

CONTENTS

	Page
1. INTRODUCTION	1
2. MATERIAL AND METHODS	1
2.1 Material	2
2.2 Methods	6
2.2.1 Otolith extraction and preparation	6
2.2.2 Otolith Reading	7
2.2.3 Estimation of growth	8
2.2.3.1 Length/age data	8
2.2.3.2 Back calculation	8
2.2.3.3 Length frequency distribution	8
2.2.4 Calculation of spawning season	9
2.2.5 Maturity studies	9
2.2.6 Verification of the ageing method	10
3. RESULTS AND DISCUSSION	10
3.1 Description of otoliths	10
3.2 Counting and Interpretation of rings	13
3.3 Growth pattern of <u>Sardinella</u> spp. as seen from the otolith microstructure	14
3.4 Consistency of countings	14
3.4.1 <u>Sardinella sirm</u>	15
3.4.2 <u>Sardinella albella</u>	17
3.4.3 <u>Sardinella gibbosa</u>	18
3.4.4 Discussion	19
3.5 Correlation between fish length and otolith radius	19
3.5.1 <u>S. sirm</u>	19
3.5.2 <u>S. albella</u>	20
3.5.3 <u>S. gibbosa</u>	21
3.5.4 <u>S. longiceps</u>	22
3.5.5 Comparison of the regressions	23
3.6 Growth estimates	23
3.6.1 <u>S. sirm</u>	24
3.6.1.1 Estimates from length/age data.	24
3.6.1.2 Estimates from back calculated data	25
3.6.1.3 Estimates from length frequency data	26
3.6.1.4 Study of larval growth	27
3.6.2 <u>S. albella</u>	30
3.6.2.1 Estimates from length/age data.	30
3.6.2.2 Estimates from back calculated data	30

	Page
3.6.3 <u>S. gibbosa</u>	32
3.6.3.1 Estimates from length/age data.	32
3.6.3.2 Estimates from back calculated data	33
3.6.4 <u>S. longiceps</u>	35
3.6.4.1 Estimates from length/age data.	35
3.6.4.2 Estimates from back calculated data	35
3.6.5 Discussion and conclusion on growth estimates	37
3.6.5.1 <u>S. sirm</u>	37
3.6.5.2 <u>S. albella</u>	39
3.6.5.3 <u>S. gibbosa</u>	40
3.6.5.4 <u>S. longiceps</u>	41
3.6.5.5 Conclusion	43
3.7 Spawning season	43
3.7.1 <u>Sardinella sirm</u>	44
3.7.1.1 Calculation of spawning season	44
3.7.1.2 Study on maturity stages	44
3.7.2 <u>Sardinella albella</u>	46
3.7.2.1 Calculation of spawning season	46
3.7.2.2 Study on maturity stages	48
3.7.3 <u>S. gibbosa</u>	49
3.7.3.1 Calculation of spawning season	49
3.7.3.2 Study on maturity stages	49
3.7.4 Discussion	51
3.7.5 Conclusion	53
3.8 Verification	53
3.8.1 Verification based on age/time between samples	53
3.8.1.1 <u>S. sirm</u>	53
3.8.1.2 <u>S. albella</u> and <u>S. gibbosa</u>	55
3.8.2 Discussion	57
3.8.3 Other verifications	57
3.8.4 Conclusion	58
 SUMMARY	 59
 ACKNOWLEDGEMENT	 60
 REFERENCES	 61