

Growth of wild muskoxen under two nutritional regimes in Greenland

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Abstract: Growth of muskoxen in Jameson Land, East Greenland (EG) and in Angujaartorfiup Nunaa, West Greenland (WG) is affected by the different nutritional conditions in the two areas. The abundance and availability of forage plants is highest in WG. Muskoxen in WG reach sexual maturity one year earlier than muskoxen in EG. A significant proportion of female muskoxen in WG conceive at the age of 16 months and give birth to their first calf as two years olds. The horn bases of the muskox bulls in WG are fully developed during their third year of life, but their maximum body weight (BW) is attained at the age of six. Average BW of adult bulls (4 yr+) in WG is 306 kg which is 23 % greater than in adult bulls in EG. BW is seasonally more variable in EG than in WG owing to greater seasonal fluctuation in food supply.

Key words: Muskox, nutrition

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Introduction

Growth and sexual development in muskoxen has been studied by Frisby *et al.* (1984), Latour (1987), Thing *et al.* (1987), Chaplin & Stevens (1989), and White *et al.* (1989). Sex and age classification of muskoxen has been described by Allen (1913); Tener (1965); Henrichsen & Grue (1980); Olesen & Thing (1989). Few data are available on growth rate in wild muskoxen in relation to pasture quality, although there is evidence for strong connection between the two factors in other species of wild ungulates (Klein 1964; Klein & Strandgaard, 1972) and domestic animals. The aim of this study was to measure body growth and sexual development

in musk-oxen from two populations in Greenland. We assumed that differences in growth between the two populations were due to differences in nutritional regimes.

Study area

The two study areas were Angujaartorfiup Nunaa, (6,600 km²) an inland area (66°15' N-67°N) south of Kangerlussuaq in West Greenland (WG) and Jameson Land, (11,000 km²) (70°26' N-71°57' N) on the north side of Scoresby Sund fiord in East Greenland (EG) (Fig. 1). The muskox population in EG is indigenous. The population in WG was established in the mid 1960's when 27 juvenile muskoxen were

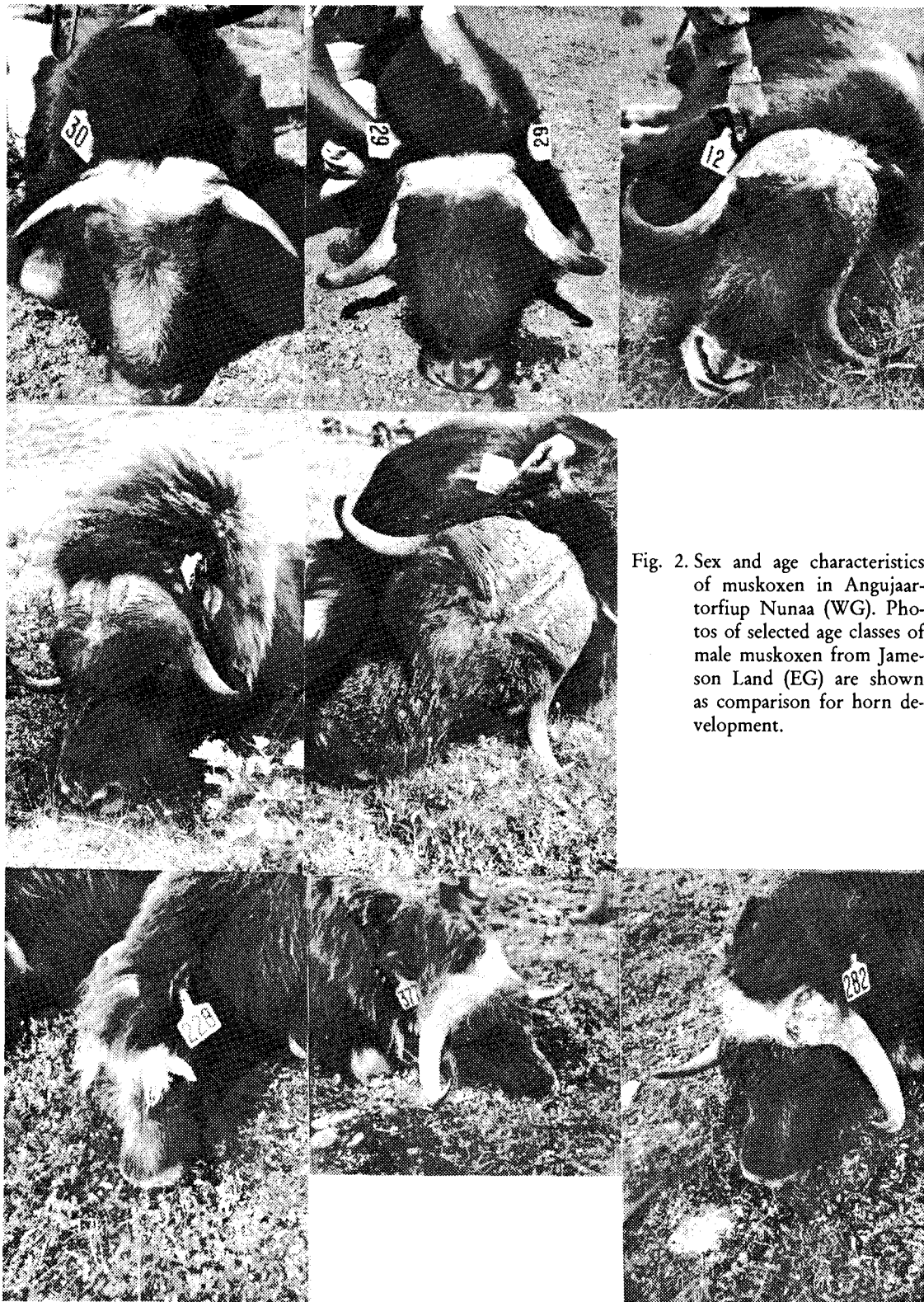
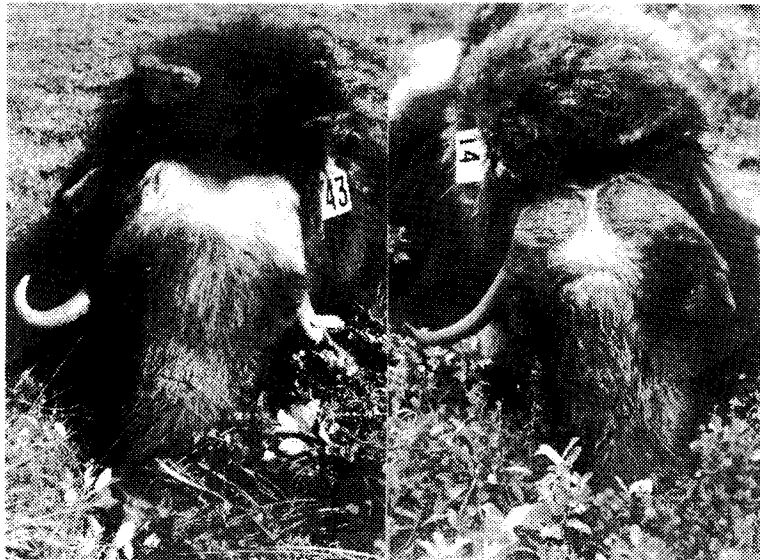


Fig. 2. Sex and age characteristics of muskoxen in Angujaartorfiup Nunaa (WG). Photos of selected age classes of male muskoxen from Jameson Land (EG) are shown as comparison for horn development.



- no. 30 ♂♂ 14 months WG
- no. 29 ♂♂ 26 months WG
- no. 12 ♂♂ 38 months WG
- no. 9 ♂♂ 50 months WG
- no. 19 ♂♂ >62 months WG

- no. 228 ♂♂ 14 months EG
- no. 377 ♂♂ 38 months EG
- no. 282 ♂♂ 38 months EG

- no. 34 ♀♀ 14 months WG
- no. 17 ♀♀ 26 months WG
- no. 31 ♀♀ 38 months WG
- no. 43 ♀♀ >=50 months WG
- no. 14 ♀♀ >=10 years WG

translocated from Scoresby Sund. The EG population was 3,300 animals in 1990 and is believed to be stable; the WG population numbered 2,600 in April 1991 and is increasing (Boertmann *et al.*, 1991). The mean annual precipitation in EG is approximately four times greater than in WG and there is usually deep snow on ground below 300 m a.s.l. in winter. Daily mean temperatures in EG exceed 0°C in only 3 months each year. WG has a dry, continental climate; annual precipitation is around 125 mm. Snow cover is not extensive and daily mean temperatures range above 0°C in about 4 months of the year (Thing, 1984; Langager, 1990).

Vegetation is generally more prolific in WG (Olesen 1990) compared to EG (Thing *et al.*, 1987), particularly with respect to graminoid habitats (meadow, moist grassland, and steppe) and the availability of food in winter is much better in WG where the limited snowfall allows unrestricted access to the lowland meadows and steppes in winter.

Material and methods

Data on length of mandibles, femur, horn, and total weight (BW) were collected during 1982–1986 in EG and during 1988–1991 in WG. The width of the horn bases was measured with callipers selecting the widest of the two horn ba-

Greenland

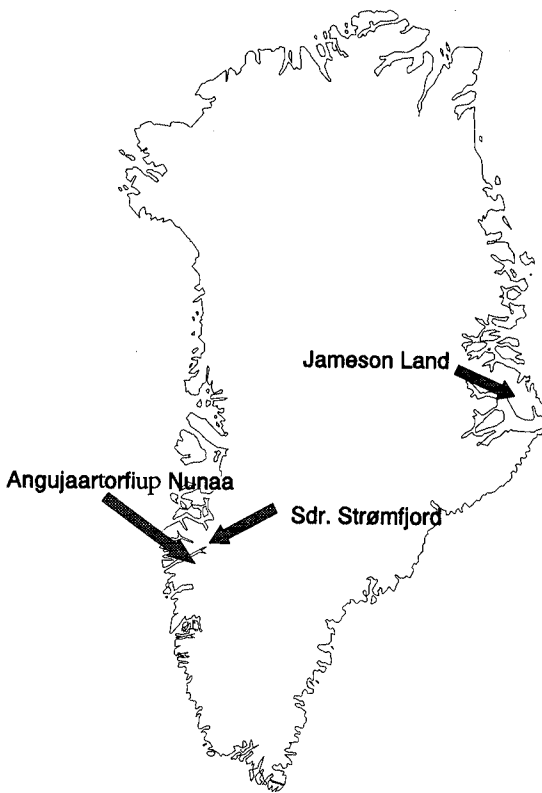


Fig. 1. Location of the two study areas in Greenland.

ses. Horn length was measured along the dorsal curve (if possible the right horn). Measurements of horns were taken at all times of the year on adult males. Mandibles and femurs (Langvatn, 1977) were collected both from carcasses found in the field and from shot animals. In March–April (late winter) 5–8 muskoxen were shot and in July–August (summer) 5–6 muskoxen were shot. Age and sex classification was based on horn development and tooth eruption according to Henrichsen & Grue (1980) and Olesen & Thing (1989). The photo documentation in Olesen & Thing (1989) and the drawings of skulls by Henrichsen & Grue (1980) were based mainly on material from populations in East Greenland and the characteristics of a 3-year-old male from this population fit very well with nos. 282 and 377 (Fig. 2) from Jameson Land. The age of animals aged ≤ 4 years was based on tooth eruption. In older animals age determination was based on counting incremental lines in the cementum of premolar teeth (pm2).

Data on total body weight were collected both from animals which were killed (males only) and from chemically immobilized animals. Animals which were killed were cut up, and weighed in the field; 2 % of the resulting body weight was added to compensate for loss of blood and other fluids. Immobilized, tagged animals were photographed to document different sex and age classes in EG in 1983–84 and in WG in 1989.

Results

Photo documentation and classification

Photo documentation of sex and age features of muskoxen showed that the difference in horn development is most pronounced for male cohorts. A 3-year old WG muskox (July) appears to have fully developed horn bases while a 3-year old EG male has not yet attained the characteristics of fully developed horns at this age. Only a limited space with white woolly hair is left between the horn bases but the medial edges are still soft and feel cartilaginous when palpated (Fig. 2, no. 12). During autumn and winter the horn bases of the 3-year-old WG male harden appearing, in late winter, as fully developed with pale horn bases. The 38 months old EG muskox bulls (Fig. 2, no. 282 and 377) have only reached a stage of horn development similar to the stage of a 26 months old WG muskox bull (Fig. 2, No. 29). The 26 months old WG males and the 38 months old EG males have both just initiated horn base development still leaving almost the whole forehead between the anteriorly curved horns covered with white woolly hair. Already at the age 141/2 month male yearlings from the two populations differ in horn development as shown in Fig 2, nos. 30 (WG) and 228 (EG).

Growth rate

An interpolated spline curve (SAS, 1988) fitted to growth data (plotted at exact dates) of male muskoxen in WG (Fig. 3) gives BW values at the exact ages of 1, 2, 3 and 4 years of 130, 200, 245 and 285 kg, respectively.

Adult muskoxen (4+years) males in WG weigh 58 kg (23 %; $p < 0.002$) more than muskoxen from EG (pooled from all seasons). The difference in average weight of male, adult muskoxen in the two populations in summer is 35 kg (12 %; $p < 0.05$) and in winter is 70 kg (32 %; $p < 0.05$). Seasonal fluctuation of BW in

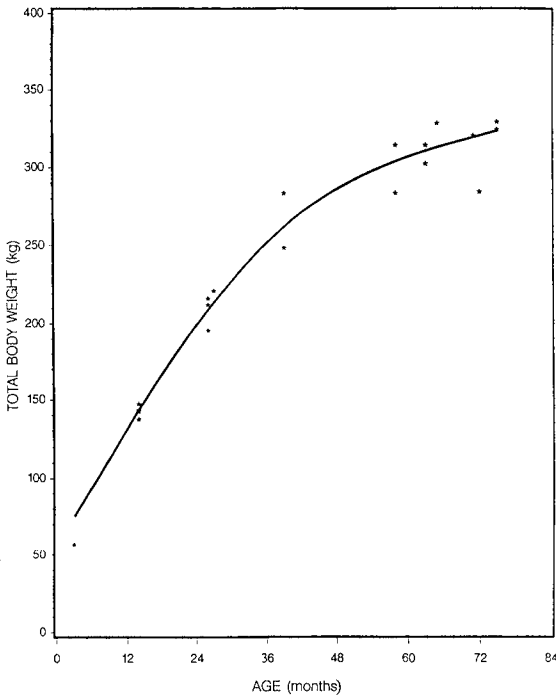


Fig. 3. Ontogeny and total body weight (BW) in male muskox in Angujaartorfiup Nunaa, West Greenland. Data were collected from immobilized animals and from animals killed 1987-1991.

Table 1. Mean body weight (BW \pm SD) in adult male (4+ years) muskoxen in Angujaartorfiup Nunaa, West Greenland (WG) and in Jameson Land, East Greenland (EG).

Population	Season	n	TBW (kg)
WG	Summer	5	321 \pm 11
EG	Summer	6	286 \pm 30 $P < 0.05$
WG	Winter	5	290 \pm 32
EG	Winter	8	220 \pm 41 $P < 0.006$

EG animals is very marked; adults weighed in average 66 kg less at the end of the winter compared to mid summer. This represents an apparent loss of 23 % of summer BW. No significant decline in mean BW during winter was evident in WG.

Mandible length

There were pronounced differences between the two populations in age-specific length of mandibles in both males and females (Figs. 4 and 5).

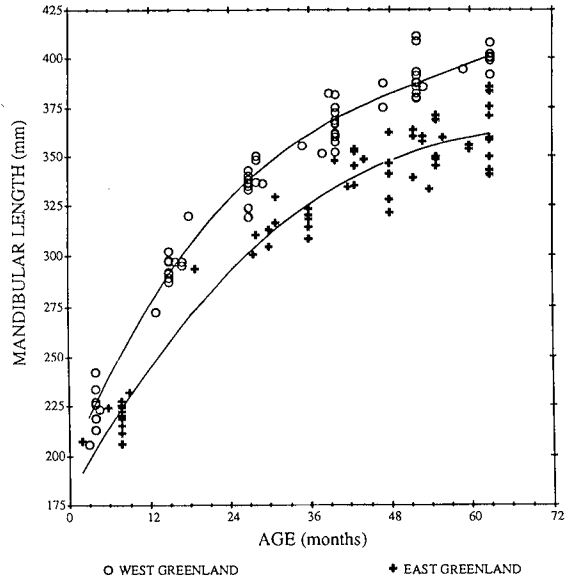


Fig. 4. Age related development in mandible length in male muskoxen in Angujaartorfiup Nunaa, West Greenland and Jameson Land, East Greenland.

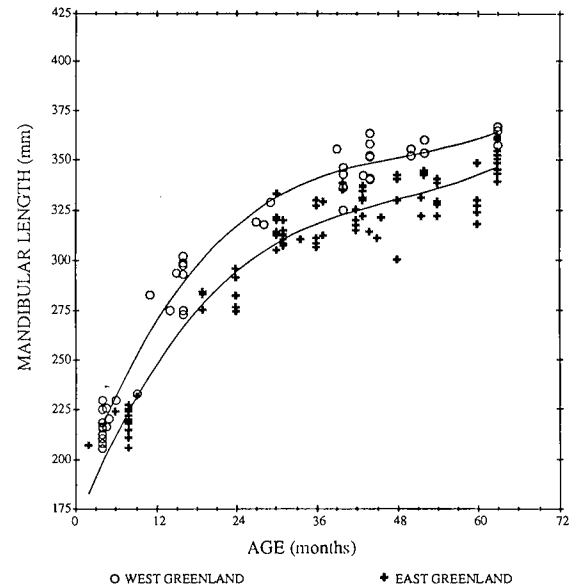


Fig. 5. Age related development in mandible length in female muskoxen in Angujaartorfiup Nunaa, West Greenland and Jameson Land, East Greenland.

Although the length of mandibles in EG varies from 344 mm to 400 mm and from 379 mm to 411 mm in WG it is evident that only a limited range overlap in mandible length of 3+ male

Table 2. Length of mandibles and femurs in adult muskoxen (4+ years) from Angujaartorfiup Nunaa, West Greenland (WG) and Jameson Land, East Greenland (EG). Mean \pm SD.

Sex	Population	n	Mandible length (mm)	n	Femur length (mm)
Males:	WG	21	394 \pm 10	12	321 \pm 11
	EG	194	377 \pm 9	29	312 \pm 6
			$P < 0.0001$		$P < 0.002$
Females:	WG	7	358 \pm 5	3	289 \pm 4
	EG	173	351 \pm 7	22	283 \pm 6
			$P < 0.008$		NS

muskoxen appears between the two populations. The mandibles of adult males in EG were on average 17 mm shorter than those of the comparable cohorts in WG (Table 2). The average difference in mandible length between the two populations is about 7 mm in females.

Growth curves for the mandibles in both males and females (Figs. 4 and 5) indicate that maximum mandibular length and TBW (Fig. 3) is reached at a minimum age of six years. Average length of mandibles of adults of both sexes is significantly higher in WG compared to EG. However, the large difference in mandible length seen among young animals becomes smaller with increasing age. At about six years of age the bulls are for the first time seen as harem bulls in the rut successfully serving the cows. This is concurrent with bulls reaching their prime physical condition.

Horn measurements

Horn measurements were collected from males only (Table 3). The mean width of horn bases in adult muskoxen from WG was 223 mm. The mean width of horn bases in adult males in EG was 183 mm. The average difference was 40 mm ($p < 0.0001$). Length of horns in muskoxen

Table 3. Width of horn base and length of horn (one side) in adult male (4+ years) Angujaartorfiup Nunaa, West Greenland (WG) and Jameson Land, East Greenland (EG). Mean \pm SD.

Population	n	Width of hornbase (mm)	n	Length of horn (mm)
WG	13	223 \pm 16	11	591 \pm 27
EG	45	183 \pm 13	44	536 \pm 25
		$P < 0.0001$		$P < 0.0001$

is a rather variable parameter. The horns are usually worn down by antagonistic behaviour and interactions during rut, reducing the horn length with increasing age over six years. Old bulls with the distal part of the horns broken or worn off are frequently seen in both populations; however, the horn length of adult bulls in WG is 591 mm which is 10 % longer ($P < 0.0001$) than in EG where the average horn length is 536 mm.

Discussion

Horn growth is a continuous process during the first years of life but occurs more rapidly in summer and in autumn compared to winter, coinciding with improved feeding conditions. Horn development was more rapid in WG compared to EG. The photo documentation of individuals from different seasons and age classes in WG and EG have made it clear that the WG population – expanding in an area with vast food resources does not follow the classifications shown by Henrichsen & Grue (1980) and Olesen & Thing (1989). Comparing No. 12 and Nos. 282 and 377 (Fig. 2) demonstrates that the vast food resources in WG make it possible for the muskox males to develop fully grown horns at an age of 3 to 3 1/2 years while the EG muskox bulls of the same age seem almost 1 year behind. A similar difference in development is seen in females (Fig. 2, Nos. 34, 17, 31, 43 and 14).

Growth rate in male muskoxen in WG exceeds that reported from wild muskoxen on Banks Island 1981–1983 (Latour, 1987) and is comparable to growth rates seen in captive *ad lib.* fed muskoxen originating from Banks Island (Chaplin & Stevens, 1989).

Adult, male muskoxen in EG, by contrast, are smaller compared to other populations. These animals weighed in average 220 kg in late winter compared to 277 kg (May) for animals on Banks Island (Latour, 1987), 290 kg in WG males (March–May) and 347 kg in captive males (Chaplin & Stevens, 1989).

There are no data on body weight in females from either WG or EG but a 26-month-old cow (Fig. 2, no. 17) in WG was evidently lactating suggesting early onset of sexual maturity in this population. Parturient muskox aged 2 years have been reported from other wild populations with good nutritional conditions (Jingfors, 1980; Jingfors & Klein, 1982). In *ad lib.* fed muskoxen, all females (n=5) conceived at the age of 16–17 months with a BW of approximately 165 kg (Chaplin & Stevens, 1989). In EG only less than half of the 3-year-old females were parous (unpublished data).

Muskoxen show physiological adaptations towards a «grazing ecotype» (Staaland & Thing, 1991) which is very pronounced in the range of the WG population (Staaland & Olesen, 1991). The muskox population has not yet reached carrying capacity here and the dominant graminoid vegetation in meadows, grasslands, moist dwarf shrub heaths, and steppes still provide excellent nutrition. The fact that WG muskoxen have free access to preferred graminoid vegetation with a large standing crop during winter – due to a stable and dry climate – may be the main key to understanding the differences in growth between muskoxen in WG and EG.

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