

CONTENTS**Page Nos.(i)**

Preface	.....	i
Acknowledgment	.....	iii
List of Tables	.....	vi
List of Figures	.....	ix
List of Plates	.....	xi
 CHAPTERS		
1. Introduction	.....	1
2. Objectives and scope of the study	.....	7
3. Review of literature	.....	9
3.1. Seasonal occurrence and inventory of insects on <i>Alnus nepalensis</i>	.....	10
3.2. Incidence and natural enemies of major folivores	.....	11
3.3. Population Dynamics of Major folivores	.....	13
3.4. Population changes and their relation with weather parameters	.....	14
3.5. Biology of major folivores	.....	15
3.6. Nutritional Ecology of Major folivores	.....	17
3.7. Ecological role of the major folivores in the large Cardamom agroforestry ecosystem	.....	19

4. Materials and Methods

4.1. Recording of common insect herbivores and their	.....	20
natural enemies occurring seasonally on the shade tree		
4.2. Incidence and population dynamics of the two major		21
folivores attacking the shade tree (<i>A. nepalensis</i>)		
4.2.1. Lepidopteran <i>Gazalina chrysolopha</i>		21
4.2.2. Coleopteran <i>Chrysomela chlorina</i>		22
4.3. Influence of weather parameters on the		22
population of the major folivores		
4.4. Study of natural enemies of the major folivores		23
4.5. Life cycle studies of the two major folivores		23
on <i>Alnus nepalensis</i>		
4.6. Survivorship of the major folivores		24
4.7. Age distribution of <i>G. chrysolopha</i> and <i>C. chlorina</i>	.....	24
4.8. Study of nutritional ecology of the major folivores		
4.8.1. Feeding preference		25
4.8.2. Growth and feeding indices		25
4.9. Evaluation of the negative and positive ecological		
role of these major folivores in the cardamom agroforestry		
4.9.1 Positive role		28
4.9.1.1 Analysis of leaves and faecal pellets		28
4.9.1.2. Analysis of soil		28
4.9.2. Negative role		29
4.10. Computer applications		31

5. Study area	.....	31
6. Observations and Results		
6.1. Recording of insect groups associated		
with <i>Alnus nepalensis</i>	.....	32
6.1.1. Insects common to <i>Alnus</i> and large cardamom plants	.....	33
6.2. Seasonal incidence of the major folivores	.....	34
6.2.1. Incidence and population of <i>G. chrysolopha</i>		
6.2.1.1. At Pangthang	.....	34
6.2.1.1.1. Relations with weather parameters	.....	35
6.2.1.2. At Kabi	.....	35
6.2.1.2.1. Relations with weather parameters	.....	36
6.2.2. Incidence and population of <i>C. chlorina</i> :		
6.2.2.1. At Pangthang	.....	36
6.2.2.1.1. Relations with weather parameters	.....	37
6.2.2.2. At Kabi	.....	37
6.2.2.2.1. Relations with weather parameters	.....	37
6.3. Life cycle of <i>G. chrysolopha</i>		
6.3.1. Egg	.....	38
6.3.2. First and second instar larvae	.....	38
6.3.3. Third, fourth and fifth instar larvae	.....	38
6.3.4. Pupa	.....	39
6.3.5. Adult	.....	39

6.3.6. Fecundity and oviposition	.....	40
6.3.7. Natural enemies associated with <i>G. chrysolopha</i>	.....	40
6.4. Life cycle of <i>C. chlorina</i>		
6.4.1. Egg	.....	41
6.4.2. Larva	.....	41
6.4.3. First Instar	.....	41
6.4.4. Second Instar	.....	41
6.4.5. Third Instar	.....	41
6.4.6. Fourth Instar	.....	42
6.4.7. Pupa	.....	42
6.4.8. Adult	.....	43
6.4.9. Fecundity and oviposition	.....	43
6.4.10. Natural enemies associated with <i>C. chlorina</i>	.....	44
6.5. Survivorship study of <i>G. chrysolopha</i>	.....	44
6.6. Survivorship study of <i>C. chlorina</i>	.....	44
6.7. Age distribution of <i>G. chrysolopha</i> and <i>C. chlorina</i>	.....	45
6.8. Nutritional Indices of larvae of <i>G. chrysolopha</i>		
6.8.1. Feeding preference and quality of food consumed by <i>G. chrysolopha</i>	.....	45
6.8.2. Feeding behaviour	.....	46
6.8.3. Consumption Index (CI)	.....	47
6.8.4. Approximate Digestibility	.....	47

6.8.5. Efficiency of Conversion of Ingested Food (ECI)	.....	47
6.8.6. Efficiency of Conversion of Digested Food (ECD)	.....	48
6.8.7. Growth Rate (GR)	.....	48
6.9. Nutritional Indices of larvae of <i>C. chlorina</i>		
6.9.1. Feeding preference and the quality of food consumed by <i>C. chlorina</i>	.....	48
6.9.2. Feeding behaviour	.....	49
6.9.3. Consumption Index (CI)	.....	49
6.9.4. Approximate Digestibility (AD)	.....	49
6.9.5. Efficiency of Conversion of Ingested Food (ECI)	.....	50
6.9.6. Efficiency of Conversion of Digested Food (ECD)	.....	50
6.9.7. Growth Rate (GR)	.....	50
6.10. Evaluation of ecological role of the major folivores		
6.10.1. Positive role		
6.10.1.1. Analysis of faecal urine of <i>G. chrysolopha</i> and <i>C. chlorina</i>	.....	50
6.10.1.2. Analysis of soil mixed with faecal urine	.....	51

6.10.2. Negative role		
6.10.2.1. Estimation of the extent of injury done to the leaves by the major folivores	.....	51
6.10.2.2. Estimation of injury potential of <i>C. chlorina</i> utilizing cardamom leaves as alternate food	.....	52
7. Discussion		
7.1. Entomofauna associated with <i>Alnus nepalensis</i>	.....	53
7.2. Insect common to large Cardamom plant and <i>A. nepalensis</i>	.....	57
7.3. Incidence of major folivores	.....	58
7.3.1. Incidence of <i>Gazalina chrysolopha</i>	.....	59
7.3.2. Incidence of <i>Chrysomela chlorina</i>	.....	59
7.4. Population changes of major folivores and their relation with weather parameters		
7.4.1. Population of <i>G. chrysolopha</i>	.....	60
7.4.1.1. Effect of abiotic factors on the population of <i>G. chrysolopha</i>	.....	61
7.4.1.2. Natural enemies as mortality factor	.....	63
7.4.2. Population of <i>C. chlorina</i>	.....	64
7.4.2.1. Effect of abiotic factors on the population of <i>C. chlorina</i>	.....	65
7.4.2.2 Natural enemies as mortality factor	.....	65

7.5. Biology of Major folivores on <i>A. nepalensis</i>	
7.5.1. Biology of <i>G. chrysolopha</i>	66
7.5.2. Biology of <i>C. chlorina</i>	68
7.6. Age distribution of <i>G. chrysolopha</i> and <i>C. chlorina</i>	69
7.7. Survivorship of <i>G. chrysolopha</i> and <i>C. chlorina</i>	70
7.8. Nutritional ecology of major folivores on <i>A. nepalensis</i>	72
7.8.1. Nutritional ecology of <i>G. chrysolopha</i>	
7.8.1.1. Feeding preference and behaviour	73
7.8.1.2. Food consumption	74
7.8.1.3. Food utilization efficiencies	75
7.8.1.4. Growth Rate (GR)	78
7.8.2. Nutritional ecology of <i>C. chlorina</i>	
7.8.2.1. Feeding preference	80
7.8.2.2. Food consumption	80
7.8.2.3. Food utilization efficiencies of <i>C. chlorina</i>	81
7.8.2.4. Growth Rate (GR)	83
7.9. Ecological role of major folivores in the cardamom agroforestry	
7.9.1. Assaying the contribution of the folivores in production of faecal-urine rich ground litter ..	84
7.9.2. Negative role of the major folivores in large	86
cardamom agroforestry	

CONTENTS*Page Nos. (viii)*

8. Summary	.....	90
9. References	.....	I-XXIII
10. Annexure		