Mammalian Fertilization as Seen With the Scanning Electron Microscope

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ABSTRACT For several years we have been looking at mammalian gametes and their interactions with the scanning electron microscope (SEM). Examining the images produced by the SEM has given us a three-dimensional view of sperm, eggs, and egg investments. We are particularly impressed with the structural variation among gametes of different mammalian species. In this short report we examine the structure of mammalian spermatozoa, eggs, zonae pellucidae, and cumuli. Our observations and those of others have led us to believe that variation in gamete structure and function may have evolved as a mechanism for reproductive isolation of mammalian species.

Of the many techniques that have been employed to analyze fertilization, the scanning electron microscope (SEM) has provided the most vivid and readily interpretable images of mammalian gametes and their interactions. The SEM produces a realistic perception of a third dimension. In contrast, reconstructing three-dimensional relationships based on images obtained with the transmission electron microscope is generally a laborious analytical exercise. During the past 8 years, we have used the SEM to complement physiological and biochemical techniques in studying aspects of mammalian fertilization. We will present here a few micrographs and some of the thoughts that occurred to us in the process of analyzing several thousand SEM images. This paper is not meant to be a review of the extensive literature on mammalian fertilization. The subject has been comprehensively and capably reviewed on several occasions; see, for instance, the recent article by Ryuzo Yanagimachi (Huang et al., 1981). This issue also contains an excellent short review by Prudence Talbot which the reader may want to read as an aid to placing in context the information we are presenting here.

SPERMATOZOA

Even before the marvellous drawings of Retzius were published at the turn of the century, scientists were well aware of the tremendous variability in the morphology of spermatozoa throughout the animal kingdom. In fact, early biologists were more interested in interspecies variation in sperm morphology than we are today. Morphology of gametes were central to the thrust of what was modern biology of the time, and most biologists in the small scientific community would have been aware of whatever work was published in the field of reproductive biology.

As reproductive biology became a science of specialists, each involved in his or her own system, most workers became less interested in the variations in spermatozoon structure. For instance, a recent review referred to the echinoderm spermatozoon as "the invertebrate spermatozoon." Echinoderm gametes have indeed been by far the most studied invertebrate sperm and egg since Frank Lillie, E.B. Wilson, and other greats collected hundreds of specimens at Woods Hole many years ago. Grams of gametes are easily obtainable from this source, and external fertilization is readily amenable to experimental manipulation. Moreover, the simple 9 + 2 flagellum of the echinoderm spermatozoon is an appropriate model to study flagellar motility (Fig. 1). The fact that we work on these gametes, however, is hardly a valid reason to equate echinoderm spermatozoa in general to invertebrate spermatozoa or even typical

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