

Sperm competition, sexual selection and the diverse reproductive biology of Osteoglossiformes

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Funding information

National Science Foundation, Grant/Award Numbers: DGE-1848739, IOS-1644965

Abstract

Osteoglossiformes are an order of “bony tongue” fish considered the most primitive living order of teleosts. This review seeks to consolidate known hypotheses and identify gaps in the literature regarding the adaptive significance of diverse reproductive traits and behaviour of osteoglossiforms within the context of sperm competition and the wider lens of sexual selection. Many of the unusual traits observed in osteoglossiforms indicate low levels of sperm competition; most species have unpaired gonads, and mormyroids are the only known vertebrate species with aflagellate sperm. Several osteoglossiform families have reproductive anatomy associated with internal fertilization but perform external fertilization, which may be representative of the evolutionary transition from external to internal fertilization and putative trade-offs between sperm competition and the environment. They also employ every type of parental care seen in vertebrates. Geographically widespread and basally situated within teleosts, osteoglossiforms present an effective study system for understanding how sperm competition and sexual selection have shaped the evolution of teleost reproductive behaviour, sperm and gonad morphology, fertilization strategies, courtship and paternal care, and sexual conflict. The authors suggest that the patterns seen in osteoglossiform reproduction are a microcosm of teleost reproductive diversity, potentially signifying the genetic plasticity that contributed to the adaptive radiation of teleost fishes.

KEYWORDS

adaptation, fish, natural selection, reproduction, sexual selection, sperm competition

1 | INTRODUCTION

The approximately 26,000 known species of teleost fish occupy a wide range of aquatic habitats (Froese & Pauly, 2019) and exhibit a remarkable array of reproductive strategies (Helfman et al., 2009). It is presently unclear which factors contribute to the evolution of such numerous reproductive strategies within teleosts (Smith & Wootton, 2016). The basally situated Osteoglossiformes (“bony tongue”) are a microcosm of teleost reproductive diversity. They exhibit variation in reproductive anatomy, gamete morphology and reproductive behaviour, all suggesting flexibility early in teleost evolution (Figure 1). Osteoglossiforms are distributed worldwide and are

comprised of five families: Osteoglossidae (15 species in South America, Africa, Asia and Australia), Notopteridae (10 species in Africa and Southeast Asia), Pantodontidae (one species in Africa), and two families of weakly electric fish, Mormyridae (>200 species, Africa) and Gymnarchidae (one species, Africa). In accordance with osteoglossiforms’ cosmopolitan distribution and their ancestral position within teleosts, insights into the evolution of their reproductive diversity may lead to a new understanding about the factors underlying the evolution of reproduction in teleosts (Figure 2).

Several reviews have considered osteoglossiform reproductive behaviour (Britz, 2004; Hopkins, 1986; Karino, 2009; Kolm, 2009; Yanwitsal, 2013) and sperm morphology (Jamieson, 1991;

Sperm Competition And Sexual Selection

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Sperm Competition and Sexual Selection Tim R. Birkhead, Anders Pape Møller, 1998-08-12 Sperm Competition and Sexual Selection presents the intricate ways in which sperm compete to fertilize eggs and how this has prompted reinterpretations of breeding behavior This book provides a theoretical framework for the study of sperm competition which is a central part of sexual selection It also discusses the roles of females and the relationships between paternal care in sperm competition The chapters focusing on taxonomic development are diverse and cover all the major animal groups both vertebrate and invertebrate and plants The final chapter provides an overview discussing the relationship between sperm competition and sexual selection in terms of both function and mechanism and how these translate into species fitness This book will be of prime interest to behaviorists ecologists and evolutionary biologists suggesting new avenues of research and new ways of approaching old problems The only up to date summary of a central and popular subject Well known editors and authors Provides a theoretical framework for the study of sperm competition Covers all major animal groups Includes a chapter on plants

Sperm Competition and the Evolution of Animal Mating systems Robert L. Smith, 2012-12-02 Sperm Competition and the Evolution of Animal Mating Systems describes the role of sperm competition in selection on a range of attributes from gamete morphology to species mating systems This book is organized into 19 chapters and begins with the conceptualization of sperm competition as a subset of sexual selection and its implications for the insects The following chapter describes the relationship between multiple mating and female fitness with an emphasis on determining the conditions under which selection on females is likely to counteract selection on males for avoiding sperm competition Other chapters consider the female perspective on sperm competition the evolutionary causation at the level of the individual male gamete and the correlation of high paternal investment and sperm precedence in the insects The remaining chapters are arranged phylogenetically and explore the sperm competition in diverse animal taxa such as the *Drosophila* Lepidoptera spiders amphibians and reptiles These chapters also cover the evolution of direct versus indirect sperm transfer among the arachnids or the problem for kinship theory presented by multiple mating and sperm competition in the Hymenoptera This book further discusses the remarkable potential for sperm competition among certain temperate bat species whose females store sperm through winter hibernation and the mixed strategies and male caused female genital trauma as possible sperm competition adaptations in poeciliid fishes The concluding chapter examines the predictions concerning testes size and mating systems in the primates and the possible role of sperm competition in human selection This book is of great value to reproductive biologists and researchers

Promiscuity Tim Birkhead, 2000 Birkhead reveals a world in which males and females vie with each other as they strive to maximize their reproductive success Color illustrations

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that sexual selection continues after mating through sperm competition. Because females often mate with multiple males before producing offspring, selection favors adaptations that allow males to preempt sperm from previous males and to prevent their own sperm from preemption by future males. Since the 1970s, this area of research has seen exponential growth, and biologists now recognize sperm competition as an evolutionary force that drives such adaptations as mate guarding, genital morphology, and ejaculate chemistry across all animal taxa. The insects have been critical to this research, and they still offer the greatest potential to reveal fully the evolutionary consequences of sperm competition. This book analyzes and extends thirty years of theoretical and empirical work on insect sperm competition. It considers both male and female interests in sperm utilization and the sexual conflict that can arise when these differ. It covers the mechanics of sperm transfer and utilization, morphology, physiology, and behavior. Sperm competition is shown to have dramatic effects on adaptation in the context of reproduction as well as far-reaching ramifications on life history, evolution, and speciation. Written by a top researcher in the field, this comprehensive up-to-date review of the evolutionary causes and consequences of sperm competition in the insects will prove an invaluable reference for students and established researchers in behavioral ecology and evolutionary biology.

Sperm Competition in Butterflies Mamoru Watanabe, 2016-01-06. This book describes about 30 years of theoretical, empirical, and experimental work on butterfly sperm competition. It considers the reproductive morphology and sperm utilization interests of males and females which shape the mating tactics of each sex. Females of most butterfly species mate multiple times throughout their lives. The reasons are explored, as well as the numerous adaptations males have developed to prevent future mating and fertilization by the sperm of other males. In particular, this volume focuses on the role of apyrene sperm. Eupyrene and apyrene sperm dimorphism is most likely a key factor in sperm competition, and the study in butterflies promotes understanding of sexual selection across animal species with sperm polymorphism. This book describing the evolutionary causes and consequences of the sperm competition in butterflies is a recommended read for students of behavioural ecology.

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competition theory males and females in many species possess anatomical behavioral and physiological adaptations that have evolved to deal with the adaptive challenges associated with sperm competition Moreover in recent years evolutionary biologists and psychologists have begun to examine the extent to which sperm competition may have been an important selective pressure during human evolution Some research has suggested that male humans like males of many bird insect and rodent species might be able to adjust the number of sperm they inseminate according to the risk of sperm competition Other research has examined whether such responses might be accompanied by psychological changes that motivate human males to pursue copulations when the risk of sperm competition is high Furthermore there is research suggesting that aspects of human penile anatomy might function to enhance success in sperm competition Much of this work has been controversial some of the findings have been disputed and others have been greeted with skepticism However the idea that some aspects of human psychology and behavior might best be understood as adaptations to sperm competition remains intriguing and in certain cases very persuasive

Sexual Selection and Sperm Competition in Soay Sheep Brian T. Preston, 2001

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Table of Contents Sperm Competition And Sexual Selection

1. Understanding the eBook Sperm Competition And Sexual Selection
 - The Rise of Digital Reading Sperm Competition And Sexual Selection
 - Advantages of eBooks Over Traditional Books
2. Identifying Sperm Competition And Sexual Selection
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Sperm Competition And Sexual Selection
 - User-Friendly Interface
4. Exploring eBook Recommendations from Sperm Competition And Sexual Selection
 - Personalized Recommendations
 - Sperm Competition And Sexual Selection User Reviews and Ratings
 - Sperm Competition And Sexual Selection and Bestseller Lists

5. Accessing Sperm Competition And Sexual Selection Free and Paid eBooks
 - Sperm Competition And Sexual Selection Public Domain eBooks
 - Sperm Competition And Sexual Selection eBook Subscription Services
 - Sperm Competition And Sexual Selection Budget-Friendly Options
6. Navigating Sperm Competition And Sexual Selection eBook Formats
 - ePub, PDF, MOBI, and More
 - Sperm Competition And Sexual Selection Compatibility with Devices
 - Sperm Competition And Sexual Selection Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Sperm Competition And Sexual Selection
 - Highlighting and Note-Taking Sperm Competition And Sexual Selection
 - Interactive Elements Sperm Competition And Sexual Selection
8. Staying Engaged with Sperm Competition And Sexual Selection
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Sperm Competition And Sexual Selection
9. Balancing eBooks and Physical Books Sperm Competition And Sexual Selection
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Sperm Competition And Sexual Selection
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Sperm Competition And Sexual Selection
 - Setting Reading Goals Sperm Competition And Sexual Selection
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Sperm Competition And Sexual Selection
 - Fact-Checking eBook Content of Sperm Competition And Sexual Selection
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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