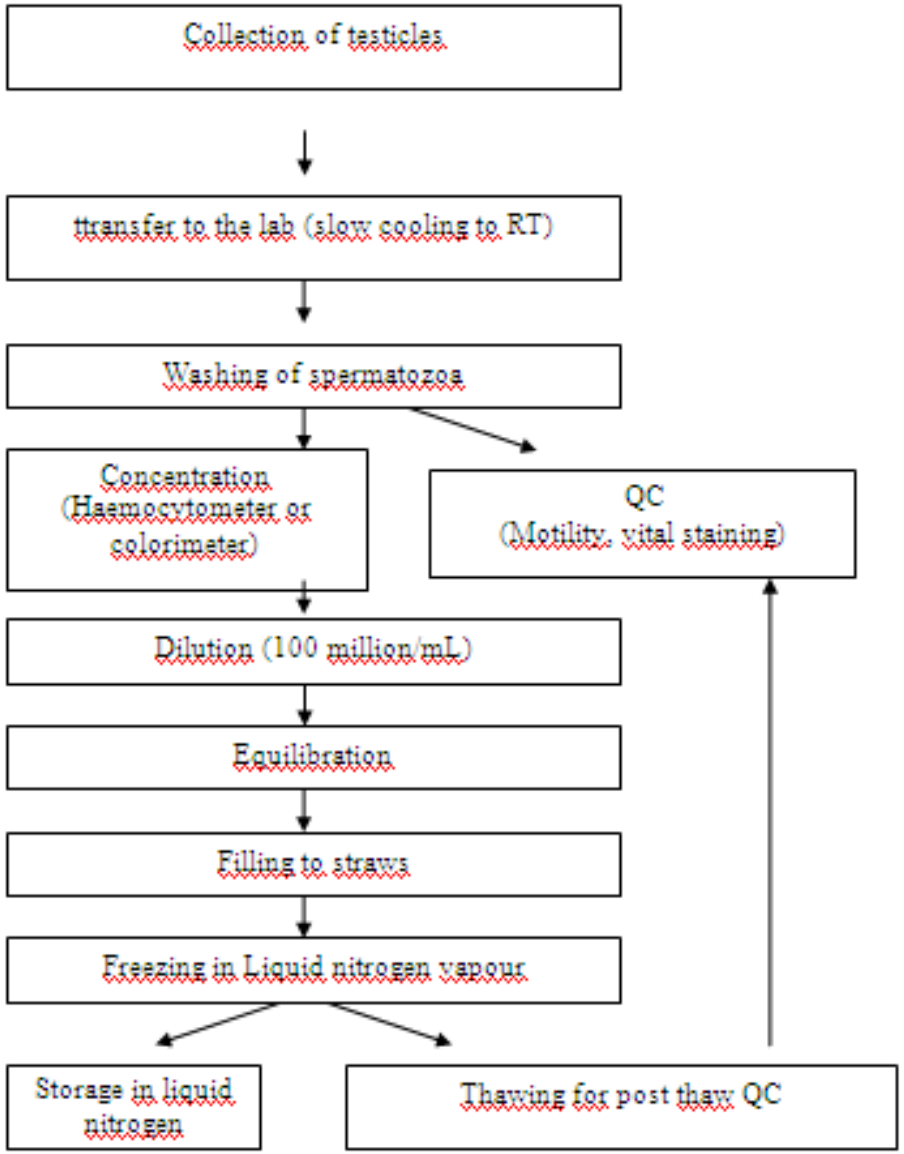
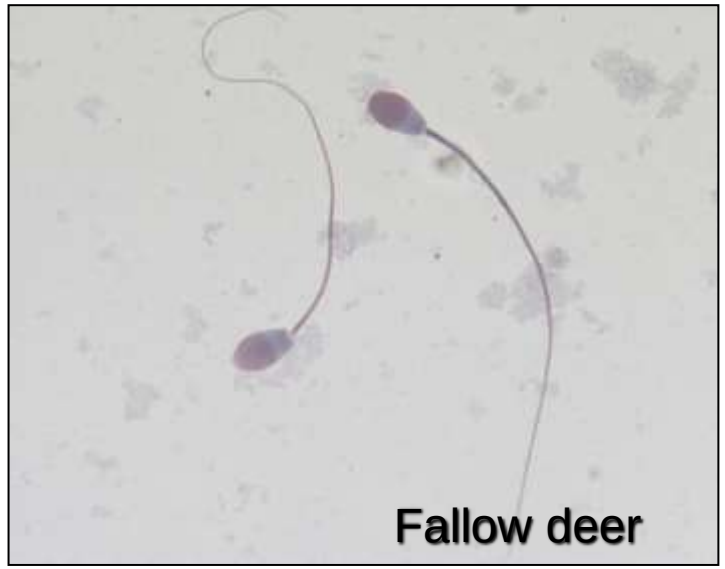
Reindeer - application of Assisted Reproductive Technologies (ART) for *in vitro* gene conservation

Szabolcs T. Nagy

Hungarian University of Agriculture and Life Sciences
Georgikon Faculty
Institute of Animal Sciences
Keszthely
Hungary

CRYOPRESERVATION FLOWCHART





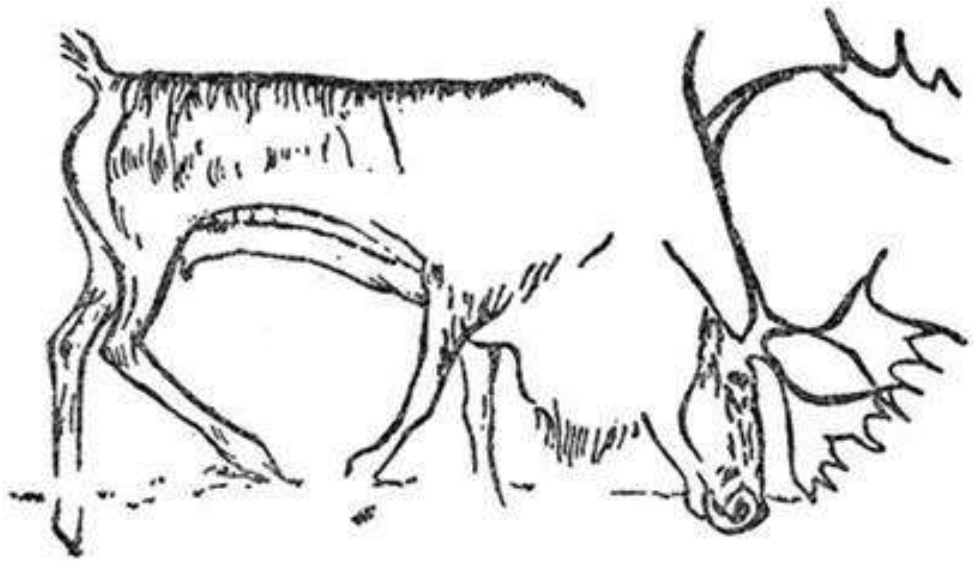
Z. Zomborszky, Sz. Nagy, L. Nánássy, M. Szabari, Sz. Bodó:
Experiences in deer sperm cryopreservation under practical conditions
a pilot study
Animal Reproduction Science, 2005, 90 (1-2): 185-190.

Adapting the experiences…

Argali sperm collection, Mongolia

Kovács A., Tumennasan, Kh., Demberel, Sh., Nagy Sz., Kútvölgyi G., Oláh J., Jávor A.: Cryopreservation of Argali spermatozoa
Hung Vet J, 2007, 129(5):306-309.

ERASMUS TRIPS, LAPIN AMK, 2013 - 2016



Time travel…

Left: Kesslerloch, Switzerland, Magdalenian culture, about 16 000 -14 000 BP.
Right: own photo, East Lapland, 2016.

NordForsk-funded project *ReiGN* in Russia

AIMS

- Reindeer sperm collection for basic spermatology studies and cryopreservation

  - Applied:
    - Sperm collection and cryopreservation
  - Basic questions:
    - Anatomy:
      - Glands?
      - „Honey fraction”?
      - *Uterus masculinus*?
    - Postcopulatory sperm competition?


Porotutkimusasema
Boazodutkanstašuvdna
Reindeer Research Station

2017 - 2019

Journal of Zoology | ZSL LET'S WORK FOR WILDLIFE

The collection and examination of semen of the Reindeer (Rangifer tarandus)

H. M. Dott, M. N. P. Utsi

First published: August 1971 | https://doi.org/10.1111/j.1469-7998.1971.tb01325.x | Citations: 11

H. M. Dott
Agricultural Research Council, Unit of Reproductive Physiology and Biochemistry, 307 Huntingdon Road, Cambridge

M. N. P. Utsi
Reindeer Council of the United Kingdom, Cambridge

Journal of Zoology | ZSL LET'S WORK FOR WILDLIFE

Artificial insemination of Reindeer (*Ragifer tarandus*)

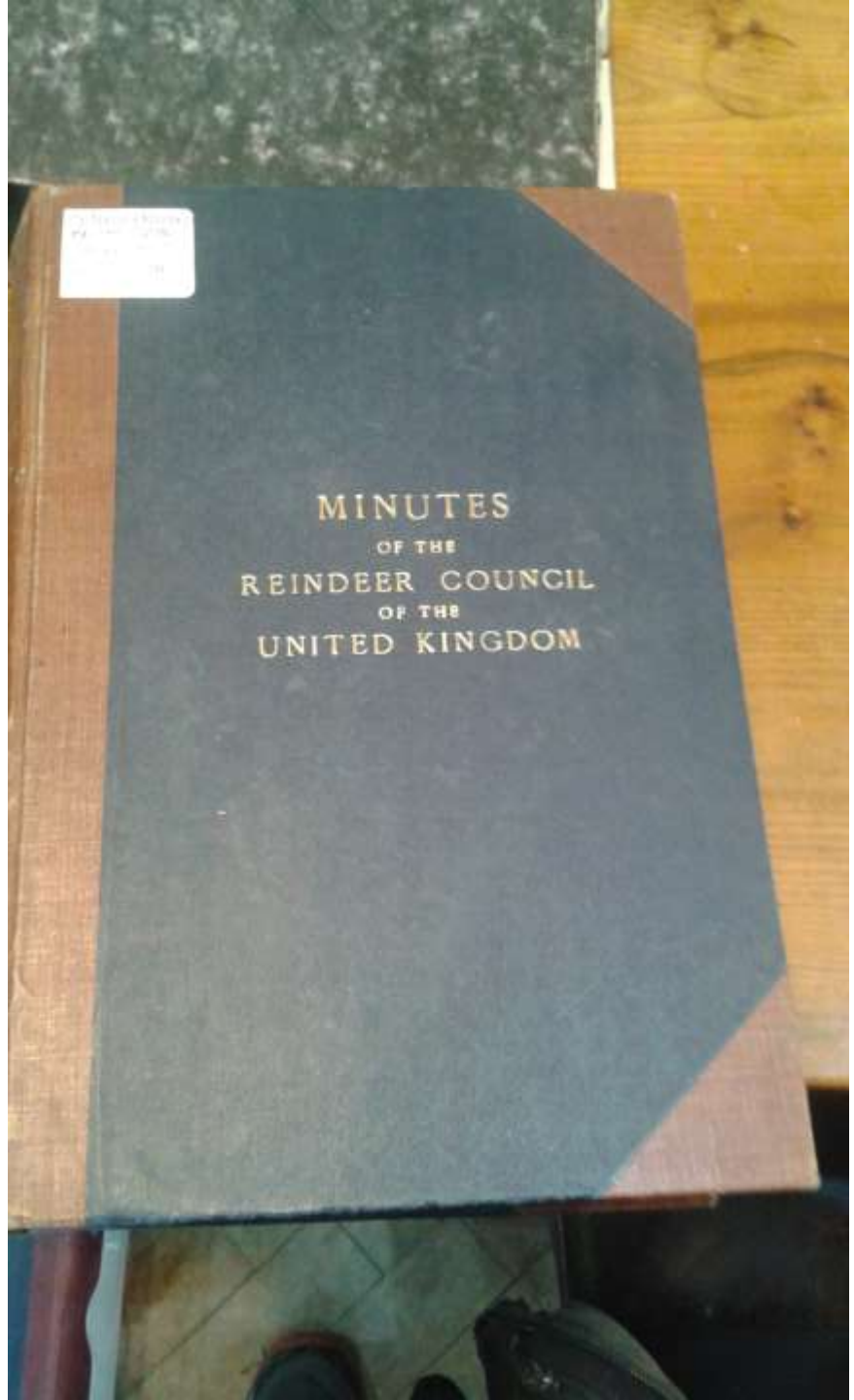
H. M. Dott, M. N. P. Utsi

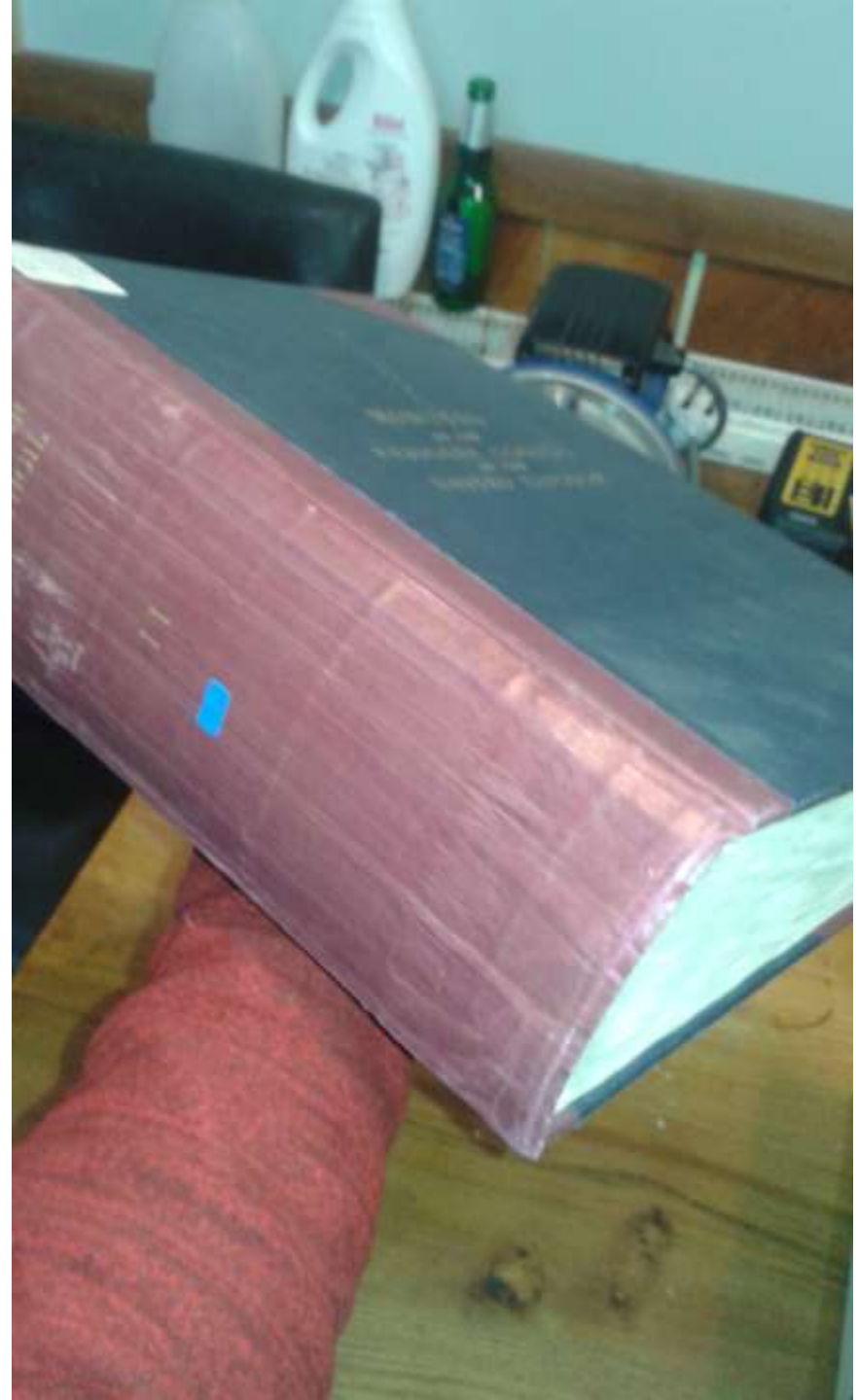
First published: August 1973 | https://doi.org/10.1111/j.1469-7998.1973.tb05065.x | Citations: 17

Epididymal sperm collection? How?
Frozen-thawed semen – success or failure?

Mikel Utsi, 1908 - 1979


THE CAIRNGORM
REINDEER CENTRE
REINDEER SHOP
& EXHIBITION
DAILY GUIDED TOURS
COACHES WELCOME


MINUTES
OF THE
REINDEER COUNCIL
OF THE
UNITED KINGDOM



Findings:

- Birth of one calf after AI with frozen-thawed semen in 1973 – **Thor**, born on the 13th of May 1973, died on the 24th of May 1973 by drowning in a waterhole.
- "Nine reindeer cows were artificially inseminated in October 1974, five with frozen pellets from Smoky, three with pellets from Henri (originally frozen in 1972) and one with pellets rom Kim. Eight came back to oestrus again, but Gay, inseminated with pellets from Smoky, did not and may be pregnant."
- Gay did calve in 1975, a calf called **Donner**
- „As for the fate of Donner, he certainly grew to be a healthy reindeer but not a bull. He was castrated at 2.5 years old in September 1977 and not used to breeding. Remarkably he then went on to live until July 1989, quite some age.”

Findings:

- Epididymal sperm collection: peristaltic pump (Granville Foster)

J. Reprod. Fert. (1979) **55**, 113–124

The maintenance of motility and the surface properties of epididymal spermatozoa from bull, rabbit and ram in homologous seminal and epididymal plasma

H. M. Dott, R. A. P. Harrison and G. C. A. Foster

A.R.C. Institute of Animal Physiology, Animal Research Station, 307 Huntingdon Road, Cambridge CB3 0JQ, U.K.

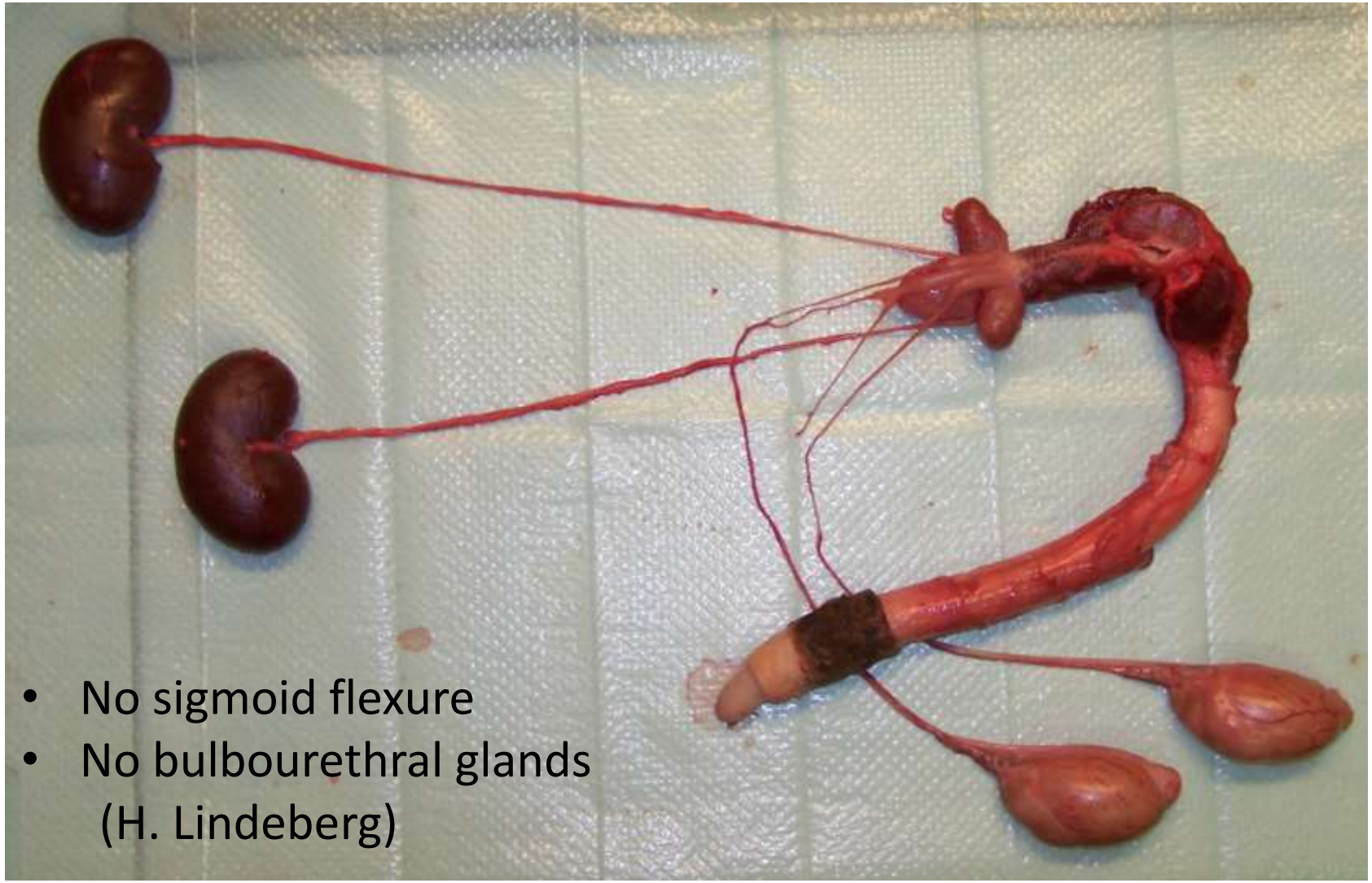
https://www.cairngormreindeer.co.uk/

Materials & methods

- Reproductive organs collected at a commercial slaughterhouse
- *post mortem* sperm collection
- 2018: 6
- 2019: 8

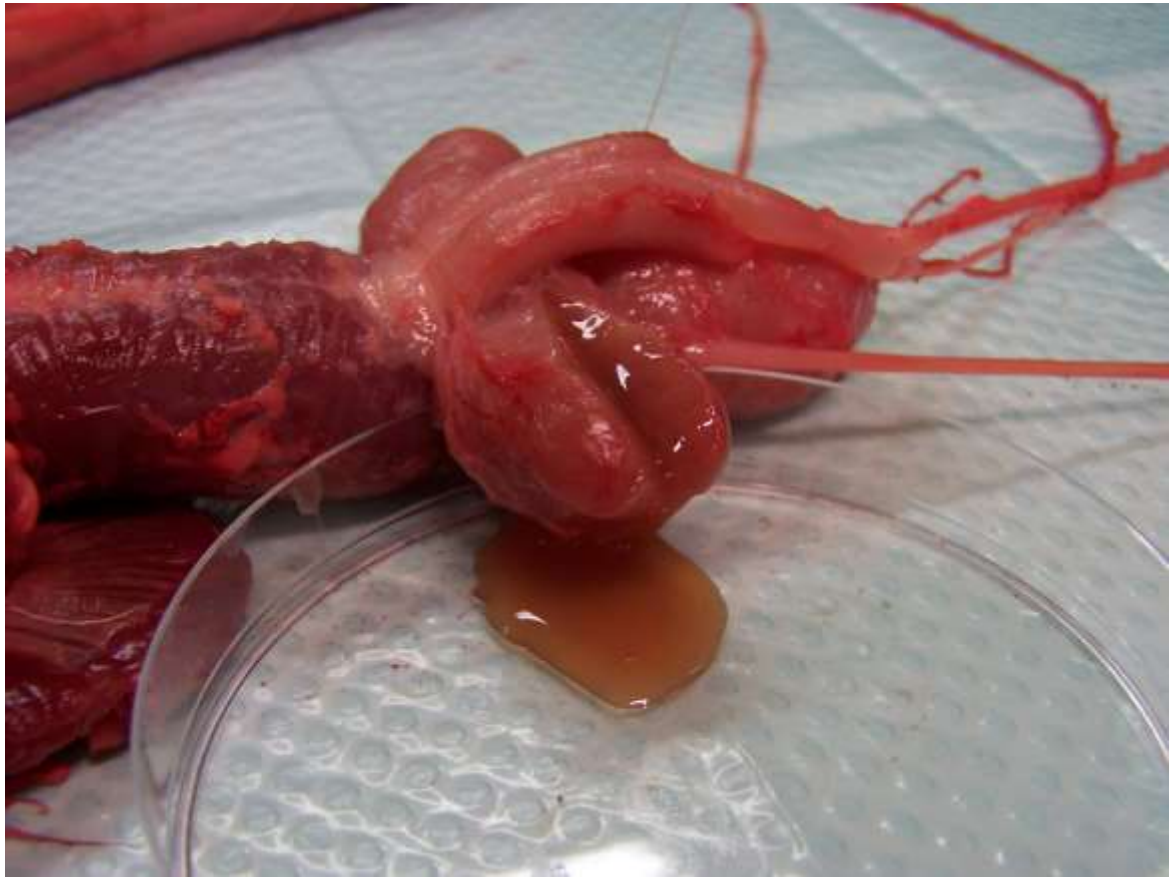
RESULTS 1. – cryopreservation

RESULTS 2. - anatomy



- No sigmoid flexure
- No bulbourethral glands
  (H. Lindeberg)

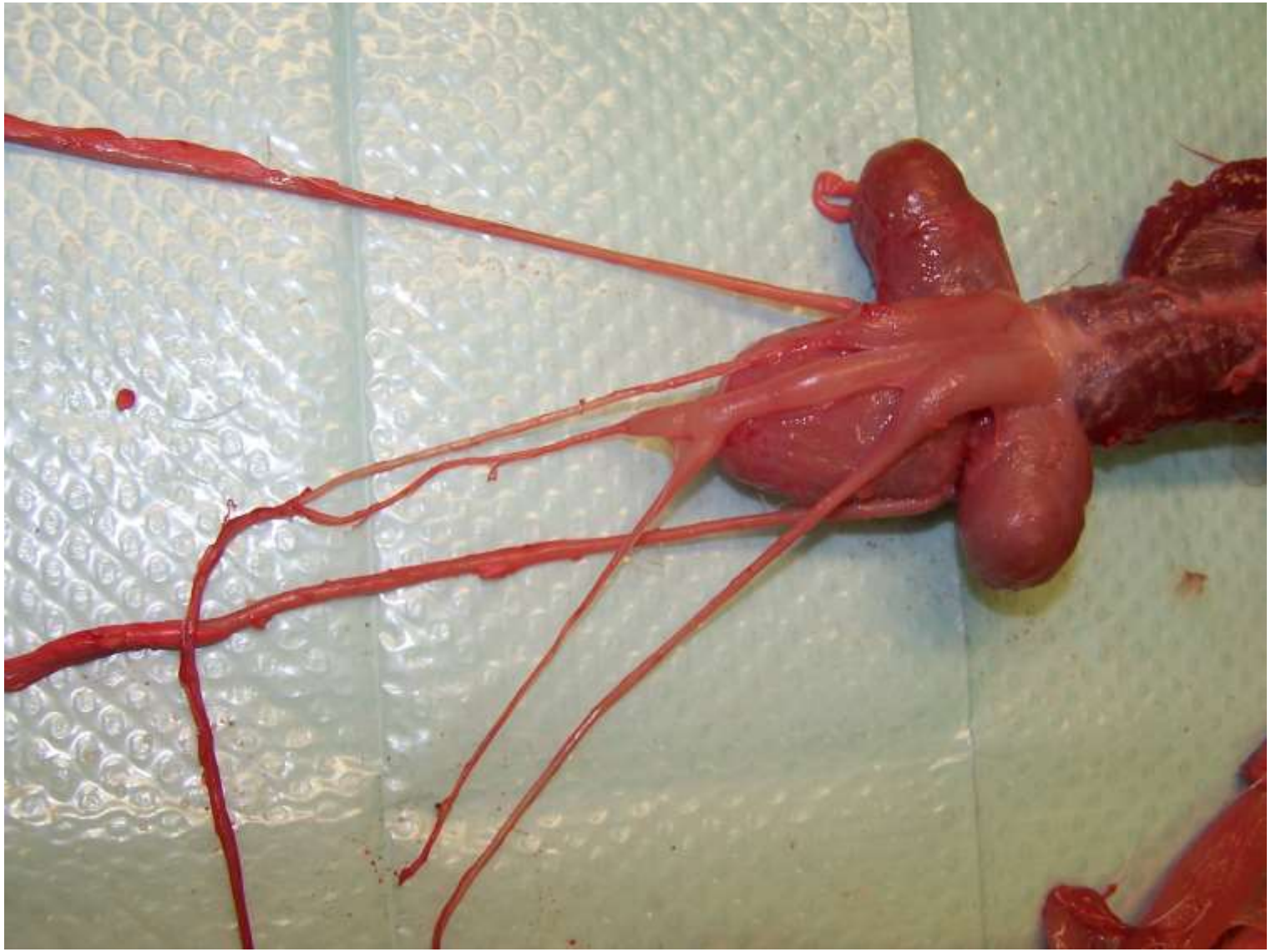
RESULTS 3. – „honey fraction”



„Honey fraction” from seminal vesicle

RESULTS 4. – *uterus masculinus*

- 6/6!
- 8/8!



Uterus masculinus in reindeer?

H. Lindeberg, personal observation

Uterus masculinus in reindeer?

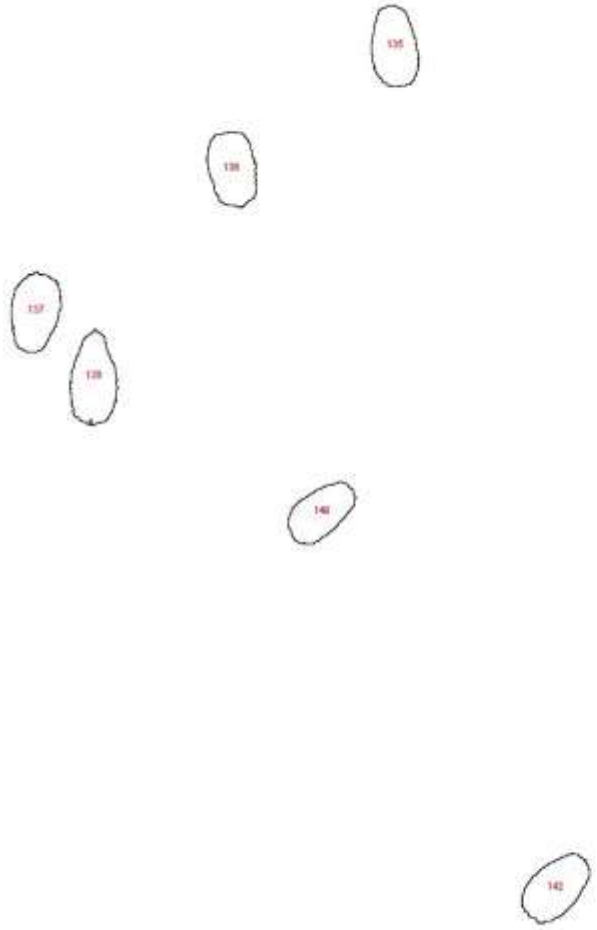
The Comparative Anatomy of the Accessory Sexual Glands.

By KENNETH WALKER, F.R.C.S.

Cervus tarandus. — An interesting point in the deer family is the great development of the uterus masculinus. Not only is the uterus reproduced, but the Fallopian tubes are represented by two cornua suspended in the mesentery between the converging vasa deferentia.

International Journal of Social Psychiatry. 1922;15(Sect_Urol):17-23.
doi:10.1177/002076406601200102

RESULTS 5. – sperm head morphometry



ImageJ sperm head area measurement

Head area measurements of dead, live, X- and Y-bearing bovine spermatozoa.
Révay T, Nagy S, Kovács A, Edvi ME, Hidas A, Rens W, Gustavsson I.
Reprod Fertil Dev. 2004;16(7):681-7.

Intramale variance (CV%):

A	14,13
B	10,19
C	13,1
D	18,55
E	9,55
F	12,23
mean	12,96
SD	3,24

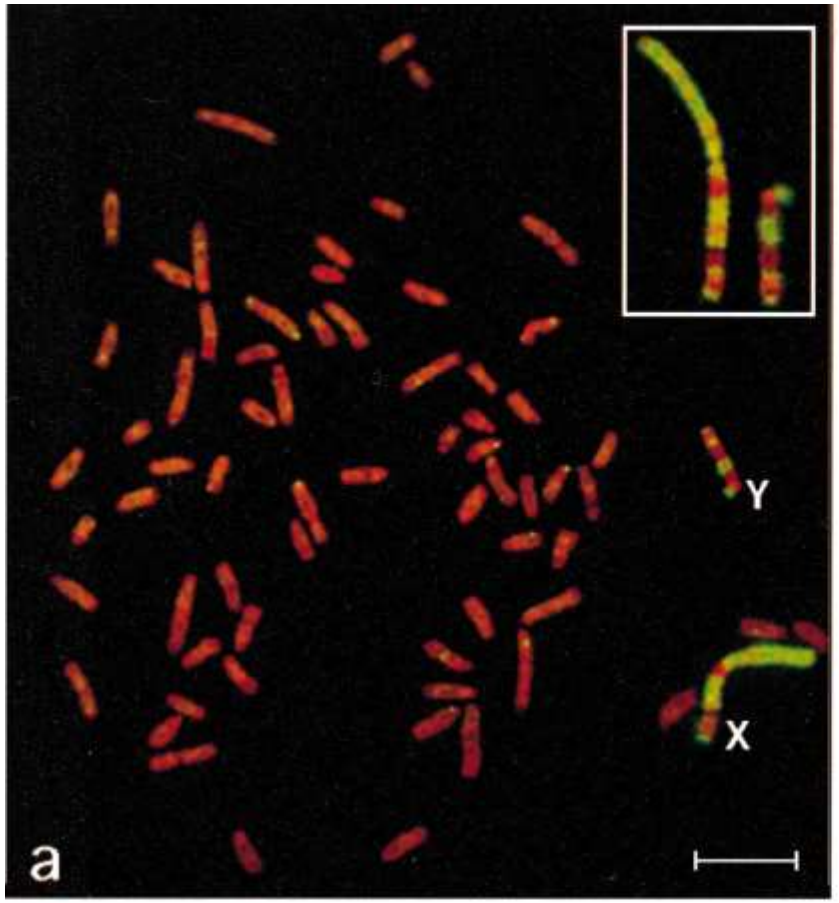
Intramale variation in sperm size: functional significance in a polygynous mammal.
Ros-Santaella JL, Pintus E, Garde JJ.
PeerJ. 2015 Dec 8;3:e1478. doi: 10.7717/peerj.1478. eCollection 2015.

Table 1 Sperm parameters in red deer ($N = 17$).

Assessed parameters	Mean ± SD	Range (min-max)
Sperm kinetics, morphology, and sperm number		
VAP (μm/s)	104.24 ± 9.95	86.73–119.71
VCL (μm/s)	154.41 ± 14.60	129.19–179.14
VSL (μm/s)	73.03 ± 11.81	53.45–93.53
Progressive motility (%)	34.43 ± 10.41	19.11–55.93
Normal morphology (%)	86.50 ± 7.00	74.00–97.00
Sperm number (10^6)	1,208.51 ± 473.34	278.83–1,889.47
Intramale CV in sperm morphometry (%)		
Head width	3.37 ± 0.54	2.48–4.65
Head length	2.92 ± 0.51	2.12–3.99
Head area	4.56 ± 0.78	3.36–5.80
Head perimeter	2.31 ± 0.44	1.56–3.06
Head ellipticity (length/width)	4.34 ± 0.69	3.45–6.21
Sperm length	1.31 ± 0.38	0.88–2.16
Flagellum length	1.33 ± 0.41	0.91–2.38
Midpiece length	2.47 ± 0.53	1.92–3.74
Principal plus terminal piece length	1.76 ± 0.50	1.26–2.91

Notes.
VAP, average path velocity; VCL, curvilinear velocity; VSL, straight linear velocity; SD, standard deviation; CV, coefficient of variation.

X-Y sex chromosome difference?



Chromosoma. 1998 Mar;107(1):61-9.
Defining the anatomy of the Rangifer tarandus sex chromosomes.
Lee C[1], Griffin DK, O'Brien PC, Yang F, Lin CC, Ferguson-Smith MA.

CONCLUSIONS

- Successful *post mortem* sperm collection and cryopreservation with a simple protocol
- No bulbourethral glands
- *Uterus masculinus* in every male – role?
- „Honey fraction” in seminal vesicle
- large intramale variation in sperm head size - less intensive postcopulatory sexual selection? – XY difference?

ELSEVIER

Animal Reproduction Science 60–61 (2000) 561–570

ANIMAL REPRODUCTION SCIENCE

www.elsevier.com/locate/anireprosci

Reproduction in female reindeer

E. Ropstad *

Department of Reproduction and Forensic Medicine, Norwegian School of Veterinary Science, P.O. Box 8146, Dep., N-0033 Oslo, Norway

Animal Reproduction Science 227 (2021) 106722

Contents lists available at ScienceDirect

Animal Reproduction Science

journal homepage: www.elsevier.com/locate/anireprosci

Review article

Reproduction of male reindeer (*Rangifer tarandus*)

Sz. Nagy [a,*], H. Lindeberg [b], E. Nikitkina [c], A. Krutikova [c], E. Smith [d], J. Kumpula [e], Ø. Holand [f]

[a] *Hungarian University of Agriculture and Life Sciences, Institute of Animal Sciences, Georgikon Campus, H-8360, Keszthely, Deak F. u. 16., Hungary*
[b] *Natural Resources Institute Finland (LUKE), Production Systems, Halolantie 31 A, FIN-71750, Maaninka, Finland*
[c] *Russian Research Institute of Farm Animal Genetics and Breeding — Branch of the L.K. Ernst Federal Science Center for Animal Husbandry, 196601, Moscowskoye sh 55a, St. Petersburg, Russian Federation*
[d] *Cairngorm Reindeer Herd, Reindeer House, Glenmore, Aviemore, PH22 1QU, United Kingdom*
[e] *Natural Resources Institute of Finland (LUKE), Terrestrial Populations Dynamics group, Saarikoskentie 8, 99870, Inari, Finland*
[f] *Norwegian University of Life Sciences, Faculty of Life Sciences, P.O Box 5025, N-1432 Ås, Norway*

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Review article

Potential applications of assisted reproductive technologies (ART) in reindeer (*Rangifer tarandus*)

H. Lindeberg [a,*], E. Nikitkina [b], Sz. Nagy [c], A. Musidray [b], G. Shiryaev [b], J. Kumpula [d], Ø. Holand [e]

[a] *Natural Resources Institute Finland (Luke), Production Systems, Halolantie 31 A, FI-71750 Maaninka, Finland*
[b] *Russian Research Institute of Farm Animal Genetics and Breeding, Branch of the L.K. Ernst Federal Science Center for Animal Husbandry, 196601, Moscowskoye sh 55a, St. Petersburg, Russian Federation*
[c] *Hungarian University of Agriculture and Life Sciences, Institute of Animal Sciences, Georgikon Campus, H-8360 Keszthely, Deak F. u. 16., Hungary*
[d] *Natural Resources Institute Finland (Luke), Terrestrial Populations Dynamics, Saarikoskentie 8, FI-99870 Inari, Finland*
[e] *Norwegian University of Life Sciences, Faculty of Life Sciences, P.O Box 5025, N-1432 Ås, Norway*

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V. Maijala

T. Smith

THANK YOU!