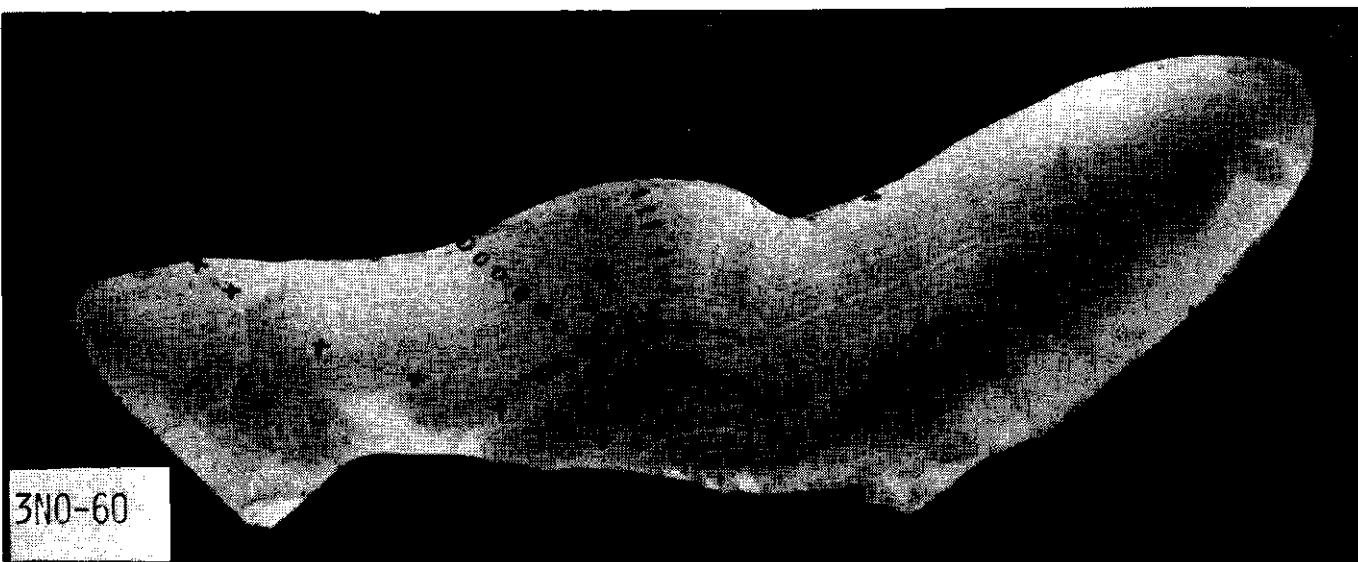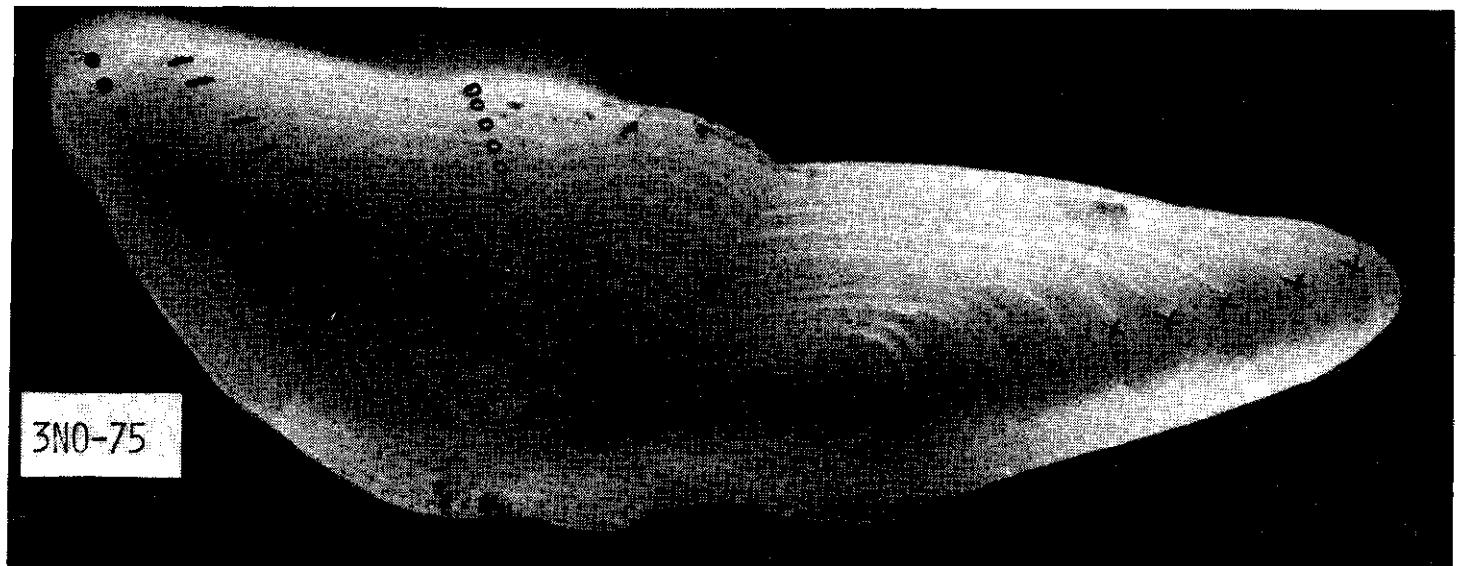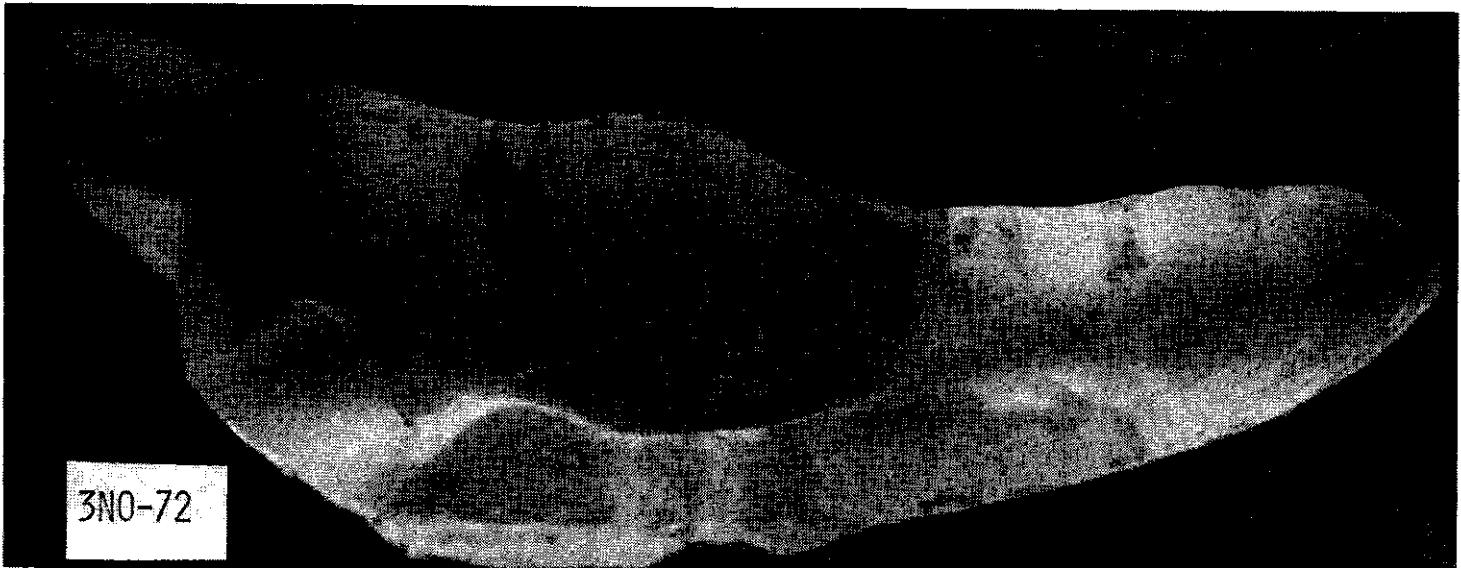
2J-14

2J-58

2J-63

2J-74

2J-85

2J-122

2J-300

C 14

DIVISION 3K

3K-317

3K-318

3K-321

3K-328

D 1

3K-337

3K-339

3K-352

3K-366

D 2

3K-404

3K-429

3K-548

D 3

DIVISION 3L

3L-6

3L-24

3L-55

3L-68

3L-102

3L-134

3L-170

3L-183

3L-189

3L-268

D 6

DIVISION 30

30-1

30-16

30-17

30-43

30-55

30-65

30-115

D 8

30-119

30-121

30-132

D 9

30-140

DIVISION 3NO

3NO-11

3NO-27

3N0-60

3N0-68

3N0-71

D 12

3NO-72

3NO-75

DIVISION 3Ps

3Ps-10

D 13

3Ps-25

3Ps-37

3Ps-45

3Ps-32

D 14

3Ps-101

3Ps-104

3Ps-127

3Ps-155

E 1
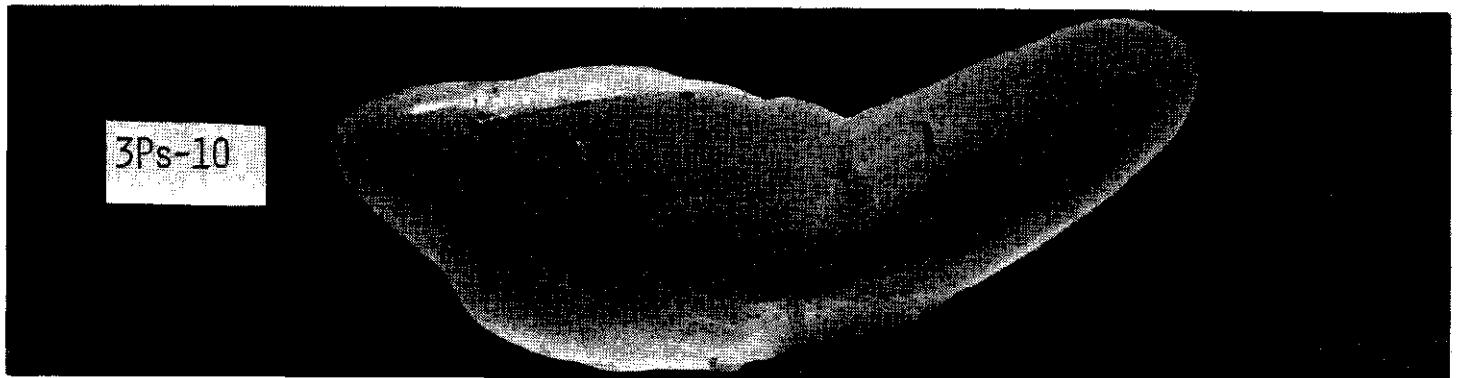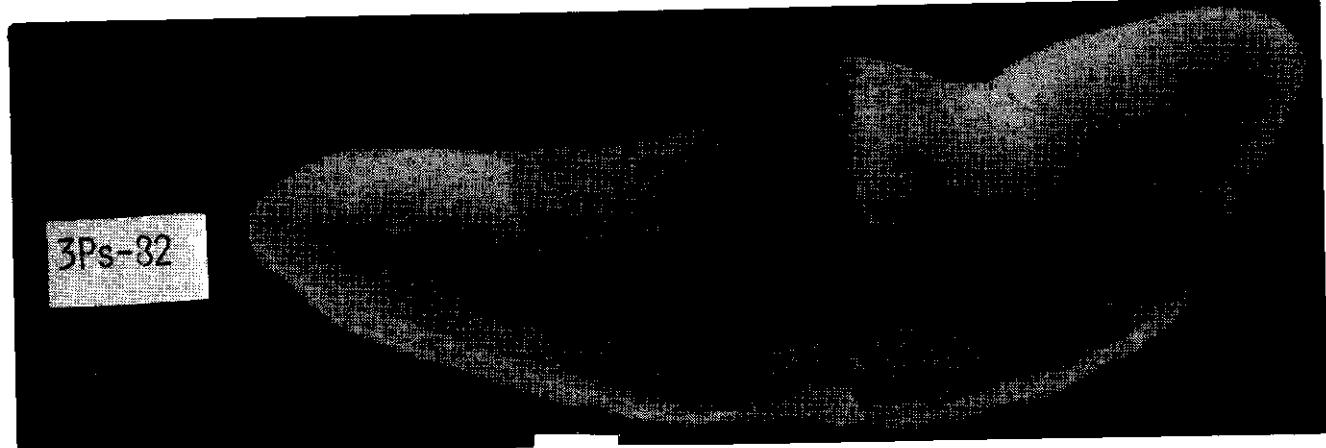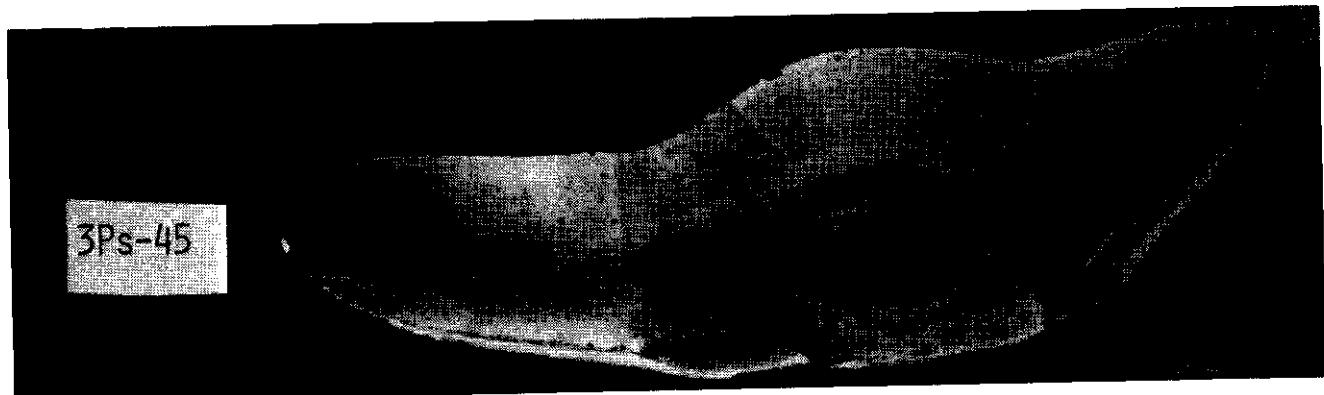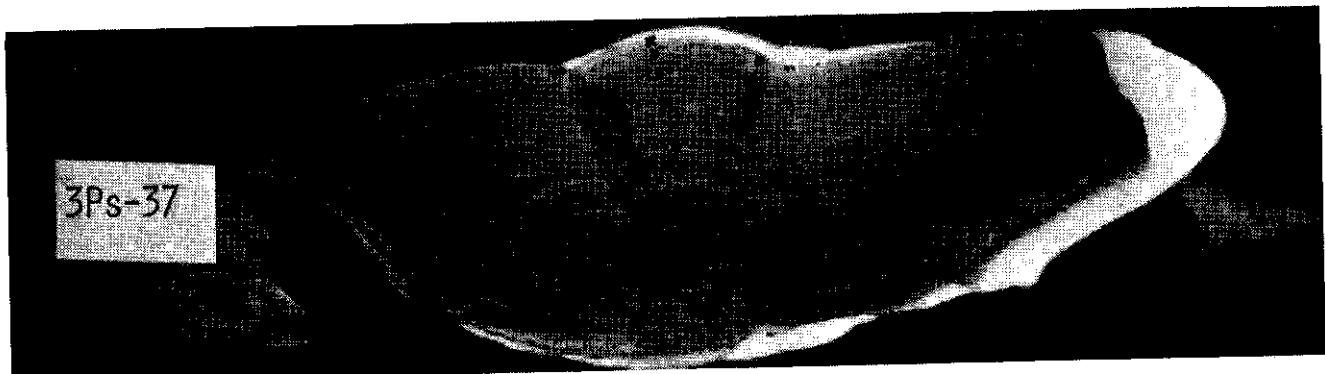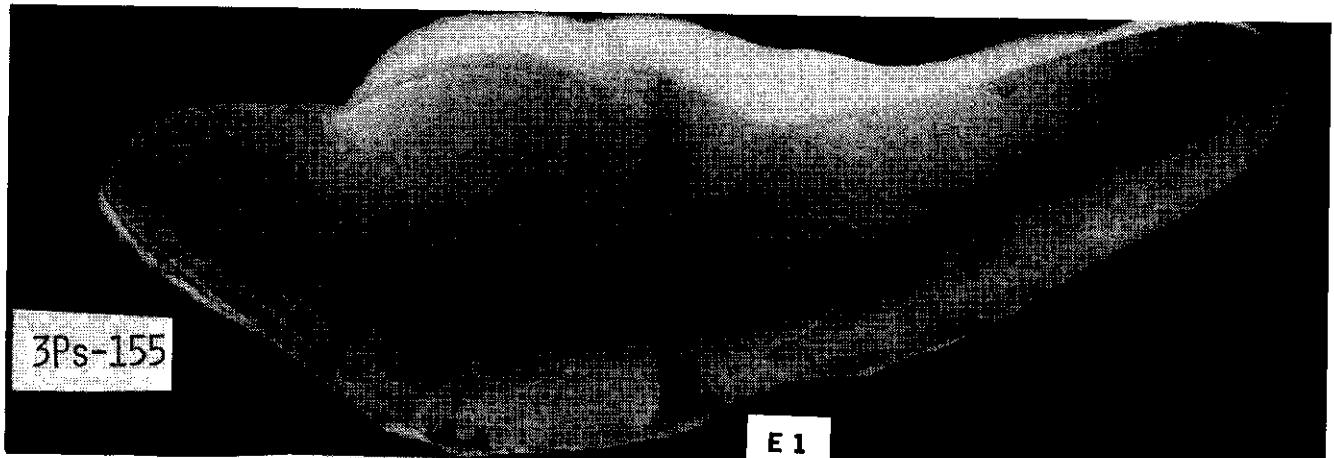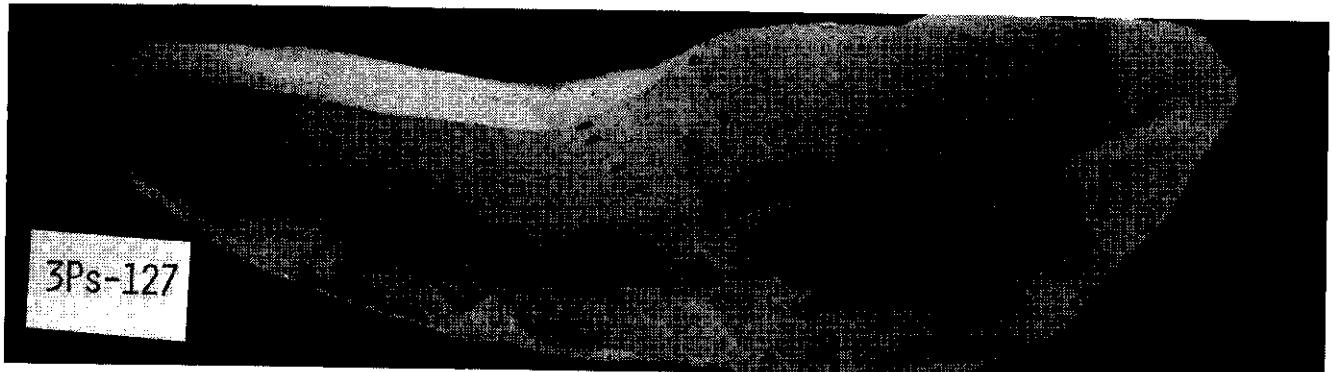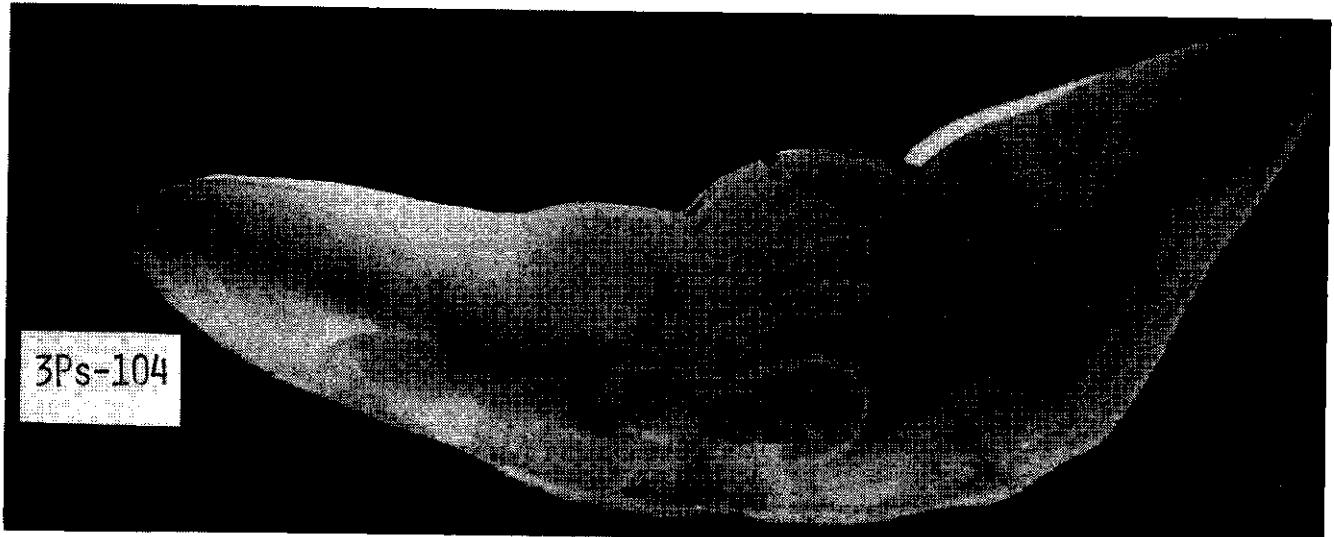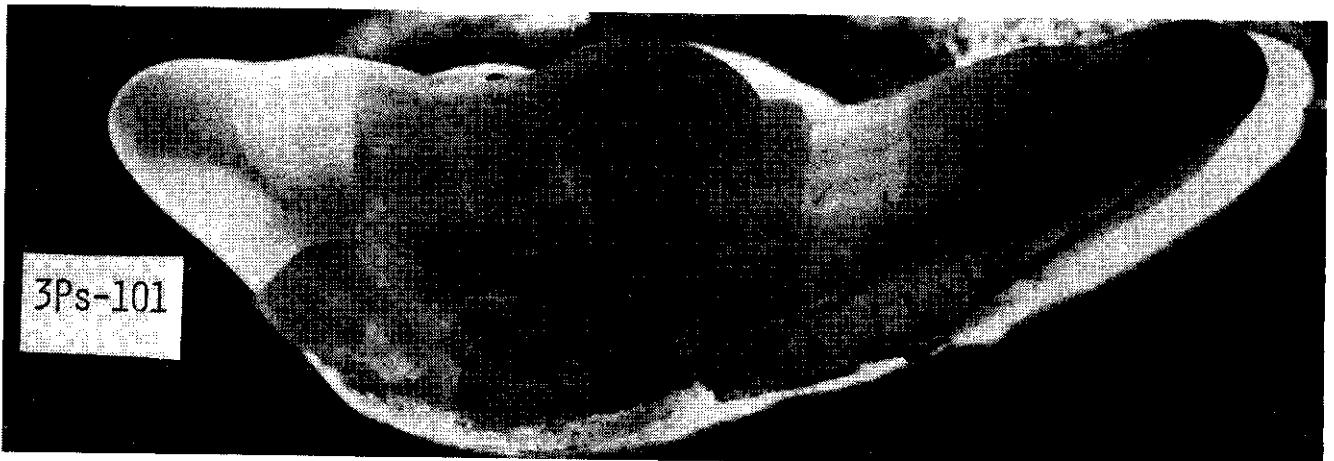
International Commission for the Northwest Atlantic Fisheries

ANNUAL MEETING – JUNE 1976

Revised Text

for

Report of the Ageing Workshop at Vigo, Spain
20-25 October 1975

Editorial Note: The Draft Report of the Ageing Workshop was issued in April 1976 as Summ.Doc. 76/VI/13 and an Addendum to this document was subsequently issued. The tables and figures referred to in the following revised text are essentially the same as those contained in the Draft Report and Addendum, except that the table numbers have been changed. Due to the lack of time available to reproduce the revised Report in its entirety, only the revised text is presented here, with cross-references to the tables as numbered in the Draft Report and the Addendum. This document will be re-issued complete with tables and figures as soon as possible after the conclusion of this 1976 Annual Meeting.

Conveners: R. Wells
            E.C. Lopez-Veiga

Introduction

Differences in the age compositions of some fish species, as derived from sampling data reported by various ICNAF Countries, were apparent at the April 1975 Meeting of the Assessments Subcommittee. Because accurate age determinations are essential for the analytical assessments of fish stocks, an Ageing Workshop was set up to ascertain if the discrepancies are due to variation in age reading among the readers of different countries and, if so, whether these differences are important. This document describes the proceedings of the Workshop, which took place as scheduled at the Instituto de Investigaciones Pesqueras, Vigo, Spain, during 20-25 October 1975, with the participation of experts from Canada, Federal Republic of Germany, Poland, Portugal, Spain and USA. Because of illness, the USSR expert was unable to attend before 3 November, at which time he had the opportunity to study part of the material on cod that was examined earlier during the Workshop.

Materials and Methods

The Workshop was established by STACRES (*Redbook* 1975, p. 20) to examine ageing material for cod and silver hake from various Northwest Atlantic stocks.

Because of illness, the USSR expert could not attend during the scheduled period
of the Workshop and the work was devoted entirely to the examination of ageing
material for cod.   In view of the STACRES recommendation at the 1975 Annual Meeting
that "countries fishing those stocks should participate in the Workshop and that
participants should include the persons who actually do the age reading" and
taking into account the difficulty of proceeding without the presence of the USSR
expert, the work on silver hake ageing was limited to an exchange of views on
techniques only.   Thus, the major problem of attempting to resolve the ageing
problem for silver hake from interpretation of the otoliths could not be achieved.
The need for a meeting of experts on silver hake ageing still exists, and it was
left to the interested countries to determine when and where such a meeting should
be held.

   With regard to the studies undertaken for cod, ageing material (otoliths)
was provided by Canada and Spain as follows:

ICNAF Div.	Sample 1 (Spain)	Sample 2 (Canada)
2J	–	49
3K	55	46
3L	106	49
3NO	–	49
3O	52	49
3Ps	52	49
4Vn	51	–
5Z	52	–

   Each reader was provided with a microscope and the otoliths were read in a
darkened room.   The otoliths were embedded in clay and arranged in trays, each
containing about 25 specimens, so that no delay was experienced in obtaining
samples.   However, there was insufficient time for most readers to read all of
the otoliths available.

   On the first day of the Workshop, Sample 1 was read by those who had arrived
by that date.   On the following day, after discussion by all participants, it was
decided to proceed with Sample 2, because both photographs and slides of these
otoliths were available.   After the otoliths were read, time was available to
study in detail about 60 slides and the various interpretations of age were noted
and discussed.   Tables 1 and 2 (Tables 1 and 2 of Addendum to Draft Report) show
the age readings by individual readers for otolith samples 1 and 2 respectively.

Results

Sample 1

   Agreement between pairs of readers.   Table 3 (Table 1 in Draft Report) shows
the percentage agreement between readers by ICNAF division and in total.   Agree-
ment between readers ranged from 0 (readers 3 and 9 for Subdiv. 3Ps) to 77%
(readers 8 and 9 in Subdiv. 3Ps).   Agreement between pairs of readers for all
divisions combined ranged from 8% (readers 1 and 3) to 63% (readers 8 and 9).   An

agreement of 76% was reached by readers 5 and 8 but this was for Div. 5Z only.
The average agreement between pairs of readers was as follows:

ICNAF Div.	No. of pairs of readers	Average % agreement between pairs
3K	3	53
5Z	10	51
3Ps	28	42
4Vn	11	42
3L	24	34
30	9	23

This grouping implies that the otoliths most difficult to interpret were those
from Div. 3L and 30.

Taking all divisions combined, the percentage agreement between pairs of
readers is shown in Table 4 (Table 2 in Draft Report). Pairs of readers with
agreements better than 50% were: (1,2), (1,5), (2,10), (5,8), (8,9), and (8,10).
Reader 2 has little bias with respect to the group as a whole; readers 1, 4, 5,
8 and 9 underread the group while readers 3, 6, 7 and 10 tended to over-read the
group.

Agreement with the modal age. For each specimen, the mode was determined
from the ages estimated by the various readers (except for those specimens
(about 20%) in which no clear mode was evident). The ages of each reader are
compared with the mode and the anomalies are listed in Table 5 (Table 3 in Draft
Report) by reader and division. The mean age and standard error of the anomalies
by division and reader were calculated. With respect to the modal age, the
deviations of the mean age from zero gives an indication of bias, while the standard
error gives a measure of consistency.

Table 6 (Table 4 in Draft Report) shows the means and standard errors by
division and reader. The information in this table may be compared with the
plots of the data in Table 5 (Table 3 in Draft Report) (see Fig. 1-8). For Div.
3K, agreement with the mode was good for all 3 readers. For Div. 3L (1973), there
was a tendency to over-read. For Div. 3L (1974), agreement was good, although
reader 7 showed a tendencyto over-read. For Div. 30, agreement was considered
fair, although reader 3 tended to over-read and reader 2 to under-read. For
Subdiv. 3Ps, agreement was very good, although readers 3 and 7 tended to over-
read. For Div. 4Vn, agreement was excellent, except that reader 1 tended to
under-read. For Div. 5Z, agreement was considered excellent.

The mean ages of the anomalies are shown in Table 7 (Table 5 in Draft Report)
by reader and division. The agreement with the mode for all divisions combined
averaged about 65%; agreement was good, except that reader 3 over-read the mode
and reader 7 tended to over-read.

Sample 2

Agreement between pairs of readers. Table 8 (Table 3 in Addendum to Draft
Report) shows the percentage agreement between readers by division and in total.

Agreements between readers ranged from 0 (readers 8 and 16 for Div. 3K) to 96% (readers 9 and 14 for Subdiv. 3Ps). The average agreement between pairs of readers was as follows:

ICNAF Div.	No. of pairs of readers	Average % agreement between pairs
3K	105	27
2J	104	34
3L	105	38
3NO	105	42
30	105	45
3Ps	105	66

The agreements ranged from 27% in Div. 3K to 66% in Subdiv. 3Ps. Taking all divisions combined, the percentage agreement between pairs of readers is shown in Table 9 (Table 4 in Addendum to Draft Report). Out of a possible 105 pairs of readers, 25 pairs had agreement better than 50% and 22 pairs worse than 31%.

Agreement with modal length. Modal ages were derived for this sample as for Sample 1. The anomalies by reader and division are listed in Table 10 (Table 6 in Draft Report), and the means and standard errors of the anomalies by division and reader are shown in Table 11 (Table 7 in Draft Report). The data in this table may be compared with the plots of the data in Table 10 (see Fig. 9-15).

For Div. 2J, readers 11 and 17 under-read and reader 16 over-read the mode, while readers 2 and 13 tended to over-read to a lesser extent. For Div. 3K, readers 1, 2 and 16 tended to over-read, while readers 4, 7, 14 and 15 tended to under-read. For Div. 3L, readers 16 and 17 over-read and readers 4 and 7 under-read. For Div. 3NO, readers 2, 16 and 17 over-read, and readers 4 and 7 under-read the mods. For Div. 30, reader 16 over-read, and reader 7 under-read. For Subdiv. 3Ps, reader 2 over-read and reader 17 under-read.

Taking all divisions combined in Table 12 (Table 8 9n Draft Report), reader 16 consistently over-read the mode, reader 2 tended to over-read and readers 4 and 7 showed a tendency to under-read. The overall agreement was about 60%.

Differences in Age Compositions and Average
Length-at-age for Otolith Sample 2

The age-length keys are listed for each age reader in Table 13 (Table 5 in Addendum to Draft Report). These keys were derived by adjusting the ages of Sample 2 to an arbitrary length frequency. Table 14 is an age-length key based on the modal age of each otolith which represents the best estimate of the true age of each specimen. Both tables include the calculated age compositions and average length-at-age.

The age compositions based on individual age-length keys are compared with the age composition derived from the modal age-length key are shown in Fig. 16. Although, with few exceptions, the age compositions of the various readers appear to be the same as that of the mode, differences are apparent and these may be

significant when the data are limited. For example, suppose that samples from a particular division are available and read only by readers 2 and/or 7; the errors may balance if ages are read by both readers, and the age compositions would be close to the true situation (assuming that the mode is correct). However, if age data are available from only one of the two sources, serious discrepancies would result, as indicated below:

Age	3	4	5	6	7	8	9	10
Reader 2	18	64	127	310	242	143	52	21
Reader 7	56	199	277	261	123	40	35	3

If the actual age composition were similar to that listed for reader 2, but ageing data were available only from reader 7, the prospects for recruitment would appear to be very much better than they actually were, and *vice versa*.

The length-at-age curves shown in Fig. 17 are, with few exceptions, similar to that derived from the modal ages, and they display differences corresponding to those shown by the age compositions.

Examination of Photographs

About 60 otoliths were examined by means of slides and the various interpretations are noted on the appended photographs (see photographs appended to the Draft Report). Some otoliths offered no difficulty and agreement was unanimous; for example, Div. 3L - 55, Div. 3L - 268, and Div. 2J - 58.

Difficulties were encountered in determining the first annulus. The following were considered typical first year annule: Subdiv. 3Ps - 37, Subdiv. 3Ps - 104, Subdiv. 3Ps - 155. Often a check occurs in the opaque zone before the first annulus is laid down as in Subdiv. 3Ps - 127, and in some cases (e.g. Subdiv. 3Ps - 101, Div. 3L - 189), it was difficult to agree if the ring was a check or the first annulus. Compounding the difficulty, otoliths cut off centre may show a deformed first annulus, such as the figure-eight shape in Subdiv. 3Ps - 192. It appeared that the second annulus might often appear characteristically clear or bright (e.g. Div. 3L - 268, Subdiv. 3Ps - 104).

The different interpretations of splits and checks were the major reasons for disagreements. Some otoliths (e.g. Div. 2J - 12) showed many splits. In otoliths Div. 3L - 134 and Div. 2J - 58, it was agreed that a definite check occurs in the opaque zone before the second annulus and that Div. 3L - 189 shows a definite check before the third annulus. Definite checks are present in the second annulus of otoliths Subdiv. 3Ps - 48 and Div. 2J - 58, and in the third annulus of otoliths Div. 3L - 102 and Div. 2J - 85. Doubtful checks and splits are common, e.g. Div. 3NO - 27, Div. 3L - 6 and Div. 3L - 183.

A problem was also encountered in determining whether the type of edge was opaque or hyaline: Div. 3L - 183, Subdiv. 3Ps - 101 and Div. 3L - 268. In a number of cases it was difficult to determine if there are one or two years at the edge, e.g. Subdiv. 3Ps - 37, Div. 30 - 65, Div. 2J - 300, Div. 3L - 189 and Div. 3NO - 1.

- 6 -

Examination of the Discrepancies Through Photographs

After the Workshop concluded, a more detailed examination of the main discrepancies in otolith readings was carried out, in order to better point out the sources of the differences. For each of the photographs examined during the Workshop, the following is a description of the main differences between the various interpretations. This may serve as a good starting point for further studies or ideas. Individual age readings for each of the otoliths in the photographs may be found in Table 2.

(DETAILED DESCRIPTIONS OF THE 60 OTOLITHS WILL BE INCLUDED IN THE COMPLETE

REVISED VERSION OF THIS REPORT TO BE ISSUED AFTER THIS ANNUAL MEETING)

Discussion and Remarks

The Workshop participants considered that, because of obvious differences between readers, there was a need for a description of the problems encountered in the age determination of cod and guidelines prepared to assist in resolving these problems.

After the detailed examination of the otolith photographs, the major problem appeared to be the lack of clear criteria to discern when a particular ring is a check or an annulus. This is the main source of variation in interpretation that must be resolved. If this problem is not solved, the subjectivity when ageing cod by otoliths will not diminish. This kind of work will require a great deal of tedious work in order to establish objectivity in ageing, and it was felt that more studies in this field are required, perhaps concentrating on a particular area (the northern dividions where the problem seems to be greatest) and thus developing a set of guidelines which could be useful for other areas or even for other species.

Other problems that emerged are: the interpretation of the innermost ring in order to establish the first annulus; the otolith edge where it is difficult to discern the rings; and splits which may sometimes be interpreted as annuli but which can be more readily defined than other problems. Some of the major problems are summarized as follows:

a) Splits and checks and how these may be distinguished from annuli.

b) Nucleus and the determination of the first annulus

c) The effects of cutting the otolith "off-centre".

d) Otolith edge—recognition of type (hyaline or opaque) and seasonal deposition of opaque and hyaline material.

e) Pecularities in the otoliths from specific areas (e.g. a very small first annulus in Subdiv. 4Vn cod; a very strong check before the second annulus in Subdiv. 5Ze cod).

E 7

In order to reduce subjective errors, studies should be made to establish guidelines for otolith interpretation for the various areas and these guidelines validated. Guidelines should be clearly illustrated by all possible means such as photographs, sketches, etc.

It was noted that, in many cases. data are incomplete and age compositions for various areas and time periods have to be derived from single age-length keys. Differences in age reading may be great and these may seriously affect the results of population analyses. The problem seems to be more severs in the northern divisions (Div. 2J, 3K, 3L) than farther south, and the greater cod catches in those northern areas stress the importance of resolving the problem.

The otolith photographs and slides used during the Workshop are available through the ICNAF Secretariat for the use of interested experts who may wish to examine the material.

Recommendations

The Workshop participants recommend:

a) that STACRES request papers dealing with the interpretation of ages of cod including (i) validation of ages, (ii) seasonal deposition of material at the otolith edge, (iii) effects of cutting otoliths off-center, and (iv) peculiarities in the otoliths of specific areas;

b) that STACRES request whatever further action is necessary to ensure that discrepancies in age composition data are eliminated or reduced as much as possible, perhaps by setting up another Workshop to deal with problems in a specific area and to establish guidelines for otolith interpretation.

International Commission for the Northwest Atlantic Fisheries

ANNUAL MEETING – JUNE 1976

DRAFT

Report of the Ageing Workshop at Vigo, Spain
October-November 1975

Tables 1 and 2 show the age readings by individual readers for otolith samples 1 and 2 respectively.

Sample 2

Agreement between pairs of readers

Table 3 shows the percentage agreement between readers by ICNAF division and in total. Agreements between readers ranged from 0 (readers 8, 16 in Div. 3K) to 96% (readers 9, 14 in Subdiv. 3Ps). The average agreement between pairs of readers was as follows:

ICNAF Div.	Number of pairs of readers	Average percentage agreement between pairs
3K	105	27
2J	104	34
3L	105	38
3NO	105	42
30	105	45
3Ps	105	66

The agreements ranged from 27% in Div. 3K to 66% in Subdiv. 3Ps.

Taking all divisions combined, the percentage agreements between pairs of readers is shown in Table 2. Twenty-five pairs of readers, out of a possible 105 pairs, had agreement better than 50%, and 22 pairs had agreement worse than 31%.

Differences in age compositions and average length-at-age for otolith sample 2

Table 5 shows age-length keys by reader. These keys were derived by adjusting the ages of sample 2 to an arbitrary length frequency. Table 6 is a similar age-length key made from the modal age of each otolith and represents the best estimate of the true age of each specimen. Both Tables include age composition and average length-at-age.

The age compositions by reader compared with the modal age composition are shown in Fig. 1. Although, with a few exceptions, the age compositions appear to be substantially the same as the mode, differences do occur and may be important when the data is limited. For example, suppose for a particular area, samples are available only from reader 2 and/or 7. If data are available from both sources, the errors may balance each other so that the results are close to the real situation (assuming that the mode is correct). However, a quite different picture may result if one only of these sources is used:

	Number at age	
Age	Reader 7	Reader 2
3	56	18
4	199	64
5	277	127
6	261	310
7	123	242
8	40	143
9	35	52
10	3	21

If the actual age composition were similar to that listed for reader 2, but only the age composition from reader 7 were available, the prospects for recruitment would appear to be very much better than in fact they were. The opposite conclusion would be drawn if the situation were reversed.

The length-at-age curves shown in Fig. 2 are, with a few exceptions, similar to that derived from the modal ages, and show differences corresponding to those displayed by the age compositions.

Remarks

During the discussions at the Workshop, no clear differences in the interpretation of cod otoliths could be discerned. It was felt that the differences between readers could be largely attributed to the lack of clear guidelines in interpretation and consequently a high degree of subjectivity.

In many cases, data is incomplete and age compositions in various periods and areas have to be derived from single age-length keys. That differences between readers can be large, has been shown above, and these differences ultimately affect population analysis. The problem is apparently more severe in the northern areas (Div. 2J, 3K, 3L) than in the southern.

In order to reduce subjective errors, studies should be made to establish guidelines in othlith interpretation for the various areas, and these guidelines validated. Guidelines should be clearly illustrated by photographs or sketches, etc.

The otoliths, photographs and slides used during the Workshop are available through ICNAF for the use of interested experts who have not had the opportunity of examining them.

Table 1. Age readings for otolith sample 1.

AREA	SP NO	LEN	1	2	3	4	5	READERS 6	7	8	9	10	11	12	13	14	15	16	17	AGE MODE
3K																				
	586	58	6	6																6
	587	61	7	6																6
	588	61	6	6																6
	589	61	8	6																7
	590	61	7	7																6
	591	61	6	5																5
	592	61	6	6																
	593	61	6	6																6
	594	61	8	7																7
	595	61	6	6																5
	596	61	6	6																6
	597	64	8	6																7
	598	64	8	7																7
	599	64	6	6																8
	600	40	6	5																4
	601	40	5	5																5
	602	40	4	4																3
	603	40	4	4																4
	604	40	5	4																4
	605	40	5	5																5
	606	40	4	4																4
	607	40	5	4																
	608	40	4	4																2
	609	40	5	4																
	610	43	5	5																5
	611	43	5	5																5
	612	43	5	5																4
	613	43	5	5																6
	614	43	6	5																6
	615	43	5	5																4
	616	43	5	5																5
	617	43	5	5																5
	618	43	5	5																6
	619	43	5	5																5
	620	43	5	5																5
	621	43	5	5																
	622	43	5	5																4
	623	46	6	5																5
	624	46	5	6																5
	625	46	5	5																4
	626	46	6	5																5
	627	46	5	5																4
	628	46	5	5																4
	629	46	6	6																4
	630	46	5	5																5
	631	46	6	6																7
	632	46	6	6																7
	633	46	6	6																6
	634	46	6	5																6
	635	46	5	4																7
	636	46	7	5																6
	637	46	6	5																5
	638	43	6	6																5
	639	49	6	6																6
	640	49	6	6																6

Table 1.   (Continued)

AREA	SP NO	LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	AGE MODE
3L	1	61	5	5							6			4		5				5
	2	61	7	6							7			5		6				7
	3	61	7	5							5			5		6				6
	4	64	7	7							7			7		6				7
	5	64	7	5							5			5		5				8
	6	64	6	6							6			5		6				8
	7	64	7	7							8			6		5				7
	8	73	7	6							9			5		6				7
	9	73	9	7							7			5		6				7
	10	73	8	6							7			5		5				7
	11	73	8	7							8			6		6				7
	12	73	7	7							7			5		6				8
	13	73	8	8							8			6		7				9
	14	73		6							7			5		3				7
	15	73	7	7							9			5						9
	16	73	7	7							8			5		6				7
	17	76	9	9							10			7		8				10
	18	76	8	7							7			5						10
	19	76	10	8							10			6		8				11
	20	76	9	8							8			6		6				10
	21	76	8	7							8			5		5				7
	22	76	8	7							7			6		6				7
	23	76	9	9							9			7		8				9
	24	76	7	7							8			6		6				11
	25	76	9	9							9			6		6				8
	26	76	8	8								9			9					10
	27	76	7	7								7			9					8
	28	58	6	6								7			7					9
	29	79	11	10								11			9					10
	30	79	10	8								9			8					9
	31	40	4	5								6			6					5
	32	40	4	5								5			5					5
	33	40	5	4								6			6					5
	34	40	5	4								5			5					5
	35	43	7	7								7			6					7
	36	43	4	4								6								5
	37	43	4	4								6			4					6
	38	43	5	5								6			4					5
	39	43	5	4								6			5					5
	40	58	5	5											5					4
	41	43	5	5								5			5					5
	42	43	5	4								4			5					5
	43	43	5	5								5			5					5
	44	43	4	5								5			5					4
	45	43	4	4								5			4					4
	46	43	5	5								8			5					5
	47	46	4	5											5					4
	48	46	5	4								5			5					5
	49	46	5	5								5			5					5
	50	46	4	5								5			5					5
	51	46	5	5								7			5					5
	52	46	5	5								6			5					6

Table 1. (Continued)

AREA	SP NO	LEN	1	2	3	4	5	READERS 6	7	8	9	10	11	12	13	14	15	16	17	AGE MODE
3L																				
	713	40	4	4								5		3	4					4
	714	40	5	5								6		5	5					6
	715	40	5	5								5		4	5					5
	716	40	4	4								4		4	4					5
	717	40	5	4								5		5	5					5
	718	40	4	5								5		5	6					6
	719	43	5	5								7		6	6					6
	720	43	4	4								5		4	5					5
	721	43	5	5								6		5	5					6
	722	43	5	5								5		5	5					6
	723	43	4	4								4		3	3					5
	724	43	5	5								6		5	5					5
	725	43	5	5										4	5					5
	726	43	4	4								6		6	5					5
	727	43	6	6								5		5	6					6
	728	43	5	5								6		5	5					5
	729	43	5	4								6		4	5					6
	730	43	5	4								5		4	5					5
	731	43	6	6								6		5	7					6
	732	43	4	4								6		4	5					4
	733	46	5	5								5		4	5					5
	734	46	6	6								7		6	6					
	735	46	6	5								5		6	6					6
	736	46	5	5										4	5					6
	737	46	5	5										5	4					5
	738	46	5	4										4	5					6
	739	46	5	5																7
	686	61	6	6										5	5					6
	687	61	6	6										5	5					
	688	61	7	6										6	5					
	689	61	7	6										6	6					
	690	61	6	6										6	7					
	691	61	6	6										6	6					
	692	64	7	6										6	6					
	693	64	6	6										5	6					
	694	67	7	7										7	6					8
	695	67	6	6										5	5					6
	696	67	6	6										5	5					7
	697	67	7	6										6	6					
	698	70	9	6										6	7					8
	699	70	9	8										7	7					7
	700	76	8	7										7	7					7
	701	34	3	3										2	3					3
	702	37	4	3										3	3					4
	703	37	4	3										4	4					4
	704	37	5	3										5	4					4
	705	40	4	3										4	4					4
	706	40	5	4										6	5					5
	707	40	5	4										5	4					5
	708	40	5	5										5	5					5
	709	40	4	5										4	3					4
	710	40	4	4										3	3					4
	711	40	5	4										5	4					5
	712	40	6	5										5	4					5

Table 1.   (Continued)

AREA	SP NO	LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	AGE MODE
30																				
	201	55	5	5							7									7
	202	55	5	5							6									7
	203	55	6	6							7									7
	204	55	5	5							7									6
	205	58	6	5							7									7
	206	58	5	5							10									
	207	58	6	5							9									6
	208	58	5	5							7									6
	209	58	5	5							7									6
	210	58	5	5							7									
	211	58	5	6							7									6
	212	58	5	5							6									6
	213	58	5	5							7									6
	214	61	5	5							6									5
	215	61	5	5							6									5
	216	61	5	5							6									6
	217	61	6	6							7									8
	218	61	5	5							6									6
	219	61	6	5							6									7
	220	61	5	6							7									6
	221	61	6	5							7									5
	222	61	5	5							7									5
	223	61	6	6							7									5
	224	61	7	6							8									6
	225	73	6	6							8									7
	226	73	7	7							8									7
	227	73	7								12				6					
	228	73	7	8							12				6					
	229	76	6	7							14				5					
	230	76	7	7							8				6					
	231	76	6	7							9				4					
	232	76	7	6							14									
	233	76	8	7							13									
	234	76	8	7							13				7					
	235	76	7	7							14				5					
	236	76	7	7							13				6					
	237	76	8	7							14				6					
	238	79	7	6							6				6					
	239	79	7	7							8				6					
	240	79	7	7							9				5					
	241	79	7	7							10									
	242	79	8	9							9				8					
	243	79	6	7							8				7					
	244	82	7	6							8				6					
	245	82	9	8							9				8					
	246	82	8	8							8				7					
	247	85	7	7							9				8					
	248	82	9	6							9				8					
	249	79	8	8							10				8					
	250	79	8	7							9				8					
	251	73	7	6							7				6					
	252	73	6	6							7				6					

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Table 1.   (Continued)

AREA	SP NO	LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	AGE MODE
4U																				
	401	40	4									3		3	3					3
	402	43	4									5		3	3					4
	403	43	3									4		4	3					3
	404	43	4									4		5	4					3
	405	43	4									4		3	4					3
	406	46	3									4		4						2
	407	46	4									6		4	4					4
	408	46	4									3		3	4					3
	409	49	5									5		3	5					4
	410	49	5									5		5	5					5
	411	49	4									5		4	6					4
	412	52	4									4		3	5					3
	413	52	5									5		4	6					5
	414	52	5									5		4	6					4
	415	52	5									4		5	5					4
	416	52	5									4		5	6					5
	417	55	5									4		5	5					5
	418	55	5									4		5	5					4
	419	55	5									4		4	5					4
	420	55	5									5		4	5					4
	421	55	5									5		5	5					4
	422	55	4									4		4	4					4
	423	55	5									5		4	5					4
	424	58	6									6		6	6	6				5
	425	58	7									6		7	7	7				6
	426	58	8									8		6	6	6				6
	427	58	5									7		6	6					
	428	58	8									8		7	7					
	429	58	6									6		5	7					
	430	58	5									5		5	5					
	431	58	5									5		5	6					
	432	58	5									5		9	8					
	433	61	8									8		4	6					
	434	61	5									5		7	7					
	435	61	7									7			6					
	436	61	8									8		7	7					
	437	61	7									7		6	7					
	438	61	7									7		5	6					
	439	61	5									5		5	7					
	440	61	5									5		6	6					
	441	61	5									5		6	6					
	442	61	5									5								
	443	64	8									9								
	444	64	7									8		7	7					
	445	64	4									5		5	6					
	446	64	9									8		9	9					
	447	64	8									8		7	8					
	448	64	7									6		6	7					
	449	64	8									7		7	7					
	450	64	5									4		5	5					
	451	64	5									6		5	6					

Table 1.   (Continued)

AREA	SP NO	LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	AGE MODE
5Z																				
	486	70	4						4					3	4	4				
	487	70	4						4					4	5	4				
	488	70	5						5					4	6	6				
	489	70	4						4					4	5	5				
	490	70	8						8					6	7	8				
	491	70	4						4					4	5	5				
	492	70	4						4					4	5	5				
	493	70	4						5					3	4	5				
	494	70	4						4					3	4	4				
	495	70	4						4					4	4	4				
	496	70	5						5					4	5	5				
	497	73	7						7					6	6	7				
	498	73	4						4					3	4	4				
	499	73	5						5					4	6	5				
	500	73	4						4					3	4	4				
	501	19	1						1					2						
	502	28	2						2					2	2	2				
	503	34	2						2					2	2	2				
	504	34	2						2					2	2	3				
	505	34	2						2					3	2	4				
	506	37	2						2					2	3	3				
	507	37	2						2					3	2	4				
	508	37	2						2					3	2	3				
	509	37	2						2					2	3	3				
	510	37	2						2					2	3	3				
	511	37	2						2					2	2	2				
	512	37	2						2					3	3	3				
	513	40	2						2					3	3					
	514	40	2						2					3	3	2				
	515	40	2						2					2		2				
	516	40	2						2					2		4				
	517	40	2						2					2	3	3				
	518	40	3						2					3	4	4				
	519	40	2						2					2	3	3				
	520	40	3						2					3	4	4				
	521	40	3						2					3	2	3				
	522	40	3						2					2	4	4				
	523	40	3						2					3		5				
	524	40	2						2					2	3	3				
	525	40	2						2					2	3	3				
	526	40	3						2					2	3					
	527	43	3						3					2	2	3				
	528	43	3						2					2	2	2				
	529	43	3						2					2	2	2				
	530	43	3						2					2	2	2				
	531	43	2						2					2	2	2				
	532	43	2						2					2	2	2				
	533	43	3						2					2	3	2				
	534	43	2						2					3	3	4				
	535	43	2						2					3	3	3				
	536	43	2						2					2	3	2				
	537	43	2						2											

Table 1. (Continued)

AREA	SP NO	LEN	1	2	3	4	5	READERS 6	7	8	9	10	11	12	13	14	15	16	17	AGE MODE
3P																				
	301	64	5	5							6	5		5	6	4		5		2
	302	31	2	2							3	2		2	3	1		2		3
	303	34	2	2							3	3		2	3	2		3		2
	304	34	2	2							3	3		2	3	1		2		2
	305	34	2	2							3	3		2	3	2		2		2
	306	34	2	2							3	4		2	3	2		2		2
	307	37	2	2							3	3		2	3	2		2		2
	308	37	2	2							3	4		2	3	2		2		2
	309	37	2	2							3	3		2	3	2		2		3
	310	37	3	3							4	4		3	3	4		3		5
	311	37	3	3							4	6		5	4			4		3
	312	37	3	2							3	4		3	3			3		3
	313	49	3	3							4	5		4	3	3		4		3
	314	55	4	4							3	7		5	4	4		6		4
	315	55	5	4							5	6		4	4	4		6		6
	316	55	5	5							6	7		5	5	5		4		6
	317	55	4	4							5	5		4	5	4		6		4
	318	55	4	4							5	5		4	4	4		5		6
	319	55	5	4							5	7		5	5	5		5		5
	320	55	5	5							6	6		6	5	5		4		5
	321	55	4	4							6	8		5	4	4		4		4
	322	55	4	4							5	5		4	4	4		5		4
	323	55	5	5							6	6		5	5	5		5		5
	324	55	5	5							7	5		5	5	4		5		5
	325	55	5	5							6	6		5	5	4		5		5
	326	55	6	6							7	8		6	5	5		8		8
	327	55	4	4								5			5	5		6		6
	328	58	4	5								5			5	4		5		5
	329	58	3	5								6			5	5		6		6
	330	58	5	5								5			5	5		5		5
	331	58	5	5								5			5	5		6		5
	332	58	5	5								5			5	5		5		6
	333	58	5	5								6			5	5		6		6
	334	58	4	5								4						5		5
	335	58	4	5								6			4			6		6
	336	58	5	5								8			5			5		6
	337	58	5	5								5			5			6		5
	338	58	5	5								7			6			5		6
	339	58	5	5								6			5			5		5
	340	61	5	5								6			5			7		5
	341	61	5	6								6			5			3		7
	342	40	2	2														4		3
	343	40	2	3								5			4			2		4
	344	40	2	2								3			3			2		2
	345	40	2	3								4			2			2		2
	346	40	3	3														3		2
	347	40	3	3								4			3			3		3
	348	40	3	3								4			3			3		3
	349	40	3	2								5			2			3		3
	350	40	3	3								3			3			3		3
	351	40	3	2											2			4		3
	352	43	4	4								5			4					4

.

Table 2. Age readings for Otolith Sample 2.

AREA	SPEC NO	LEN	SEX MAT	SEQ NO	8	9	11	12	13	14	5	15	3	7	16	4	2	1	17	AGE MODE
2J																				
	74	55	51	1	7	7	6	6	7	6		6	7	7	8	7	6	7	6	7
	33	58	11	2	7	7	5	4	5	4		3	4	4	4	5	4	4	4	4
	34	58	11	3	9	8	5	5	9	8		7	7	7		6	6	6		
	79	58	51	4	8	7	5	6	10	8		8	6	7	9	8	6	6	10	
	36	61	11	5	8	7	8	8	8	8		8	8	8	8	8	8	7	8	8
	37	61	11	6	7	7	7	7	9	7		7	6	6	9	7	7	6	10	7
	85	61	51	7	8	7	7	7	7	7		7	7	6	7	7	7	7	7	7
	38	64	11	8	7	7	5	6	9	7		7	7	7	7	7		7		7
	92	64	51	9	8	7	6	5	7	7		7	5	6	8	7	8	6	8	7
	94	64	51	10	11	10	10	9	12	11		11	9	11	11	10	9	9	10	11
	42	67	11	11	8	8	8	7	10	9		10	7	8	11	8	8		11	8
	43	67	11	12	10	10	10	9	10	10		10	10	9	10	10	11	9	11	10
	99	67	51	13	9	9	8	9	10	9		9	9	9	10	10	9	9		9
	49	70	11	14	8	8	8	7	9	8		10	7	8	8	8	8	7		8
	50	70	11	15	9	10	8	8	9	8		9	8	8	9	9	8	9	11	
	299	85	51	16	12	12	11	11	12	12		12	11	11	13	10	11	10	13	
	1	34	10	17	4	4	3	4	4	4		3	3	4	5	4	4	4	3	4
	2	37	10	18	4	4	2	4	4	2		3	3	5		4	3	4	2	4
	3	37	10	19	4	4	3	4	4	4		3	4	4	5	5	4	5	4	4
	6	40	10	20	4	4	2	3	4	4		3	4	3	4	4	3	4	3	4
	12	40	11	21	5	5	3	5	6	4		4	5	5	6		6	5	3	5
	13	43	11	22	5	5	2	6	6	4		4	5	6	7	5	5	6	4	5
	14	46	11	23	6	6	3	6	6	4		5	5	6	7	6	6	5	4	6
	58	37	50	24	4	4	3	4	4	4		4	4	4	5	4	5	4	4	4
	59	40	50	25	4	4	2	4	4	4		4	4	3	4	4	4		3	4
	60	43	50	26	4	4	3	4	4	4		4	4	3	4	4	5	3	3	4
	62	43	50	27	4	7		6		6		5	4	4	7	4	5		5	4
	63	46	50	28	5	7	4	6	7	6		6	6	6	7	7	6	6	4	6
	243	46	10	29	5	5	3	6	6	5		5	5	7	7	6	6	6	5	5
	17	49	11	30	8	6	3	6	7	6		6	6	5		6	7	5		6
	129	79	51	31	11	11	9		11	10		11	8	7	13		8	9	9	11
	135	82	51	32	10	10	8		9	9		8		6		8	9	8	7	8
	300	85	51	33	9	9	10		10	9		9	8	8	11	8	10	8		
	66	49	50	34	6	6	7	7		6	6	7	6	5	7	5	6	7	5	6
	24	52	11	35	7	7	7	7		7	7	7	7	6	8	6	7	7	.6	7
	25	52	11	36	6	6	5	5		5	5	6	6	5	6	4	6	5	5	5
	67	52	50	37	6	6	5	7		6	6	8	6	6	8	5	7	7	5	6
	136	82	51	38	12	12	11	8		12	9	11	8	10	13		12			12
	53	73	11	39	10	9	10	8		10	7	9	8	8		6	8	10	8	8
	122	76	51	40	11	11	9	9		11	7	9	8	8	10	8	10	9	7	9
	107	73	50	41	8	8	7	7		7	6	7	6	6		6	7		6	
	20	49	11	42	6	6	7	7		6	7	7	6	5	7	6	7	7	7	7
	54	76	11	43	10	11	11	10		13	12	12	11	10	11	7	10			
	178	79	51	44	11	11	11	11		11	7	12	9	9	11	9	11	12	14	11
	27	55	11	45	7	7	8	7		7	6	7	6	7		7	9			7
	105	70	51	46	10	9	9	8		10	9	10	7	8	11	7	8	10	9	
	108	73	51	47	9	9	10	9		9	10	9	8	9	10	9	9	9	8	9
	130	79	51	48	13	13	9	8		8	7	8	7	7	9	9	9		8	
	121	76	51	49	12	12	9	8		9	9	9	8	9	10	7	10	8	10	9

Table 2 continued.

AREA	SPEC NO	LEN	SEX MAT	SEQ NO	8	9	11	12	13	14	5	15	3	7	16	4	2	1	17	AGE MODE
3K	317	34	10	1	3	3	3	4	3	2	3	2	4	4	5	3	4	4		3
	339	49	11	2	5	5	7	5	5	3	8	4	7	4	9	5	7	7	8	5
	331	43	10	3	4	4	11	11	11	10	12	10	12	9	15	9	14		14	11
	326	40	10	4	4	4	3	4	4	3	2	3	5	3	7	3	6	4	5	
	328	40	10	5	5	5	5	5	5	4	2	3	4	4	8	5	6	4	6	5
	332	43	10	6	5	4	4	4	4	4	4	4	4	4		4	6	4	7	4
	327	40	10	7	5	5	4	5		2	6	4	5	4	6	4	6	4	6	4
	330	43	10	8	5	5	5	6	5	5	5	5	6	5	7	5	6	5	5	5
	366	34	50	9	4	4	4	6	3	4	3	3	5	4	6	4	6	4	5	4
	398	55	50	10	5	6	5	6	5	5	4	4	6	4	7	5	6	4	5	5
	335	46	10	11	6	5	5	5	4	5	5	3	6	4	9	4	7	5	6	5
	336	49	10	12	5	5	4	6	6	4	4	3	6		9	6	7	4		
	548	64	11	13	9	7	7	7	6	8	7	7	7	6	11	6	8	6	7	7
	345	49	11	14	6	6	5	6	6	6	5	6	6	5	8	6	6	5	6	6
	583	79	11	15	8	11	5	7	7	6	6	4	6	6	9	6	7	6	7	6
	401	52	51	16	6	7	11	8		9	9	8	8	9	13	7	10	10	8	8
	348	55	11	17	7	7	7	6	7	7	8	8	7	7	8	7	7	8	7	7
	322	37	10	18	4	5	5	7		3	8	3	7	6	8	4				
	404	61	51	19	8	8	8	8	8	8		2	8	9	10	7	9	9	7	8
	352	61	11	20	7	7	1	6	5	5	6	4	6	5	10	4	7	8	6	
	361	52	10	21	6	6	6	6	5	4	6	6	6	5	9	5	5			6
	403	58	51	22	7	7	7	7	7	7		5	7	6	8	7	7	8	6	7
	399	55	50	23	6	6	5	7		5	7	6	7	5	8	6	8	8	6	6
	430	76	51	24	8	8	5	6	6	6	7	5	6		7	6	7	8	5	6
	406	55	51	25	6	7	6	6	5	6	5	6	5	4	7	5	7		4	6
	349	61	11	26	7	7	7	6	9	7	9	4	6	8	11	7	8	10	6	7
	334	46	10	27	6	4	4	5	5	4	6	8	5	6	7	5	7	8	4	
	422	67	51	28	9	9	6	7	8	8	8	9	7	6	10	7	8	10	6	8
	320	37	10	29	4	5	5	6		4	5	6	5	5	5	5	6			5
	530	82	11	30	10	9	8	7	10	9	10	7	7		14		12	13	9	
	351	70	11	31	8	8	7	7	9	7	8	7	7	7	10	6	7	7	7	7
	464	58	11	32	7	7	6	7	7	7	8	7	6	7	4	7	8	8	7	7
	470	64	51	33	7	7	6	8	8	7	7	6	7	7	8	6	8	7	7	7
	350	64	11	34	10	10	11	10	10	9	10	10	10	9	11	9	12	11	9	10
	635	70	51	35	9	9	9	9	9	8	9	8	8		10	7	8	8	7	9
	340	52	11	36	6	6	7	7	6	7	7	5	7	6	8	5	8	8	6	
	318	34	10	37	4	4	3	4	4	2	4	4	4	4	5	4	4	4	3	4
	337	49	10	38	5	5	6	7	7	4	6	5	5	6	7	5	6	6	6	6
	465	67	11	39	9	9	9	9	11	9	9	9	9	6	10	5	8		7	9
	531	67	51	40	10	8			9	9	9	9	11	8	7		6	9		9
	423	79	51	41	10	10	7	9		8	10	6	8	7	11		7	9		
	517	58	51	42	6	7		7	8	7	7	5	7	7		6	9	7	4	7
	321	37	10	43	4	4		4	7	3	4	4	5	5	5	5	6	7	4	4
	428	82	51	44	10	8	8	8	9	8	8	7	8	7	9	6	9	9	5	8
	429	58	51	45	7	7	6	6	7	7	6	6	6	7		6	7			
	405	61	51	46	7	7	6	7	9	7	7	7	7	6	8	6	7	8	5	7

Table 2 continued

AREA	SPEC NO	LEN	SEX MAT	SEQ NO	8	9	11	12	13	14	5	15	3	7	16	4	2	1	17	AGE MODE
3L																				
	1	34		1	4	4	3	4	3	3	4	3	4	3	6	3	4	5	3	3
	2	34		2	3	4	3	3	3	3	3	3	3	3	3	4	4	3	2	3
	6	37		3	4	5	4	4	4	3	5	4	5	4	8	5	4	5	5	4
	7	37		4	4	4	4	4	3	4	3	4	4	3	5	4	4	4		4
	10	37		5	6	6	5	4	4	5	6	4	5	4	8	5	5		5	5
	24	40		6	5	6	5	6	6	5	6	5	6	5	5	5	5	5	4	5
	25	40		7	4	4	4	5	4	4	4	4	5	4	7	4	4	5	5	4
	26	40		8	5	6	6	5	6	6	6	6	6	6	6	6	5	6	5	6
	39	43		9	5	6	4	5		4	5	5	5	4	6	4	5	5	5	5
	40	43		10	5	5	6	7	6	5	6	5	7	5	7	6	6	6	6	6
	41	43		11	6	5	5	6	5	5	6	6	6	5	7	6	6	6		6
	55	46		12	4	4	4	4	4	4	4	4	7	3	5	4	4	4		4
	56	46		13	5	5	5	5	5	5	4	5	6	4	8	5	6	5	6	5
	57	46		14	6	6	6	6	6	6	6	6	6	6	7	6	6	6	8	6
	66	49		15	4	5	4	4	4	5	4	5	6	4	5	4	5	5		4
	67	49		16	6	6	6	6	6	6	6	6	6	6	7	6	6	6	7	6
	68	49		17	7	7	7	5	6	7	7	7	7	5	8	5	7		8	7
	88	52		18	6	6	5	5	6	5		4	6	6		4	6	5		6
	89	52		19	5	5	4	4	5	5	6	4	5	4	7	4	7	5		5
	90	52		20	7	6	5	4	5	6	5	4	4	6	8	4	7	5	8	
	101	55		21	6	6	6	5	6	5	5	6	5	5	6	4	6	6		6
	102	55		22	7	6	6	6	6	6	6	6	6	6	6	6	6	7	7	6
	103	55		23	7	5	6	6	6	7	7	4	4	4	7	4	7	7	6	7
	112	58		24	6	6	6	7	7	6	8	6	6		8	5	7			6
	113	58		25	6	6	6	6	6	5	7	5	6	5		5	6			6
	114	58		26	7	6	6	6	6	6	6	5	6	6		5	6	7	5	6
	132	61		27	7	6	6	6	6	6	7	5	6	5	7	6	6	7		6
	133	61		28	6	6	6	6	6	6	6	6	6	6	6	5	7	6	6	6
	134	61		29	6	6	6	6	6	6	6	6	6	5	8	5	8	7	5	6
	155	64		30	9	8	7	7		7	8	7	7	7			6	8		7
	156	64		31	6	7	6	6		7	5	6	6	5	8	4	7	7		6
	157	64		32	8	7	6	7	8	7	9	7	6	5	10		8	8		
	169	67		33	6	6	6	6	8	6	7	7	6	6	8	5	9	7	9	6
	170	67		34	10	9	9	9	9	9	10	9	9	8	10	8	9	9	8	9
	171	67		35	9	10	9	8		10	9	8	8	6			7	8	11	8
	177	70		36	9	6	6	6		8	6	6	7	6	8	6	7	6	11	6
	178	70		37	8	8	9	8		9	8	7	8	7	8	6	8	7		8
	179	70		38	7	6	8	7		6	6	6	7	6	8	6	7	6	7	6
	183	73		39	8	7	8	8		7	9	8	8	6	9	6	8	8	8	8
	184	73		40	8	8	7	8		7	7	8	8		11	7	7	8		8
	185	73		41	9	9	7	8		10	10	11	8	9	11	7	9	10	12	9
	188	76		42	9	8	7	7		8	8	9	7	7	11	6		7	9	7
	189	76		43	11	11	10	10		11		8	10		11	8	9	10	13	
	191	79		44	9	6	9	6		6	6	6	6	6	10	7	7	6	10	6
	192	79		45	9	8	8	8		9	8	8	8	8	9	8	9	8		8
	193	79		46	9	9	7	7		9	9	10	7	9	10	7	8	7	14	
	258	82		47	9	7	8	7		9	7	7	7	7	11	8	7		12	7
	268	82		48	11	11	11	11		11		11	11	8	12	9	10	10	10	11
	269	82		49	12	12	12	12		12	11	11	11	10	12	9	11		14	12

Table 2 continued

AREA	SPEC NU	LEN	SEX MAT	SEQ NO	8	9	11	12	13	READERS 14	5	15	3	7	16	4	2	1	17	AGE MODE
3NO																				
	1	37		1	4	4	4	4	4	4		4	4	4	5	4	6	4	6	4
	2	40		2	4	4	3	4	4	4	4	4	4	4	5	3	6	4	6	4
	5	40		3	4	4	4	4	4	4	4	4	5	4	4	4	7	4	7	4
	8	40		4	4	4	4	4	4	4	4	4	5	4	5	4	6	4	5	4
	9	43		5	4	4	5	5	4	4	5	4	4	4	7	4	6		4	4
	11	43		6	4	4	4	5	4	4	4	4	5	4	6	4	7	4	7	4
	13	43		7	4	4	4	4	4	4	4	4	4	4	4	4	5	4	5	4
	15	46		8	4	4	4	4	4	4	4	4	4	4	5	4	5	4	5	4
	16	46		9	3	4	4	4	4	3		3	4	4	5	3	5	4	5	4
	17	46		10	5	5		5		4	4	5	5		8		7		6	5
	26	49		11	5	5	4	5	4	5		4	5	5	7	4		4		5
	27	49		12	4	4	4	5	5	4	4	4	5	4	7	4	6	4	5	4
	28	49		13	4	5	5	5	5	5	6	5	6	5	9	5		5	5	5
	38	52		14	6	6	6	6	6	5	6	5	6	5	7	5	8		8	6
	40	52		15	5	5	5	5	5	4	4	5	5	4	8	4		5	5	5
	41	52		16	6	6	6	6	6	7	7	6	6	5	9	5	8		8	6
	43	55		17	5	7	4	5	5	6	6	4	6	4		3	5	5	5	5
	45	55		18	5	7	4		6	5	7	4	6	4	6	4	5	6		
	46	58		19	7	7	8	7	8	7	7	6	8	6	8	6	7	7	6	7
	47	58		20	7	7	7	8	7	7	7	5	8	6	8	7	7			7
	49	61		21	7	7	7	7	7	7	8	7	7	5	7	6	8	7	7	7
	50	61		22	7	7	7	7	7	7	7	6	7	6	7	7	7	7	7	7
	51	61		23	6	7	6	6	6	6	6	6	6	6	7	6	6	9		6
	54	64		24	6	6	6	6	5	5		6	6	6						6
	57	64		25	6	6	6	7	6	6	6	6	6	6	7	6	7	8		6
	59	64		26	7	7	6	9	8	8	8	8	8	7	9	6	8	10	8	8
	60	67		27	7	9	6	7	7	7	7	6	8	7	12	6	7	9		7
	61	67		28	7	7	5	6		7	6	6	6	5		5		9		6
	64	67		29	7	8	7	7	7	7	7	8	7	7	7	6	8	8	8	7
	66	70		30	7	7	6	7	7	7	8	6	7	6	8	5	6			7
	67	70		31	7	7	7	7	7	7	7	7	7	7	7	6	7	7	6	7
	68	70		32	7	7	7	6	6	7	6	7	6	6	9	6	6	8		6
	70	73		33	6	7	6	6	7	7	7	7	6	6	7	5	5	7	8	7
	71	73		34	9	9	7			7		5	7	6	8	7	7	7		7
	72	73		35	10	8	8	8		8		8	8	7	10	9	8	8	7	8
	74	76		36	8	8	7	8		8		7	8	7		7	8	8	7	8
	75	76		37	8	8	8	9		9		7	8	7	10	8	9	8	8	8
	76	76		38	7	7	6	6		7		6	7	6	7	7	7	7	7	7
	77	79		39	7	7	6	7		7		7	8	6	8	6	8	7	7	7
	78	79		40	7	7	7			8		7	7	7	7	6	7	7	7	7
	79	79		41	11	11	8	9		10		8	11	9	11	8	12	11		11
	82	82		42	11	11	11	9		10		9	11	8	11	10	10	10	10	
	83	82		43	11	10	7	8		10		7	9	8	11	11	11		10	11
	84	82		44	7	8	6	8		8		7	7	7	8	6	7	8		
	85	85		45	10	9	9	8		10		9	9	8	10	8	8	9		9
	86	85		46	9	9	9	9		11		9	9	9					8	9
	87	88		47	8	7	9	7		8		7	8	7		7	8			7
	88	88		48	8	7	9	7		8		7	8	6	10	8	7	7		7
	89	91		49	8	8	8	8		8		7	8	7		8	8	7	6	8

Table 2 continued

AREA	SPEC NO	LEN	SEX MAT	SEQ NO	8	9	11	12	13	14	5	15	3	7	16	4	2	1	17	AGE MODE
30																				
	48	52		1	6	6	6	8			7	5	8	5	8	8	8	8	8	8
	55	55		2	6	6	4	7			9	5	7	5	8	7	9	9	7	7
	56	55		3	6	7	5	6			7	5	7	5	8	6				
	57	55		4	6	6	6	6			6	6	7	5	7	6	8		7	6
	65	58		5	6	7	6	6			6	5	6	5	6	6	6	6	5	6
	66	58		6	6	6	5	6			7	6	6	6	7	5	6	6	5	6
	67	58		7	6	6	5	7			7	6	7	5	10	6	7	7	8	7
	76	61		8	6	7	6	7			6	7	7	5	7	6	5	5		7
	77	61		9	6	7	5	6			7	6	6	5	8	6	6		6	6
	78	61		10	5	6	4	6				5	7	4		4	6	6		6
	86	64		11	6	7	5	6			7	6	6	5	7	6	6	7	6	6
	87	64		12	7	7		7			7	7	7		11	6		8	9	7
	88	64		13	7	7	6	6			6	6	6	6	7	6	6	7		6
	102	67		14	6	7	6	7			6	7	6	6	8	7	7	8		
	103	67		15	6	6	6	6			6	6	6	6	6	6	6	7	5	6
	108	67		16	6	6	5	6			6	6	7	6	7	6	6	7	8	6
	113	70		17	7	8	7	7			7	7	7	6	9	7	7	7		7
	115	70		18	7	7	7	7			8	8	7	5	9	7	7	8	7	7
	119	70		19	9	12	10	8	10	10	10	10	10	7	10	10	11		8	10
	120	73		20	6	7	6	6	6	6	6	6	6	5	6	6	7	6		6
	121	73		21	8	8	7	7	7	7	7	7	7	6		7	8	7	8	7
	122	76		22	8	8	8	7	10	8	8	7	7	7	12	8	11	7	9	8
	123	76		23	7	7	7	7	9	9	10	7	7	7	10	9	10	7		7
	124	76		24	6	6	6	6	6	6	7	6	6	6	8	6	7	5	5	6
	131	79		25	6	7	6	6	6	6	6	6	6	5	6	6	7	6	5	6
	132	79		26	8	8	8	7	7	7	8	7		7	8	7	7	7	6	7
	133	79		27	9	9	8	7	9	9	9	9		7	13	9	9	9		9
	140	82		28	9	9	9	8	10	10	9	9	8	8	14	8	10	10	7	9
	141	85		29	9	10	9	9	8	8	7	9	9	8	10	9	9	8	8	9
	142	85		30	9	8	8	8	8	8	11	9		7	13	8			8	8
	143	85		31	9	9	7	7	8	10	9	9		7	13			8	8	9
	146	88		32	9	10	6	8		9	8		8	7					6	8
	147	88		33	9	9	8	7	8	8	8	8	8	7	9	8	10	7	5	8
	149	88		34	9	10	7	8	7	11	9	11	8	7		7	8	7	5	7
	1	34		35	4	4	5	5	4	5	5	5	5	5	5	4	4	4	7	5
	2	34		36	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	3
	3	34		37	4	4	5	5	5	5	5	4	5	5	5	5	4	5	5	5
	4	37		38	4	4	3	4	4	4	4	4	4	4	4	3	4	4		4
	5	40		39	4	5	5	6	6	6	6	6	5	6	6	5	4	6	7	6
	6	40		40	5	5	4	5	4	4	5	4	5	5	4	4	4	4	5	4
	7	40		41	5	5	5	5	4	5	5	4	5	5	5	4	5	5	6	5
	15	43		42	5	5	5	5	5	5	5	4	5	5	5	5	5	5		5
	16	43		43	5	5	5	7	6	5	6	5	5	5	6	4	6	6	7	5
	17	43		44	4	4	5	5	6	5	4	4	6	5	5	4	6		7	
	25	46		45	5	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6
	26	46		46	4	5	5	5		5	6	5	5	5	6	5	5	5		5
	27	46		47	5	5	5	6	5	5	5	6	5	5	6	4	6	5	6	5
	35	49		48	5	6	6	6	5	5	6	6	6	5	6	5	6	5	8	6
	36	49		49	5	5	6	6	6	6	6	6	6	5	6	4	6	6	7	6

Table 2 continued

AREA	SPEC NO	LEN	SEX MAT	SEQ NO	READERS															AGE MODE
					8	9	11	12	13	14	5	15	3	7	16	4	2	1	17	
3P s																				
	1	31	10	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
	2	34	50	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
	3	34	10	3	3	3	3	4	3	3	3	3		3	4	3	4	4	2	3
	4	34	10	4	3	3	3	3	3	3	3	3	3	3	4	3	3	3	2	3
	5	37	10	5	3	3	3	3	3	3	3	3	3	3	3	3	4	3	2	3
	6	37	10	6	3	3	3	4	4	3	3	3	3	3	6	3	4	4	3	3
	7	37	50	7	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3
	9	40	50	8	4	4	4	4	4	4	3	4	3	4	7	4	4	4	3	4
	10	40	10	9	3	3	3	3	3	3	3	4	3	3	4	3			3	3
	11	40	10	10	3	3	3	3	3	3	3	3	3	3	3	3	4	3	2	3
	23	43	10	11	4	4	4	4	4	4	4	4	4	4	7	4	5	5	3	4
	25	43	50	12	3	3	3	3	4	4	3	3	3	3	5	3	4		3	3
	33	43	10	13	5	5	5	5	5	5	5	5	5	4	6	5	5	5	4	5
	37	46	50	14	5	5	6	6	7	7	7	6		5	7	7	6	6	5	
	41	46	10	15	5	5	5	5	5	5	5	5	5	4	5	5	5	5	4	5
	45	46	11	16	5	5	5	4	5	5	5	5	5	4	5	5	5	5	4	5
	52	49	50	17	5	5	5	6		5	6	4	6	6	10	6			5	
	53	49	50	18	4	4	4	4	4	4	4	4	4	4	4	4	5	4		4
	58	49	50	19	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	67	52	51	20	5	5	5	5	4	5	5	5		5	5	5	6	5	6	5
	73	52	11	21	6	6	6	5	6	6	6	6		6	6	6	6	6	6	6
	77	52	11	22	5	5	5	5	5	5	5	5	5	5	5	5	6	5	5	5
	82	55	10	23	5	5	5	5	4	5	5	5	4	4	5	5	5	5	5	5
	86	55	11	24	6	6	6	6	6	6	6	6	6	6	6	6	7	6	8	6
	93	55	50	25	5	5	5	5	5	5	5	5	5	5	5	5	7	5	7	5
	101	58	11	26	6	5	5	4	4	5	5	5	4	5	5	5	6	5	5	5
	102	58	50	27	5	5	5	5	5	5	5	5	5	5	5	5	6	5	5	5
	104	58	11	28	6	6	6	7	6	6	7	7	6	7	7	5	8	7	7	7
	117	61	50	29	6	6	6	7	5	7	7	6	6	7	7	5	7	6	8	
	120	61	11	30	5	5	5	5	5	5	5	6	5	5	5	5	6	5	6	5
	126	61	11	31	6	6	6	6	5	6	6	6	6	6	6	6	7	6	7	6
	127	64	11	32	6	6	6		5	6	6	5	5	6	6	6	6		6	6
	170	67	51	33	7	7	6	6	6	7	6	6	7	6	6	6	7	6	7	6
	173	70	51	34	6	6	6	6	6	6	6	6	6	6	6	6	7	6	6	6
	174	70	51	35	6	6	6	6	6	6	6	6	6	6	6	6	7	6	8	6
	175	70	11	36	9	9	9		9	9	9	8	8	8	9	7	9	9	9	9
	178	73	11	37	8	8	8	8	8	8	8	8	8	8	8	7	8	8	8	8
	179	73	11	38	7	7	7	7	7	7	7	7	7	7	7	7	8	7	7	7
	180	73	51	39	9	9	9	9	9	9	9	9	9	9	9	9	10	9	8	9
	183	76	11	40	7	7	7	7	7	7	7	7	7	6	7	7	8	7	6	7
	184	76	11	41	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	185	76	51	42	7	7	7	7	7	7	7	7	7	7	8	7	7	7		7
	188	79	51	43	8	8	8	8	7	8	8	8	7	7	8	7	8	7	7	8
	189	79	11	44	9	8	8	8	8	8	8	8		7	8	8	8	7	8	8
	143	64	51	45	6	6	6	6	6	6	6	6	6	6	6	6	6	7	6	6
	148	64	51	46	8	9	6	9	9	9	9	9	8	7	9	7	8	9	7	9
	155	67	11	47	6	6	5	6	7	6	6	6	6	6		6	7	5	6	6
	163	67	51	48	6	6	6	6	6	6	6	6	6	6	6	6	7	6	5	6
	190	82	51	49	9	10	8	8	13	10	10	9	8	8	9	8	9	9	8	8

Table 3. Percentage agreements between pairs of readers of
sample 2 by ICNAF Division.

READER	ICNAF DIV.	READER														
		1	2	3	4	5	7	8	9	11	12	13	14	15	16	17
1	2J		29	40	38	33	40	29	25	25	50	31	29	35	22	23
	3K		30	26	20	35	42	19	28	31	21	24	30	28	23	10
	3L		41	47	36	47	26	44	47	47	47	43	45	51	18	30
	3NO		33	48	38	50	38	55	75	51	55	72	55	53	28	37
	3O		57	58	45	48	45	36	38	42	55	81	72	42	46	23
	3Ps		42	70	73	79	70	76	78	79	78	71	77	77	58	33
	TOTAL		39	49	42	51	43	43	48	46	51	54	50	48	34	26
2	2J	29		40	31	19	35	39	35	31	55	33	41	33	36	27
	3K	30		27	12	20	23	16	20	16	29	28	22	13	22	19
	3L	41		45	30	35	21	47	45	37	41	42	35	35	20	30
	3NO	33		33	26	31	16	33	24	18	38	28	36	20	19	43
	3O	57		60	46	43	29	41	41	37	56	53	45	45	36	24
	3Ps	42		38	36	44	29	44	44	44	42	43	46	45	39	36
	TOTAL	39		40	31	34	25	37	35	31	44	38	37	32	29	30
3	2J	40	40		39	38	44	40	42	17	48	31	39	36	21	22
	3K	26	27		34	43	24	27	40	29	63	25	36	30	5	30
	3L	47	45		27	40	33	41	52	50	72	50	40	50	13	29
	3NO	48	33		28	50	35	61	54	50	62	68	45	40	33	26
	3O	58	60		55	56	44	46	46	59	72	71	68	58	45	26
	3Ps	70	38		76	74	64	78	73	75	75	78	71	72	51	39
	TOTAL	49	40		44	52	41	49	51	47	65	54	50	48	29	29
4	2J	38	31	39		7	38	49	47	23	32	58	35	32	33	14
	3K	20	12	34		20	41	36	36	36	27	44	29	30	5	26
	3L	36	30	27		29	43	19	29	46	31	32	31	44	7	23
	3NO	38	26	28		45	48	39	35	54	28	47	46	46	12	29
	3O	45	46	55		44	31	52	37	58	57	68	63	56	28	24
	3Ps	73	36	76		65	76	76	78	84	75	75	82	76	67	39
	TOTAL	42	31	44		39	46	45	44	51	43	55	47	48	26	26
5	2J	33	19	38	7		33	19	25	38	19	–	31	25	17	40
	3K	35	20	43	20		27	35	43	39	43	38	35	29	12	19
	3L	47	35	40	29		41	40	52	42	44	47	42	42	23	12
	3NO	50	31	50	45		48	53	50	52	50	63	72	50	27	12
	3O	48	43	56	44		33	48	47	55	48	56	60	49	49	13
	3Ps	79	44	74	65		73	78	86	84	83	78	88	79	76	43
	TOTAL	51	34	52	39		44	49	54	54	52	57	55	49	38	23
7	2J	40	35	44	38	33		33	28	18	41	24	33	23	13	31
	3K	42	23	24	41	27		23	27	37	16	33	36	24	5	26
	3L	26	21	33	43	41		32	39	41	39	53	45	51	8	12
	3NO	38	16	35	48	48		44	40	49	48	52	38	60	12	22
	3O	45	29	44	31	33		31	33	48	47	44	53	40	25	22
	3Ps	70	29	64	76	73		69	67	71	73	60	67	67	55	53
	TOTAL	43	25	41	46	44		39	39	44	44	45	45	45	20	29

F 10

Table 3. (Continued)

READER	ICNAF DIV.	READER														
		1	2	3	4	5	7	8	9	11	12	13	14	15	16	17
8	2J	29	38	40	49	19	33		76	16	37	48	59	43	30	14
	3K	19	16	27	36	35	23		70	32	37	43	33	26	0	23
	3L	44	47	41	19	40	32		50	46	47	44	45	46	21	26
	3NO	55	33	61	39	53	44		70	52	57	70	63	49	31	21
	30	36	41	46	52	48	31		60	44	43	38	44	50	27	19
	3Ps	76	44	78	76	78	69		92	90	80	69	86	80	63	37
	TOTAL	43	37	49	45	49	39		69	47	50	53	56	49	29	24
9	2J	25	35	42	47	25	28	76		20	29	45	55	38	26	17
	3K	28	20	40	36	43	27	70		43	43	38	37	30	5	26
	3L	47	45	52	29	52	39	50		44	52	55	67	49	15	12
	3NO	75	24	54	35	50	40	70		54	57	63	57	54	29	29
	30	38	41	46	37	47	33	60		40	43	38	44	45	33	11
	3Ps	78	44	73	78	86	67	92.		88	73	74	96	80	71	45
	TOTAL	48	35	51	44	54	39	69		48	50	53	60	50	31	24
11	2J	25	31	17	23	38	18	16	20		31	15	27	31	24	40
	3K	31	16	29	36	39	37	32	43		35	24	41	30	5	24
	3L	47	37	50	46	42	41	46	44		56	69	56	50	19	27
	3NO	51	18	50	54	52	49	52	54		48	65	40	63	22	22
	30	42	37	59	58	55	48	44	40		50	56	70	49	39	15
	3Ps	79	44	75	84	84	71	90	88		78	74	86	82	70	38
	TOTAL	46	31	47	51	54	44	47	48		50	51	53	51	32	28
12	2J	50	55	48	32	19	41	37	29	31		33	47	44	20	24
	3K	21	29	63	27	43	16	37	43	35		43	33	36	7	23
	3L	47	41	72	31	44	39	47	52	56		56	41	54	13	27
	3NO	55	38	62	28	50	48	57	57	48		68	51	47	26	24
	30	55	56	72	57	48	47	43	43	50		47	56	59	41	30
	3Ps	78	42	75	75	83	73	80	73	78		68	75	78	62	32
	TOTAL	51	44	65	43	52	44	50	50	50		53	50	54	29	27
13	2J	31	33	31	58	-	24	48	45	15	33		36	33	38	19
	3K	24	28	25	44	38	33	43	38	24	43		33	20	8	21
	3L	43	42	50	32	47	53	44	55	69	56		50	47	20	31
	3NO	72	28	68	47	63	52	70	63	65	68		68	58	31	33
	30	81	53	71	68	56	44	38	38	56	47		78	57	50	19
	3Ps	71	43	78	75	78	60	69	74	74	68		79	71	61	28
	TOTAL	54	38	54	55	57	45	53	53	51	53		57	48	37	25
14	2J	29	41	39	35	31	33	59	55	27	47	36		55	27	27
	3K	30	22	36	29	35	36	33	37	41	33	33		28	0	26
	3L	45	35	40	31	42	45	45	67	56	41	50		54	23	17
	3NO	55	36	45	46	72	38	63	57	40	51	68		43	24	20
	30	72	45	68	63	60	53	44	44	70	56	78		61	55	15
	3Ps	77	46	71	82	88	67	86	96	86	75	79		78	85	40
	TOTAL	50	37	50	47	55	45	56	60	53	50	57		53	35	25
15	2J	35	33	36	32	25	23	43	38	31	44	33	55		23	30
	3K	28	13	30	30	29	24	26	30	30	36	20	28		2	21
	3L	51	35	50	44	42	51	46	49	50	54	47	54		19	22
	3NO	53	20	40	46	50	60	49	54	63	47	58	43		14	31
	30	42	45	58	56	49	40	50	45	49	59	57	61		33	20
	3Ps	77	45	72	76	79	67	80	80	82	78	71	78		68	35
	TOTAL	48	32	48	48	49	45	49	50	51	54	48	53		28	27

F 11

Table 3.(Continued)

READER	ICNAF DIV.	READER														
		1	2	3	4	5	7	8	9	11	12	13	14	15	16	17
16	2J	22	36	21	33	17	13	30	26	24	20	38	27	23		20
	3K	23	22	5	5	12	5	0	5	5	7	8	0	2		5
	3L	18	20	13	7	23	8	21	15	19	13	20	23	19		16
	3NO	28	19	33	12	27	12	31	29	22	26	31	24	14		22
	30	46	36	45	28	49	25	27	33	39	41	50	55	33		18
	3Ps	58	39	51	67	76	55	63	71	70	62	61	85	68		31
	TOTAL	34	29	29	26	38	20	29	31	32	29	37	35	28		19
17	2J	23	27	22	14	40	31	14	17	40	24	19	27	30	20	
	3K	10	19	30	26	19	26	23	26	24	23	21	26	21	5	
	3L	30	30	29	23	12	12	26	12	27	27	31	17	22	16	
	3NO	37	43	26	29	12	22	21	29	22	24	33	20	31	22	
	30	23	24	26	24	13	22	19	11	15	30	19	15	20	18	
	3Ps	32	36	39	39	43	53	37	45	38	32	28	40	35	31	
	TOTAL	26	30	29	26	23	29	24	24	28	27	25	25	27	19	

Table 4. Percentage agreements between pairs of readers of sample 2. Bias between readers is shown in parentheses and equals percentage over-read minus percentage under-read.

READER	>60	51-60	41-50	31-40	<30	AV. BIAS	AV. AGREEMENT
1		5 (-6) 12 (11) 13 (-1)	3 (9) 4 (-31) 7 (40) 8 (1) 9 (1) 11 (22) 14 (7) 15 (20)	2 (21) 16 (-54)	17 (5)	3	45
2			12 (36)	1 (-21) 3 (-34) 4 (-56) 5 (-26) 8 (19) 9 (20) 11 (44) 13 (30) 14 (32) 15 (42)	7 (65) 16 (-37) 17 (32)	10	34
3	12 (1)	5 (11) 9 (-15) 13 (-7)	1 (-9) 4 (-32) 7 (35) 8 (-10) 11 (16) 14 (-1) 15 (13)	2 (34)	16 (-62) 17 (-9)	-3	46
4		11 (-12) 13 (-32)	1 (31) 3 (32) 7 (4) 8 (-38) 9 (-40) 12 (-28) 14 (-24) 15 (-13)	2 (56) 5 (33)	16 (-72) 17 (-17)	-9	42
5		1 (6) 3 (-11) 9 (-2) 11 (13) 12 (4) 13 (9) 14 (7)	7 (40) 8 (0) 15 (19)	2 (26) 4 (-33) 16 (-55)	17 (4)	2	47
7			1 (-40) 3 (-35) 4 (-4) 5 (-40) 11 (-18) 12 (-37) 13 (-38) 14 (-36) 15 (-23)	8 (-43) 9 (-46)	2 (-65) 16 (-75) 17 (-27)	-38	39

Table 4. (Continued)

READER	>60	51-60	41-50	31-40	<30	AV. BIAS	AV. AGREEMENT
8	9 (-3)	13 (0) 14 (15)	1 (-1) 3 (10) 4 (38) 5 (0) 11 (29) 12 (12) 15 (23)	2 (-19) 7 (43)	16 (-16) 17 (8)	7	46
9	8 (3)	3 (15) 5 (2) 13 (0) 14 (13)	1 (-1) 4 (40) 11 (30) 12 (16) 15 (27)	2 (-20) 7 (46) 16 (-55)	17 (7)	9	47
11		4 (12) 5 (-13) 13 (-22) 14 (-17) 15 (-5)	1 (-22) 3 (-16) 7 (18) 8 (-29) 9 (-30) 12 (-15)	2 (-54) 16 (-66)	17 (-15)	-19	45
12	3 (-1)	1 (-11) 5 (-4) 13 (-9) 15 (13)	2 (-36) 4 (28) 7 (37) 8 (-12) 9 (-16) 11 (15) 14 (-1)		16 (-66) 17 (1)	-4	47
13		1 (1) 3 (7) 4 (52) 5 (-9) 8 (0) 9 (0) 11 (22) 12 (9) 14 (21)	7 (38) 15 (22)	2 (-30) 16 (-52)	17 (8)	5	49
14		5 (-7) 8 (-15) 9 (-13) 11 (17) 13 (-21) 15 (14)	1 (-7) 3 (1) 4 (29) 7 (36) 12 (1)	2 (-32) 16 (-60)	17 (0)	-4	48
15		11 (5) 12 (-13) 14 (-14)	1 (-20) 3 (-13) 4 (13) 5 (-19) 7 (23) 8 (-23) 9 (-27) 13 (-22)	2 (-42)	16 (-65) 17 (-10)	-16	45
16				1 (54) 5 (55) 9 (55) 11 (66) 13 (52) 14 (60)	2 (37) 3 (62) 4 (72) 7 (75) 8 (60) 12 (66) 15 (65) 17 (44)	51	30

Table 4. (Continued)

READER	>60	51-60	41-50	31-40	<30		AV. BIAS	AV. AGREEMENT
					1	(-5)	-2	26
					2	(-32)		
					3	(9)		
					4	(17)		
					5	(-4)		
					7	(27)		
					8	(-8)		
					9	(-7)		
					11	(15)		
					12	(-1)		
					13	(-8)		
					14	(0)		
					15	(10)		
					19	(-44)		

Table 5. Age-length keys by reader of otolith sample 2. Age composition and average length-at-age is included.

READER NO. 8

LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

READER NO. 9

LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

G 2

Table 5. (Continued)

READER NO. 11

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

READER NO. 12

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

G 3

Table 5. (Continued)

READER NO. 13

READER NO. 14

AGES

LEN

TOTAL

NK

Table 5. (Continued)

READER NO. 5

READER NO. 15

Table 5. (Continued)

READER NO. 3

LEN	\ AGES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

READER NO. 7

LEN	\ AGES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

Table 5. (Continued)

READER NO. 16

AGES

LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL
																						5.
																						15.
																						40.
																						60.
																						80.
																						100.
																						120.
																						100.
																						90.
																						80.
																						70.
																						60.
																						50.
																						40.
																						30.
																						20.
																						10.
																						5.
	0.	0.	15.	54.	130.	154.	232.	192.	81.	68.	41.	7.	14.	2.	5.	0.	0.	0.	0.	0.	5.	1000.
	0.0	0.0	34.9	45.2	46.4	52.0	52.9	56.4	59.2	66.9	69.5	72.9	68.3	82.0	43.0						91.0	

READER NO. 4

AGES

LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL
																						5.
																						15.
																						40.
																						80.
																						100.
																						120.
																						100.
																						90.
																						70.
																						60.
																						50.
																						40.
																						30.
																						20.
																						10.
																						5.
	0.	0.	54.	213.	244.	273.	127.	49.	24.	15.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1000.
	0.0	0.0	40.1	46.4	51.2	57.9	62.2	72.7	68.3	70.1	82.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1000.

Table 5. (Continued)

READER NO. 2

AGES

LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

| | 0. | 0. | 18. | 64. | 127. | 310. | 242. | 143. | 52. | 21. | 12. | 6. | 0. | 4. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1000. |
| | 0.0 | 0.0 | 35.3 | 40.2 | 47.0 | 50.8 | 57.8 | 64.3 | 66.1 | 70.5 | 75.5 | 70.3 | 0.0 | 43.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |

READER NO. 1

AGES

LEN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NK	TOTAL

| | 0. | 0. | 27. | 143. | 235. | 194. | 193. | 111. | 57. | 33. | 5. | 1. | 1. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1000. |
| | 0.0 | 0.0 | 37.1 | 43.7 | 49.0 | 53.4 | 61.7 | 63.4 | 66.9 | 66.5 | 66.1 | 79.0 | 82.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |

Table 5. (Continued)

READER NO. 17

Table 6. Age-length key derived from modal ages of otolith sample 2. Age composition and average length-at-age.

Mode

Fig. 1. Age composition by reader compared with the modal age composition.
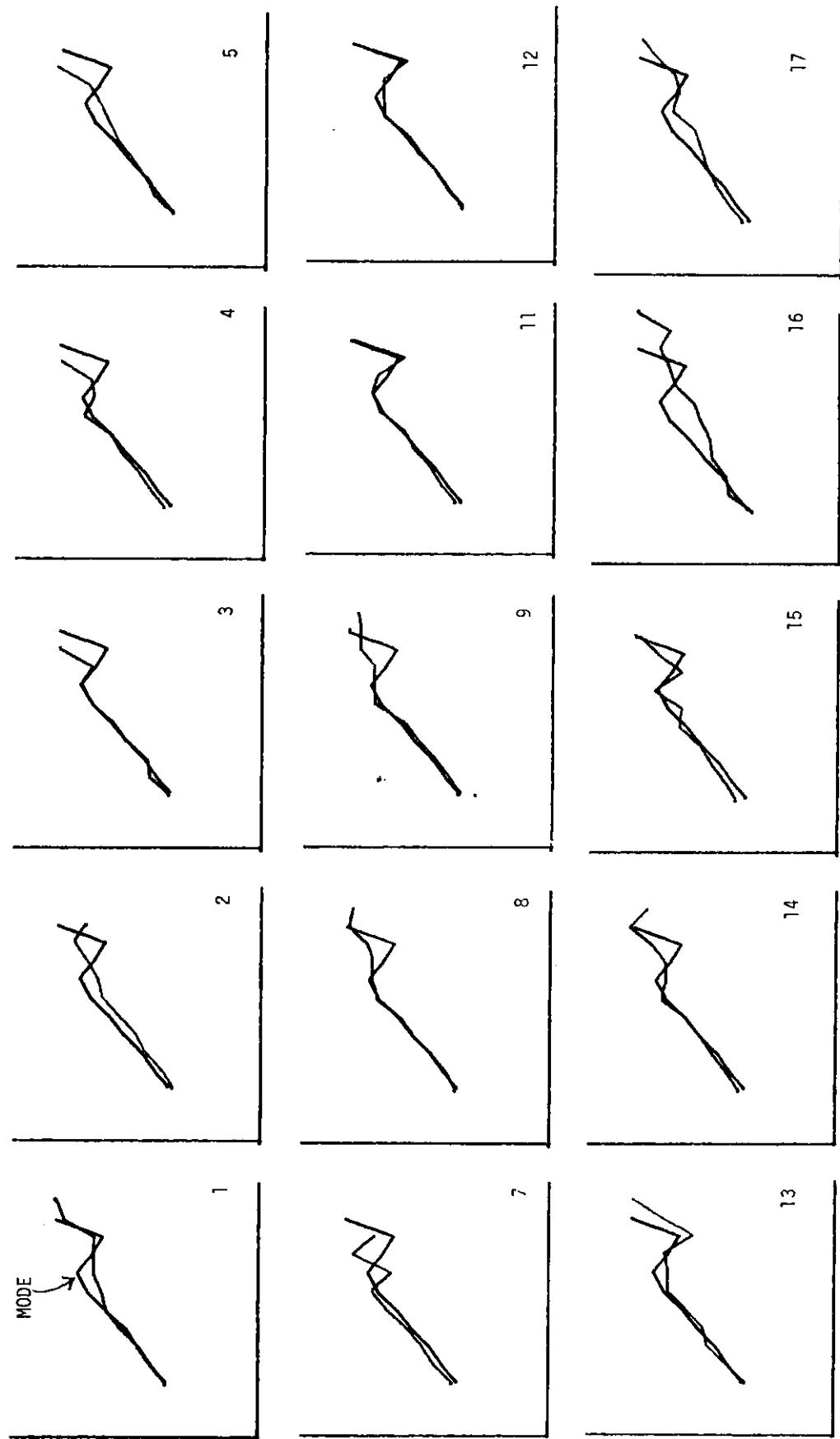
Fig. 2. Average length-at-age by reader compared with the modal average length-at-age.