

Contents

Preface

ix

1. Introduction

- | | |
|---|---|
| 1.1 What is a Mixed-Species Group? Defining the Scope of the Book | 1 |
| 1.2 Historical Perspective on Research on Mixed-Species Groups | 5 |

2. A Diversity of Mixed-Species Associations

- | | |
|--|----|
| 2.1 Classifying Mixed-Species Associations | 11 |
| 2.2 Interactions Between Species Without Association | 12 |
| 2.3 Association of Species Despite Lack of Interaction | 15 |
| 2.3.1 Aggregations in Habitat Patches | 15 |
| 2.3.2 Aggregations Around a Resource | 17 |
| 2.3.3 Aggregations Influenced by Predation | 18 |
| 2.3.4 Aggregations During Migration | 21 |
| 2.4 Stationary Associations Centered Around Species Interactions | 22 |
| 2.4.1 Associations Based on a Protective Species | 23 |
| 2.4.2 Mixed-Species Colonies or Roosts | 24 |
| 2.4.3 Cleaning Mutualisms | 25 |
| 2.5 Conclusions | 25 |

3. Moving Mixed-Species Groups in Different Taxa

- | | |
|--|----|
| 3.1 Comparing Moving Mixed-Species Groups | 27 |
| 3.2 Invertebrates | 28 |
| 3.3 Fish and Aquatic Amphibians | 37 |
| 3.3.1 Saltwater Fish | 37 |
| 3.3.2 Freshwater Fish and Aquatic Amphibians | 39 |
| 3.4 Mammals | 40 |
| 3.4.1 Cetaceans | 40 |
| 3.4.2 Ungulates | 41 |
| 3.4.3 Primates | 42 |
| 3.5 Birds | 44 |
| 3.5.1 Seabirds | 44 |
| 3.5.2 Shorebirds | 46 |

3.5.3	Waterfowl	47
3.5.4	Waders	48
3.5.5	Grassland Birds	49
3.5.6	Forest Birds	50
3.6	MSGs That Include Multiple Taxa and Where One Species Makes Food More Accessible to Others	53
3.6.1	Associations Based on One Species Increasing Prey Accessibility	53
3.6.2	Cooperative Hunting	55
3.6.3	Mutualisms in Which Increased Foraging Is Traded for Vigilance	55
3.7	Conclusions	56
4.	Adaptive Implications of Mixed-Species Grouping: Foraging, Physical, and Reproductive Factors	
4.1	Different Types of Mixed-Species Groups in Terms of Adaptation	59
4.2	Some Potential Foraging Benefits of (Mixed-Species) Grouping	62
4.2.1	Sharing Information About Foraging Opportunities	63
4.2.2	Beater Effects and Enhancement of Food Availability	67
4.2.3	Niche Separation, Reduced Competition, and Altered Social Interaction	69
4.2.4	Reduced Variance in Food Finding	72
4.2.5	Group Hunting	73
4.2.6	Defending a Food Source	74
4.2.7	Improved Efficiency of Exploiting the Local Environment	74
4.3	Some Potential Foraging Costs of (Mixed Species) Grouping	75
4.3.1	Competition for Food, Food Stealing, Dominance, and Within-Group Aggression	75
4.3.2	Conflict Over When and Where to Feed and/or Over Speed of Movement Through the Environment	76
4.4	Reduced Cost of Locomotion in Groups	77
4.5	Protection From Adverse Environments in Groups	77
4.6	Further Social and Reproductive Aspects of (Mixed-Species) Grouping	78
4.7	Conclusions	80
5.	Adaptive Implications of Mixed-Species Grouping: Predators and Other Antagonists	
5.1	Consequences of Mixed-Species Grouping for Predation Risk	81
5.1.1	Encounter-Dilution Effects	81
5.1.2	Vigilance and Collective Detection	82
5.1.3	Confusion and Oddity	85
5.1.4	Mobbing and Aggressive Defense	87

5.1.5	Nonrandom Prey Choice Within Groups by Predators	89
5.1.6	Educating Naive Individuals About Predatory Threats	91
5.2	Other Enemies (Parasites and Disease)	93
5.3	Herbivory in MSAs of Plants	95
5.4	Case Studies of Selection Pressures on MSGs	96
5.4.1	Thomson's and Grant's Gazelles	96
5.4.2	Hornbills and Mongooses	97
5.4.3	Oxpeckers and Mammalian Grazers	98
5.4.4	Cleaner Fish	99
5.4.5	Birds That Use False Alarm Calls to Kleptoparasitize	101
5.4.6	Association Between Dolphins, Tuna, and Seabirds	101
5.5	Conclusions	103
6.	Communication	
6.1	Introduction	105
6.2	Eavesdropping	107
6.2.1	Eavesdropping to Locate Resources	107
6.2.2	Eavesdropping to Locate Groups	110
6.2.3	Eavesdropping to Mob Predators	111
6.2.4	Eavesdropping to Assess Predation Risk	113
6.3	Signaling	117
6.3.1	Honest Signals	118
6.3.2	Deceptive Signals	118
6.3.3	Mimicry	119
6.4	Conclusions	122
7.	Leadership and Sentinel Behavior	
7.1	Introduction	125
7.2	Leadership	126
7.2.1	Historical Perspective	126
7.2.2	How to Quantify Leadership	128
7.2.3	Characteristics of Leader Species	139
7.3	Sentinel Behavior	141
7.4	Conclusions	144
8.	Mixed-Species Groups and Conservation	
8.1	Introduction: The Need for Conservation of Mixed-Species Associations	147
8.2	Mixed-Species Group Responses to Anthropomorphic Disturbance	148
8.3	Mechanisms of This Response	153
8.4	Gaps in Knowledge	155
8.5	Conservation Actions: Protect Locations	158
8.6	Conservation Actions: Protect Species	158
8.7	Conservation Actions: Restoration of Disturbed Areas	159
8.8	Conclusions	160

9. Conclusions

9.1 What Have We Learned?	161
9.2 Empirical Research on Mixed-Species Groups	161
9.3 Theoretical Review of Benefits and Costs	163
9.4 Social Interactions Within Mixed-Species Groups	165
9.5 Conservation and Conclusion	166

References	169
Index	199