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A note on the entrance of the spermatozoon into the starfish egg.

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In 1876 Fol made the classic discovery that the spermatozoon actually enters the egg in fertilization. This fact he observed in the starfish egg. Fol's treatise was apparently so exhaustive and so carefully worked out that no one has questioned the details of his observations and his interpretation of the process is generally accepted to this day. Conical elevations were seen to form on the surface of the egg and the spermatozoa travelled in a straight line toward them. When a spermatozoon reached a cone its head penetrated it. Fol called the conical elevation the "attraction cone" and believed that it attracted the spermatozoon from a distance.

The starfish egg is surrounded by a zone of glutinous jelly the thickness of which is about one fifth the diameter of the egg. When the eggs are placed in a sperm suspension all the spermatozoa that accidentally come into contact with the surface of the jelly stick and are unable to penetrate it to any extent.

My observations confirm those of Fol regarding the formation of the cones on the egg's surface. The number of cones depends upon the age of the egg and upon the density of the sperm suspension surrounding it. An overripe egg forms these cones quickly and in considerable numbers. A fresh mature egg forms only a few cones unless the sperm suspension is very dense.

Fol, however, failed to observe the following: From the tip of each cone a slender filament grows outward piercing the jelly until it reaches the periphery where the trapped spermatozoa are lying. If there be no spermatozoa in the immediate vicinity nothing more happens. If, however, the tip of the filament comes into contact with a spermatozoon the cytoplasm of the tip and that of the sperm head immediately flow together so that the sperm nucleus now lies within the cytoplasm of the egg fila-

ment. An extraordinary reaction then takes place. The filament begins to draw back into the egg dragging the spermatozoon along with it. Not only this but all the other filaments projecting from the egg are similarly withdrawn. Apparently, a wave of response is started when a filament fuses with a spermatozoon. This wave must travel down the filament and over the egg.

As the filament with a spermatozoon on its tip shortens, the spermatozoon is pulled deeper and deeper into the jelly and the lashing of its tail becomes more and more restricted. The spermatozoon behaves like an unwilling victim and occasionally, frees itself, especially when other filaments have been slightly ahead in activity and have also secured spermatozoa which they are now pulling in. With the microdissection needle one may free a spermatozoon by breaking the filament to which it is attached. Such a spermatozoon is generally unable to extricate itself from the jelly in which it lies embedded. After a few vibrations of its tail it becomes permanently quiescent.

By the time the filament has dragged the spermatozoon half way through the jelly the base of the cone changes in shape. The convexly rounded border, which gives it the appearance of a rounded nipple, draws in so as to become concave. In doing so it leaves the egg membrane behind and this now becomes plainly visible owing to the space intervening between it and the surface of the cone. By the time the filament is withdrawn so as to bring the sperm head to the summit of the cone, the lifting of the egg membrane has spread from the base of the cone over the egg and is recognized as the fertilization membrane.

When the filament is completely withdrawn into the base of the cone the head of the spermatozoon is taken in with it. The tail of the spermatozoon remains for a time outside the fertilization membrane. As long as the tail maintains organic continuity with its head it keeps up a feeble oscillatory movement. As the cone recedes into the egg, the strand extending from it to the tail outside the fertilization membrane breaks and the tail then lies motionless. The tail can be seen for several minutes marking the site where the sperm head had gone in.