# Spermatology in Sweden

**Ulrik Kvist**

Lecture given by Ulrik Kvist on June 3rd 2018, XIIIth International Symposium on Spermatology, 9th to 13th May 2018, Stockholm.

**Gustaf Retzius,**
**Åke Franzén,**
**Björn Afzelius,**
**Lennart Nicander,**
**Leif Plöen.**

## Gustaf Retzius 1842–1919 (Fig. 1)

Gustaf Retzius was a physician, anatomist and also a member of the Swedish Academy 1901–1919 chair no 12, appointing the Nobel laureates in literature. He was Professor in Anatomy and Histology at the Karolinska institute, Stockholm, Sweden. His works on the sensory organs and the nervous system are particularly famous.

Gustaf Retzius retired early and took up a complete new field of research—comparative spermatology when he was in his sixties. Retzius financed all spermatology research with family money and his world-wide contacts. He examined spermatozoa from over 400 animal species from all six continents.

He was exceedingly productive; all the large volumes seen on his right side in the photograph were written and illustrated by him.

Retzius worked at his home in Stockholm or at the Kristineberg Marine Research and Innovation Center in Fiskebäckskil on the Swedish Westcoast (Fig. 2) where

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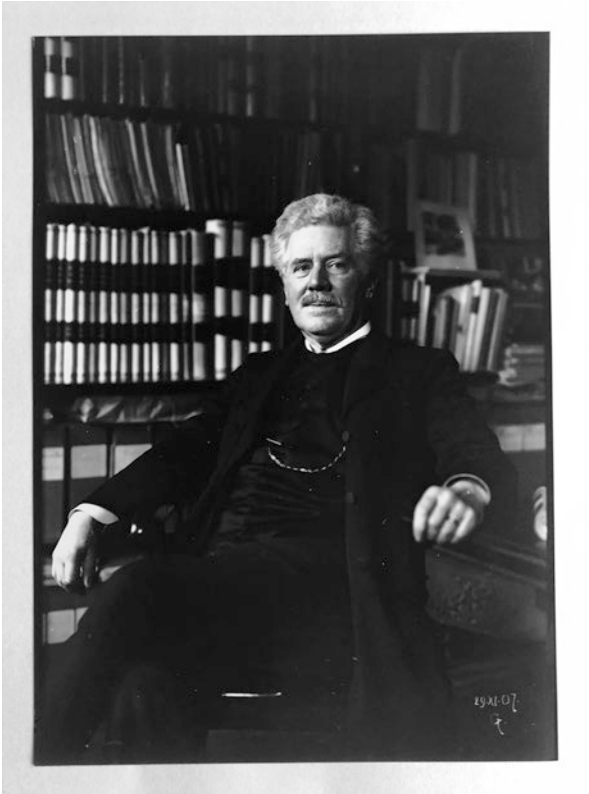


**Fig. 1** Gustaf Retzius 1842–1919. Portrait 1907-11-21 (in Thomas Lindblad Collection), Photo 2021 by Anna Lantz, Hagstromer Library Karolinska Institutet, Stockholm, Sweden

**Fig. 2** Kristineberg Center for Marine Research & Innovation. Fiskebäckskil, Sweden. Dronefoto by Eduardo Infantes. https://kristinebergcenter.com

**Fig. 3** Retzius first Microscope by C. Verick eleve special de E. Hartnack, Rue de la Parcheminerie 2, Paris", Photo 2021 by Anna Lantz, Hagstromer Library Karolinska Institutet, Stockholm, Sweden

also two later Swedish Spermatologists, Åke Franzén and Björn A. Afzelius, spent summers as teacher and researcher.

Retzius instrument was the light microscopy. Initially he used the Verrick microscope (Fig. 3) and later a Zeiss microscope. He preferred to use sun rays and was thus dependent of favourable weather for drawing the spermatozoa he investigated.

## Retzius and Technical Excellence

His investigations were at the top of what could and can be achieved by light microscopy.

Wherever possible he took his material from freshly killed animals, fixed their spermatozoa with osmium tetroxide or Zenker's fixative and performed the examination with a good Zeiss microscope provided with apochromatic lenses with good resolution and numerical apertures of 1.3 or 1.4.

Retzius stated in 1904: "In order to understand the fertilization process it is necessary to undertake a detailed investigation of the two parties at fertilization—the spermatozoon and the oocyte" (Retzius 1904–1921, cited in Björn 1995). Retzius

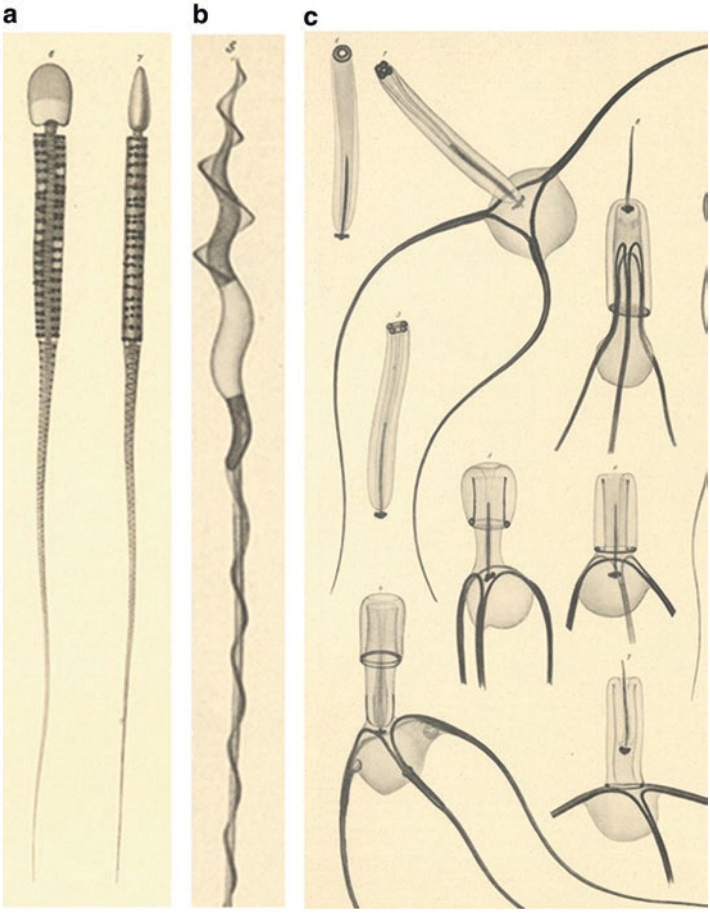



**Fig. 4** (**a**) Pipistrelle Bat Vol XIII Table XXIX; (**b**) Passerine Bird Vol XIV: Table XXXVII; (**c**) Marine Crustacean Vol XIV: Table XII; Spermatozoa drawn by Gustaf Retzius. Photo and compilation from Biologische Untersuchungen, Neue Folge, Volumes XI–XIX. Photo 2021 Anna Lantz. For further descriptions see Björn A. Afzelius. Gustaf Retzius and Spermatology Int. J. Dev. Biol. 39: 675–685, 1955 and original paper in Biologische Untersuchungen, Neue Folge, hagstromerlibrary@ki.se

microscope and the original collection of Biologische Untersuchungen can be studied at the Hagströmer Library at the Karolinska Institute, Stockholm, Sweden (hagstromerlibrary@ki.se) (Figs. 4–6).

Like Carl von Linnaeus/1707–1778, another Swedish natural scientist Retzius made systematic comparisons. In contrast to Linnaeus, who believed spermatozoa to be parasites infecting drinking water Retzius realized their importance and opened up a new field of Comparative Spermatology. His systematic work of sperm morphology had mostly phylogenetic implications and is still a unique source for future researcher. Retzius also claimed it to be necessary to study spermiogenesis in order to be able to interpret the homologies.

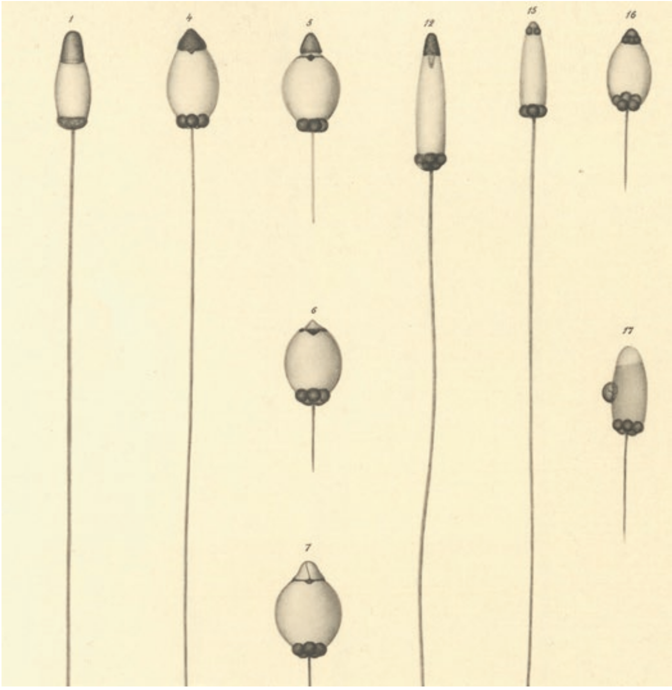


**Fig. 5** Primitive spermatozoa. Drawing by Gustaf Retzius. Photo from Biologische Untersuchungen, Neue Folge, Volume XIII : Tabloid I. Photo 2021 Anna Lantz. For further descriptions see Björn A Afzelius. Gustaf Retzius and Spermatology Int. J. Dev. Biol. 39: 675–685, 1955 and original paper in Biologische Untersuchungen, Neue Folge, hagstromerlibrary@ki.se

Retzius noted the intraspecies variation in sperm size and shape in the case of the gorilla and the gibbon, just as it had been described both by him and by others in the case of the human ejaculate (Fig. 7). The gorilla was wild and not captured in a Zoo or Circus. This inherent pleiomorphism is still of importance when discussing the possible reasons for the poor semen quality in our species.

During 40 years 1974–2016, I had the privilege to introduce physicians to be into the field of male reproductive physiology in the Gustaf Retzius Lecture Hall at the Karolinska Institute Campus in Stockholm, Sweden, with photos of his drawings of various spermatozoa on the lecture hall walls (Figs. 8 and 9).

Retzius was the pioneer that introduced the concept of the primitive spermatozoon. The functional aspects with respect to fertilization was revealed some 50 years later by his Swedish successor Åke Franzén (Fig. 10).

Åke Franzén (1925–2011) was the director of the Invertebrate Department at the Swedish Museum of Natural History, retiring from this appointment in 1991.

Franzén showed that the primitive sperm described by Gustaf Retzius (Fig. 5) was found only in such animal species, where the semen is discharged in the ambient water, usually for external fertilization. With this enlargement of the concept, emphasis shifted from phylogeny to the mode of fertilization (Fig. 11).

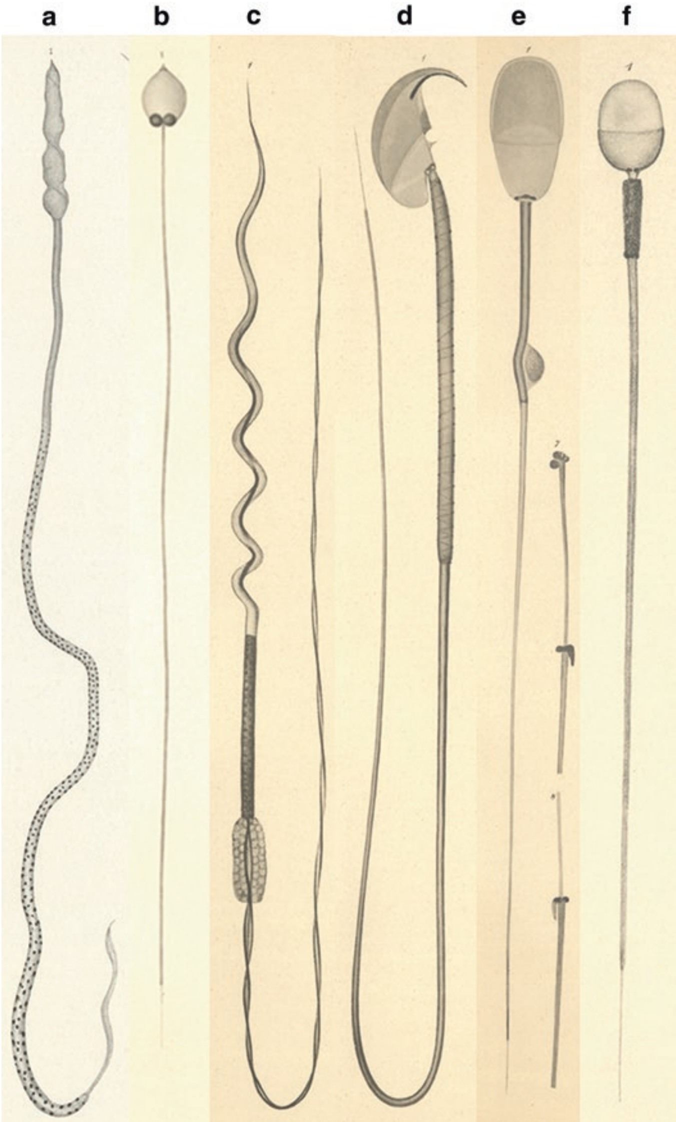



**Fig. 6** Comparative spermatology. (**a**) Flat worm Vol XII: Table XIII, (**b**) Blue Mussel Vol XI: Table X, (**c**) Thornback Ray XIV: Table XXVIII, (**d**) House mouse Vol XIV: Table XVI, (**e**) Bull Vol XIV: Table VIII, (**f**) Human Vol XIV: Table LX. Selected drawings of various spermatozoa by Gustaf Retzius. Photo and compilation from Biologische Untersuchungen, Neue Folge, Volumes XI–XIX. Photo 2021 Anna Lantz. Hagstromer Library Karolinska Institutet, Stockholm, Sweden. For further descriptions see Björn A Afzelius. Gustaf Retzius and Spermatology Int. J. Dev. Biol. 39: 675–685, 1955 and original paper in Biologische Untersuchungen, Neue Folge hagstromerlibrary@ki.se

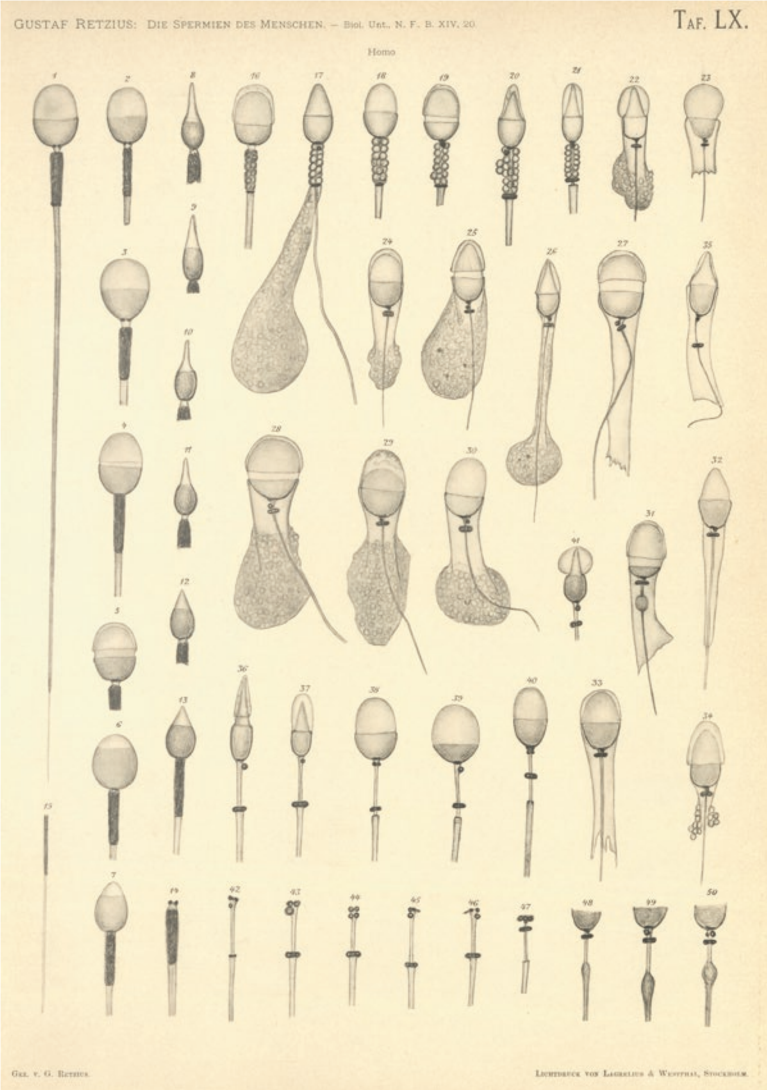



**Fig. 7** The Pleiomorphism of human spermatozoa. Drawings by Gustaf Retzius. Photo from Biologische Untersuchungen, Neue Folge, Volumes XIV: Table LX. Photo 2021 Anna Lantz**.** For further descriptions, see Björn A Afzelius. Gustaf Retzius and Spermatology Int. J. Dev. Biol. 39: 675–685, 1955 and original paper in Biologische Untersuchungen, Neue Folge, hagstromerlibrary@ki.se

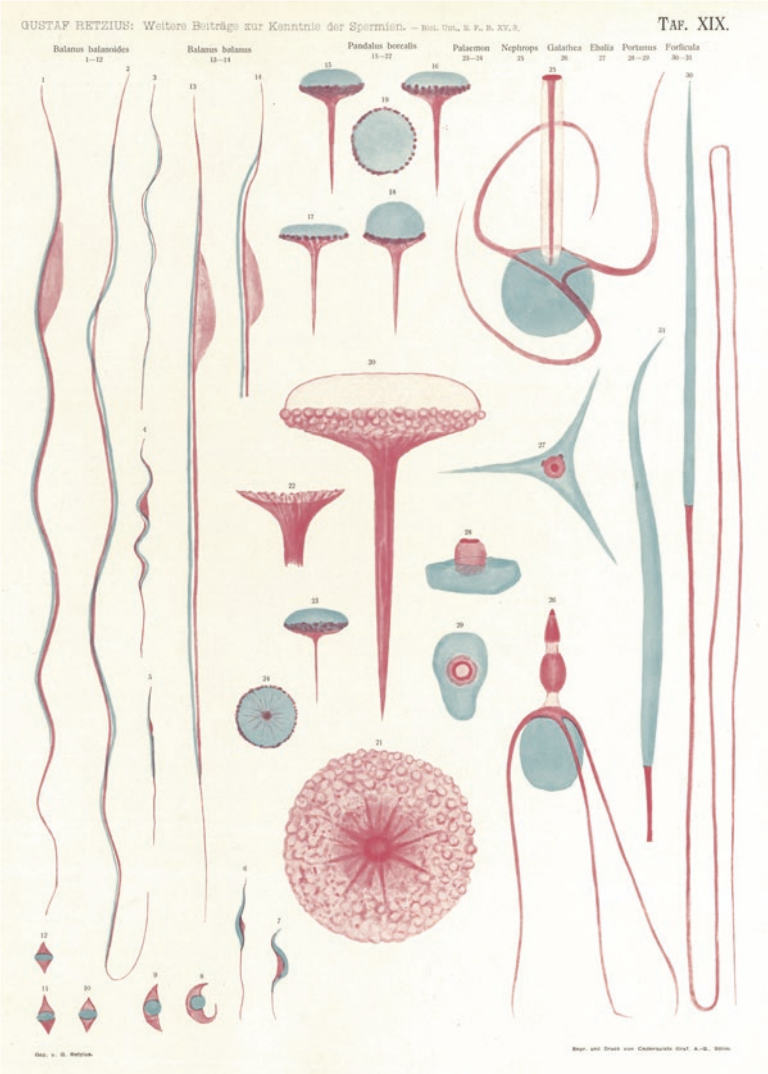


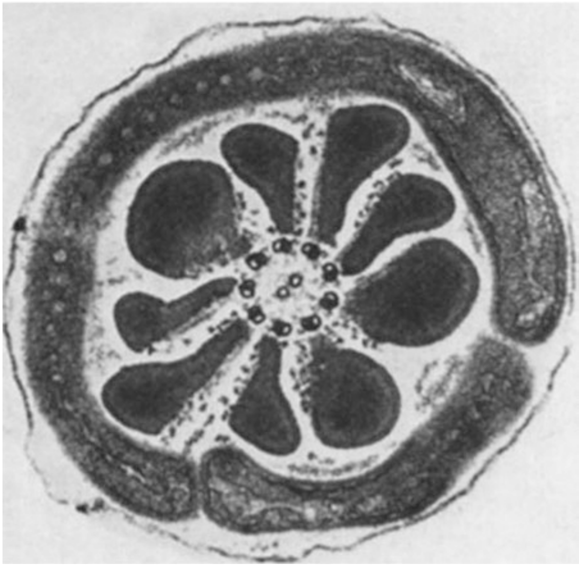

**Fig. 8** Original of Wall Photo in Retzius Lecture Hall (Fig. 9 below) at the Karolinska Institute Campus, Stockholm, Sweden. Lecture hall for teaching Male reproductive Physiology by Kvist 1970–2016. Photo 2021 Anna Lantz, hagstromerlibrary@ki.se

Franzén pointed out the differences between sperm evolved from external to internal fertilization. At external fertilizing sperm has a small spherical head, large acrosome, a small midpiece with 4–5 mitochondria and a simple tail with a 9 + 2 axoneme. This is in contrast to sperm of internal fertilizing species which have evolved to be more complex with an elongated head, extended midpiece with many mitochondria and with nine solid outer fibres around the axoneme forming a 9 + 9 + 2 pattern (Fig. 11). This complex sperm could meet the challenge of elastic

**Fig. 9** Retzius Lecture Hall at the Karolinska Institute Campus, Stockholm, Sweden. Lecture hall for teaching Male reproductive Physiology by Kvist 1970–2016

**Fig. 10** Åke Franzén 1925–2011

**Fig. 11** Electron microscopy section of Sperm tail illustrating Franzéns concept of the 9 + 9 + 2 pattern of the sperm tail organization



forces encountered during motility and endure the structural integrity in the viscous media of an internal fertilization environment.

Franzén used the phase contrast microscopy and later also the transmission electron microscopy. In 1955/1956, two notable research papers appeared in a study of some 200 mainly marine invertebrate species (internal and external fertilizers) where he showed that the fertilization environment was evolutionary very important to shape sperm form and Franzén (1955, 1956).

He continued to published his observations on sperm structure from 1956 to 2002 (van der Horst 2018).

Åke Franzén showed that sperm morphology and ultrastructure can serve as a guide to phylogenetic relationships (Franzén 1956). This inspired further phylogenetic research by Afzelius, Baccetti, Cummins, Dallai, and Jamieson (Cummins 1983).

**Björn Afzelius** (1925–2008) was professor in biological ultrastructure research at Stockholm University (Fig. 12).

In the 1950s, Björn Afzelius realized that microtubules effected flagellar motion by sliding past one another (Fig. 13).

In 1976, he described the human syndrome with immotile cilia due to loss of dynein arms and situs inversus (Afzelius et al. 1975).

Björn Afzelius wrote in 1967 a popular Swedish textbook called “Cellen”—the Cell—that has inspired many young students including myself. The Cell was translated into many languages. At 17 years, I was fascinated by the chapter “About mitochondria” and became eager to learn more—I turned the page and was immediately blessed! The next chapter was of course named “More about mitochondria”.

At my dissertation party Björn had my mum at the table, an experience she never stopped talking about and with concern to locomotion, he danced all evening.

Björn encouraged and supported many young researchers, among them myself and Lars Björndahl to focus on Spermatology and facilitated us to take part in the International Symposia on Spermatology.

When I presented my interest in the sperm head chromatin and role of zinc, he smiled and said, “I think the tail is the most interesting part of the sperm—the head is just the passenger”.

Björn made it possible for Björndahl and me to study zinc in sperm head in individual spermatozoa with Gottfried Roomans (Kvist et al. 1988; Kvist et al. 1980).

## Lennart Nicander

Lennart Nicander was professor in Anatomy and Histology at the Swedish University of Agricultural Sciences 1958–1979.

I first met him at the Spermatology meeting in Seillac 1982. He was then professor in Anatomy and Histology at the veterinary university of Norway. His

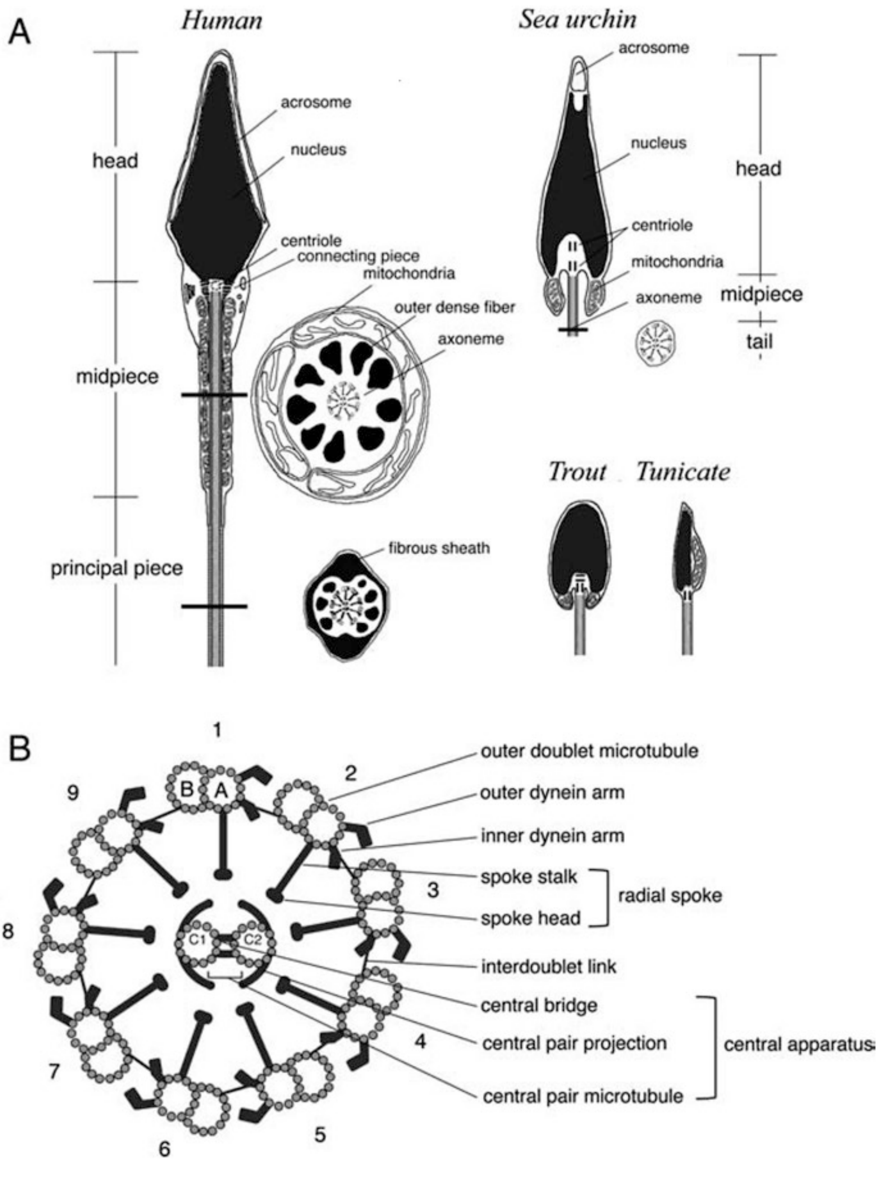



**Fig. 12** Sperm tail organization illustrating Afzelius concept of dynein arms as essential for tail movement. Internal structure of sperm flagella. (**a**) Comparison of human sperm flagella and primitive sperm flagella. In human sperm, the axoneme is surrounded by ODFs, mitochondria, and plasma membrane, whereas in the principal piece, it is surrounded by ODF, an FS, and a plasma membrane. In sperm from sea urchins, tunicates, and teleosts, the axonemes are simply surrounded by a plasma membrane. (**b**) Substructures comprising flagellar axonemes. Axonemal structures are well conserved among invertebrates, lower vertebrates, and mammals. Figure 12 is reproduced with kind permission from professor Kazuo Inaba University of Tsukuba, Shimoda Marine Research Center. Zoolog. Sci. 2003 Sep;20(9):1043–56. https://doi.org/10.2108/zsj.20.1043

**Fig. 13** Björn Afzelius 1925–2008

encouragement to my findings on sperm chromatin presented in Seillac never to be forgotten.

He contributed to our understanding of the functional organization of the epididymis and the Blood–testis barriers (Nicander 1967; Plöen and Setchell 1992).

## Leif Plöen 1941–2003

Leif Plöen worked at the Department of Anatomy and Histology at the Swedish University of Agricultural Sciences in Stockholm and Uppsala, Sweden.

His supervisor was Lennart Nicander. Leif Plöen investigated the ultrastructure of spermatogenesis in the rabbit and he developed experimental models for cryptorchidism (Plöen 1972).

He succeeded Lennart Nicander as professor in Anatomy and Histology in 1979 and made important clinical contributions concerning testicular ultrastructure and methods for diagnostic testicular investigations.

I first met Leif Plöen 1980 as the opponent on my thesis On the sperm chromatin decondensation ability (Kvist 1980), and 6 years later he returned to Karolinska as Björndahls opponent (Björndahl 1986) (Fig. 14).

Plöen made possible for Andrology at the Karolinska Institutet and Karolinska University Hospital to run comparative research with the Swedish Veterinary University in Uppsala Sweden (Rodriguez-Martinez et al. 1990; Rosenlund et al. 1998, 2001) concerning spermatogenesis, spermatology and sperm chromatin organization (Fig. 15).

**Fig. 14** Leif Plöen 1941–2003

**Fig. 15** Opponent and respondent 1980. Leif Plöen and Ulrik Kvist at the Dissertation Celebration Party

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