

Preface

Ever since 1676, when Anton Leeuwenhoek first witnessed 'animalcules' rapidly wriggling in a drop of his own semen, using a single-lens microscope of his own construction, people have been fascinated by spermatozoa. The extraordinary variation in their size and design across the animal kingdom, as well as their physiological and molecular sophistication, have intrigued biologists – ourselves included – from a wide range of disciplines. The study of 'sperm biology' is 330 years old and the pace of discovery shows no sign of slowing. Investigations of 'sperm biology' and evolution are generating great advances in a wide array of disciplines, including reproductive biology, phylogenetics, sexual selection and speciation. New assisted reproduction technologies have also made knowledge of 'sperm biology' crucial for efforts to treat human infertility and to restore populations of endangered species.

Interest in 'sperm biology' proliferated during the middle of the twentieth century, with a focus on the comparative use of sperm ultrastructure to deduce phylogenetic relationships among taxa. This new scientific endeavor gave rise in 1969 to the first international Spermatology Congress. Over the years, the size and scope of this meeting has broadened to include spermatogenesis, sperm surface properties, maturation, motility and fertilization. These meetings have resulted in a superb series of volumes that provide a clear and stimulating account of the field (see Chapter 1).

A second wave of interest in 'sperm biology' was inspired by the revolution in evolutionary thinking that occurred in the late 1960s and early 1970s, best characterized by the idea of 'individual selection' or 'selfish gene' thinking. An important proponent of this change was Geoff A. Parker, and it was fortunate indeed that his main interest was in sperm competition. Although much of the initial wave of interest in 'sperm biology' was evolutionary, the type of thinking spearheaded by Parker was strikingly unique. Prior to the early 1970s most biologists viewed reproduction as a cooperative venture between males and females. However, the idea that selection operated on individuals and maximized individual reproductive success raised the possibility that rather than being cooperative, reproduction might be characterized by conflicts of interest between the sexes as each attempted to maximize its reproductive success – even at the other's expense. Parker's explicitly individual view of selection has had – and continues to have – a profound influence on our way of thinking about reproduction.

First, based on his observations of the reproductive behavior of the yellow dung fly *Scatophaga stercoraria*, which included females copulating with several males in succession, Parker recognized that the sperm of different males would

compete to fertilise the female's ova and that sperm competition – as he called it – was a form of post-copulatory male–male competition. Parker's observations overturned a century of mistaken belief, promoted initially by Darwin, that females were sexually monogamous. Sexual selection did not cease once an individual had acquired a partner as Darwin proposed, but instead continued up to fertilization. This revolution in evolutionary thinking made it clear that rather than competing for females, as Darwin suggested, males competed for fertilizations.

Second, Parker highlighted the fact that the conflicting interests generated by sperm competition – both between males and females and between competing males – would result in the rapid evolution of anatomical, physiological and behavioral traits that he referred to as 'adaptations to sperm competition'. As the field developed, it became increasingly clear that selection generated by sperm competition accounted for many of the extraordinary and diverse features of reproduction across the animal kingdom – including those of sperm *per se*.

The study of sperm competition focused originally on males, but as the field developed, it became clear that females were not passive participants in sperm competition and in many cases played an important role in determining fertilization success. Also, after initially directing their efforts to identifying the adaptive significance of male traits, behavioural ecologists recognized that knowing something about the underlying mechanisms of sperm competition would improve our overall understanding of how reproductive traits evolved. These endeavors have in recent years expanded into investigations of coevolution between the characteristics of ejaculates and of female reproductive tracts, and the resultant contribution of sperm competition in reproductive isolation and species formation.

The Spermatology Congresses acknowledged the new style of evolutionary thinking by inviting a small number of behavioural ecologists to discuss sperm competition at their meeting in Siena in 1991. However, the focus of these meetings – for the time being at least – remained primarily comparative. The recognition that the behavioural and evolutionary ecology approaches, whose somewhat narrow focus in the 1990s was on the adaptive significance of traits rather than on mechanisms, provided the incentive for one of us (TRB, a behavioural ecologist) together with Harry Moore (an andrologist), to start in 1992 a new series of meetings, referred to as the Biology of Spermatozoa (BoS). These meetings, which have taken place biennially at Loosehill Hall, in the Peak District National Park, Derbyshire, UK, were from the outset very different from the Spermatology Congresses in that they were small (a maximum of 60 participants), focused on informal discussion, and produced no published proceedings.

One of the most encouraging developments in the last few years is the heightened overlap in the topics discussed at both meetings. With increasing numbers of behavioral ecologists attending the Spermatology Congresses and more and more spermatologists participating in the Biology of Spermatozoa meetings, the opportunities for greater understanding and collaboration continue to increase. As our respective interests converge, it is clear that each group has much to learn

from the other, and we are enthusiastic about seeing this trend toward more integrative and interdisciplinary research on sperm continue.

At the BoS meeting in 2003, the present editors began to think about the possibility of producing a broad synthesis of the field of 'sperm biology'. Over the following months our ideas began to take shape and at the 2005 BoS meeting we discussed a framework for the topics and identified appropriate authors for the various chapters. Our aim has been to encourage authors to provide a broad overview of their respective topics such that they can be read independently, but which together provide a comprehensive synthesis of the entire field. Undoubtedly others would have had a different emphasis or selected different topics, but in addition to our main goal of discussing animal sperm, we hope we will inspire others to fill the gaps (e.g. sperm of plants and fungi) we have left, to forge further links between biologists in different disciplines and to develop the many ideas presented here.

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