Acta vet. scand. 1991, *32*, 89–96.

Epidemiological and Genetical Studies in Norwegian Pig Herds
II. Overall Disease Incidence and Seasonal Variation

By *Frode Lingaas* and *Knut Rønningen*

Department of Animal Genetics, Norwegian College of Veterinary Medicine, Oslo, Norway.

Lingaas F. and K. Rønningen: Epidemiological and genetical studies in Norwegian pig herds. II. Overall disease incidence and seasonal variation. Acta vet. scand. 1991, 32, 89–96. – The present epidemiological study is based on individual health records from 1984 to 1986 in 70 pig herds in the south-eastern part of Norway. For most of the recorded diseases, the incidence rate was less than 1 % per farrowing. The majority of disease recordings concerned 6 frequently-occurring conditions; the MMA-syndrome, mastitis, metritis, neonatal diarhoea, arthritis and scrotal hernia. A seasonal effect on the incidence rate was shown for several diseases. The incidence rate for the MMA-syndrome of about 17.5 % seems to be of the highest recorded for this disease in a population study.

MMA-syndrome; mastitis; metritis; neonatal diarrhoea; arthritis; scrotal hernia; seasonal effect; age effect; swine; disease recordings.

Introduction

The frequency of clinical disease in Norwegian pig herds has seldom been investigated, the absence of a disease recording scheme making such studies difficult and tedious. Work done so far has mostly concerned diseases in piglets (*Simensen & Karlberg* 1980, *Grøndalen & Gjestvang* 1986) and reproductive disorders in sows (*Karlberg* 1981). Some reports from other countries deal with the disease frequency in herds producing piglets for sale (*Bäckström* 1973, *Bäckström et al.* 1975, *Jorsal* 1983, *Svensmark et al.* 1989), and with respiratory diseases in fatteners (*Aalund et al.* 1976, *Willeberg et al.* 1978, *Jørgensen* 1986). The infrastructure of the swine industry is, however, different from country to country and it is important to study diseases in the local environment to successfully handle the problems. The purpose of the present study was to examine incidence of all recorded diseases, and seasonal variation of the 6 most frequently recorded diseases.

Material and methods

The present epidemiological study is based on disease registrations from 70 pig herds in the south-eastern part of Norway (*Lingaas & Rønningen* 1990). Disease registrations were performed both in herds providing breeding stock for the Norwegian Pig Breeders' Association ("Breeding herds"), and normal commercial herds during the three-year period from 1984 through 1986. The only inclusion criterion applied was that the herds should practice herd performance recording (*Landsrådet for husdyrkontrollen* 1986), this being a necessary prerequisite for the study of epidemiological and genetical aspects of disease. Herd size varied from 3 to 70 sows, which is a representative range for Norwegian herds with herd performance recording. The basic data set contained 8350 observations. Disease recordings were performed by the local veterinarians for all diseases in sows. Some diseases in piglets were registered by the farmers (Table 1).

Table 1. Diseases recorded in the health card project.

Reproductive Disorders:
Code 5. HCG + Oestradiol
- 6. HCG + PMSG
- 7. Birth induction
- 8. Other hormone treatments

Diseases of the sow:
Code 10. Dystocia
- 11. MMA-syndrome
- 12. Mastitis
- 13. Metritis
- 14. Unspecific reduced appetite
- 15. Abscess/phlegmons
- 16. Agalactia
- 17. Diarrhoea
- 18. Abortion
- 19. Hoof/joint diseases
- 20. Deficiency diseases.
- 21. Respiratory diseases.
- 22. Erysipelas
- 23. Skeletal muscular disease
- 24. Urinary tract diseases
- 25. Non-specific fever
- 26. Other diseases

Diseases in piglets:
Recorded by the veterinarian:
Code 30. Neonatal diarrhoea
- 31. 3-week diarrhoea
- 32. Diarrhoea at weaning
- 33. Arthritis
- 34. Respiratory diseases
- 35. Skin diseases
- 36. Deficiency diseases
- 37. Trauma/injury
- 38. Other diseases

Recorded by the farmer:
Code 39. Splay-leg
- 40. Cryptorchism
- 41. Atresia ani
- 42. Umbilical hernia
- 43. Scrotal hernia
- 44. Shivering
- 45. Hermaphrodism

Table 2. The rate of reported first incidence diseases in the 3 year period. (The figures concerning the MMA-syndrome, mastitis and metritis are based on recorded cases, no matter the time of treatment).

	Incidence rate ‰ (per farrowing)		
Code	1984	1985	1986
5	1.42	1.07	0.54
6	0.55	0.63	2.32
7	0.86	1.27	1.41
8	0.12	0.23	0.27
10	1.54	2.50	2.01
11	16.49	17.49	18.49
12	4.62	6.26	6.64
13	2.52	3.63	2.65
14	0.98	1.70	1.81
15	–	0.33	0.20
16	–	0.40	0.10
17	0.18	0.30	0.13
18	0.74	0.73	0.57
19	0.37	1.67	1.71
20	–	–	–
21	0.12	0.73	0.06
22	0.49	1.47	0.57
23	2.40	0.97	0.67
24	–	0.93	1.14
25	0.22	2.33	2.45
26	0.28	2.93	3.29
30	5.29	5.80	5.81
31	0.68	0.67	0.47
32	0.80	1.13	0.44
33	2.52	5.10	4.66
34	0.06	0.03	0.07
35	0.06	0.40	0.40
36	0.12	0.53	0.20
37	–	0.03	0.06
38	1.29	1.40	1.14
39	0.49	0.53	0.23
40	0.37	1.40	1.17
41	0.31	0.43	0.10
42	0.12	0.53	0.54
43	1.60	7.10	6.48
44	0.03	0.37	0.23
45	0.12	0.40	0.30

Sows were observed throughout the year, while the piglets were observed from farrowing until weaning. The diseases recorded in the project are listed in Table 1.

Disease incidence can either be estimated as total incidence (all reported cases) or as first-incidence based on the first case in each animal only. In this study it was decided to express the disease frequency as first incidence. The disease incidence in Table 2 is based on the recorded disease codes. To achieve uniformity when working with statistical associations of diseases with season and litter number the cases of mastitis and metritis, which occurred within 3 days after farrowing, were redefined and included in the MMA-group.

Statistical methods

When considering the effect of litter number on disease incidence adjustment for effects such as year and herd was performed using indirect standardization (*Lilienfeld & Lilienfeld* 1980).

The significance of the different effects on the incidence of the MMA-syndrome was tested in the following models (*SAS Institute Inc.* 1985):

Model 1:

$Y_{ijklmno} = \mu + A_i + B_j + C_k + D_l + t_m + M_n + e_{ijklmno}$ where

$Y_{ijklmno}$ = the dependent categorial variable diseased/non-diseased

μ = "Least squares mean"

A_i = effect of i'th year

B_j = effect of j'th herd

C_k = effect of k'th litter number

D_l = effect of l'th breed

t_m = effect of total number "m" of piglets in the litter

M_n = effect of month "n"

$e_{ijklmno}$ = random error

All the effects, except e, were considered as being fixed.

Model 2:

In this model the effect of month was deleted and the following two effects were added:

m_n = effect of farrowing-density "n"

o_t = effect of outside temperature "t"

Results

The first incidence of the various diseases on a litter basis, and according to year, are given in Table 2. The respective disease codes are shown in Table 1.

Table 2 shows that most of the separate diseases had an incidence rate of less than 1 %, and that most treatments concerned a limited number of diseases. Most of the diseases were treated and recorded only once. The conditions that often needed several treatments were hoof/joint-diseases, mastitis, abscesses/phlegmons, non-specific fever and the MMA-syndrome.

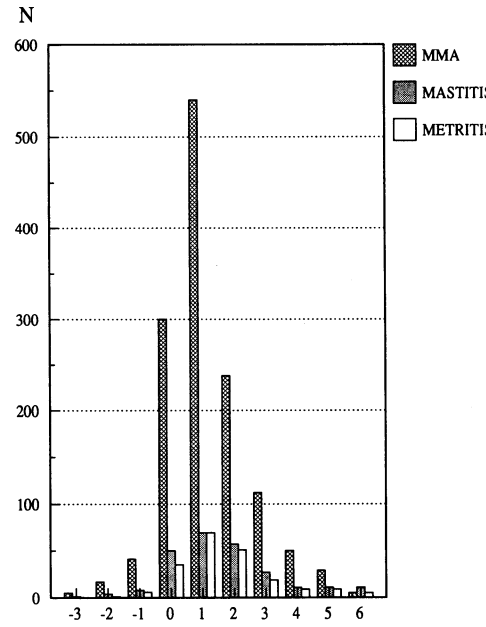

Figure 1. The time of treatment (days) of some important diseases relative to farrowing.

Time of treatment in relation to farrowing

The time of treatment in relation to farrowing for the 3 most frequent diseases in sows is shown in Fig. 1.

There was a peak in the number of treated animals the day after farrowing after which the number of treatments decreased gradually.

Seasonal variations

Farrowing frequency was slightly higher in the spring and summer than in the autumn and winter. Therefore the estimates of disease frequencies were corrected for farrowing frequency in order to take into account natural fluctuations in farrowing rate. The total number of recorded diseases per litter during the recording period is shown in Fig. 2.

Fig. 2 shows considerable random variation in disease incidence from month to month. There has also been a tendency to increased disease incidence during the registration period.

The number of recorded diseases per farrowing per month for the 6 most frequently recorded diseases during the three-year period is shown in Fig. 3.

The incidence of some of the common diseases in sows, as well as of neonatal diarrhoea increased in the summer. In contrast,

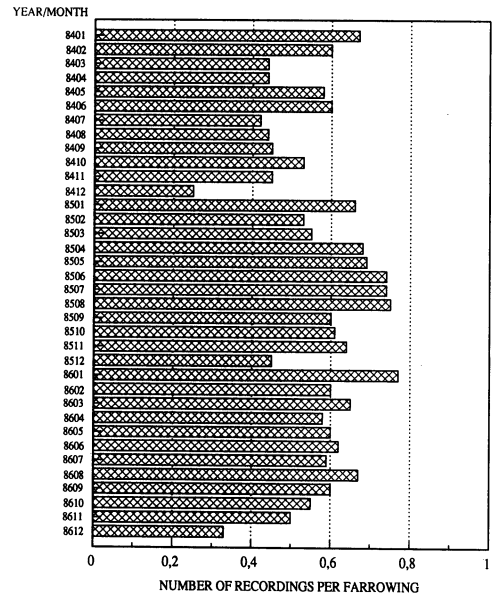

Figure 2. Variation in number of disease recordings per farrowing during the 3 year period. All diseases.

arthritis in piglets and scrotal hernia showed a decreased incidence during the summer.

The seasonal effect on the MMA-syndrome was tested with Model 1, and a significant overall effect of month was then revealed. A month by month comparison of the incidence of the MMA-syndrome showed a significantly higher incidence ($p < 0.05$) in some

Table 3. Disease incidence in relation to age of sows as expressed by litter number.

		Incidence (%)					
Litter number	No. of litters	MMA	Mastitis	Metritis	Diarrhoea	Arthritis	Scrotal hernia
1	2566	20.2	7.5	1.6	6.1	4.1	5.7
2	1754	21.6	4.0	1.3	5.3	4.0	5.7
3	1287	21.8	3.9	0.3	4.2	3.3	5.4
4	887	19.4	3.9	1.1	4.6	4.9	5.7
5	542	18.8	1.6	1.3	4.5	2.5	5.6
6	345	17.3	1.7	1.0	3.9	6.4	5.3
7	155	13.6	2.2	0.6	6.1	–	7.2

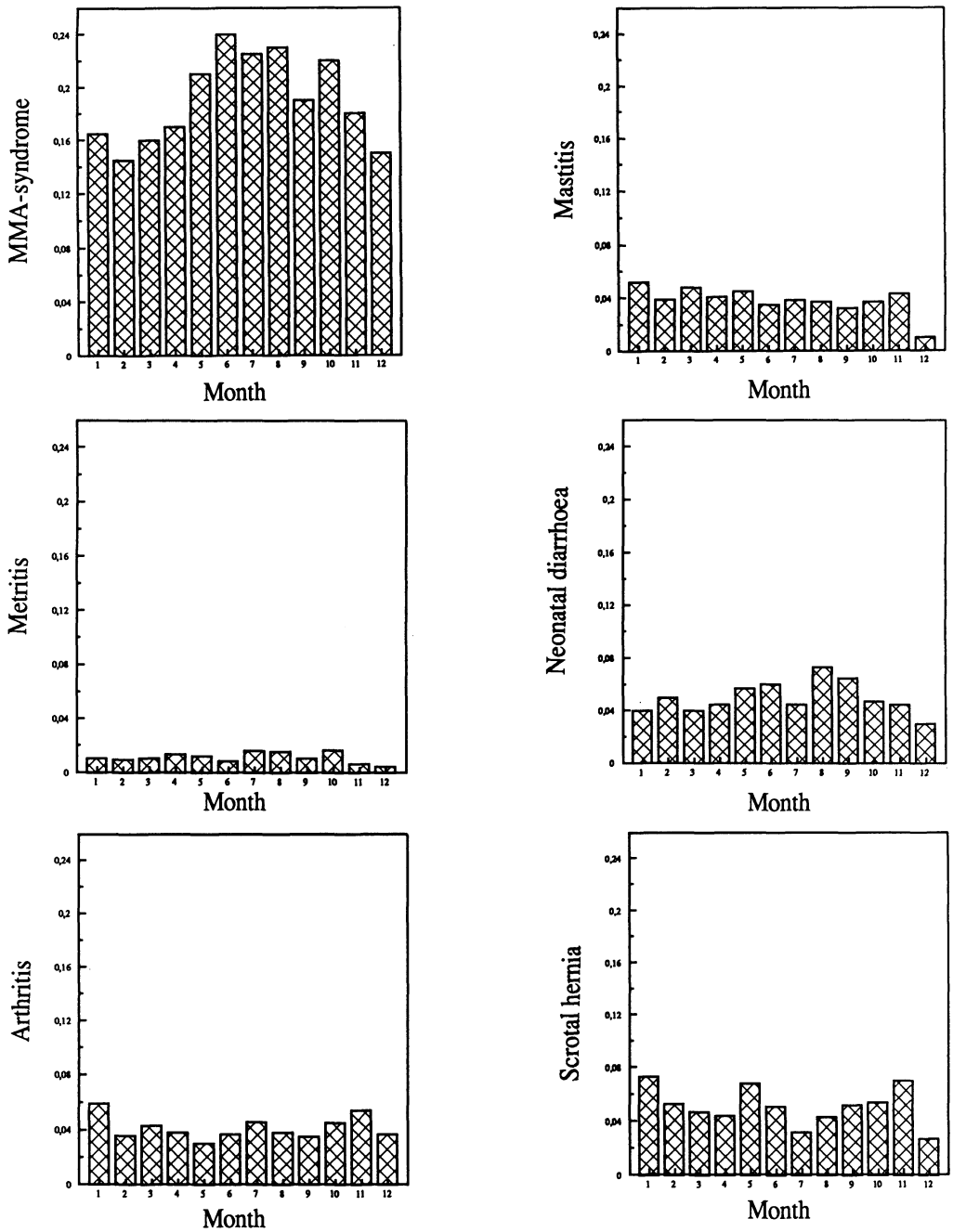

Figure 3. Seasonal variation in number of disease recordings per farrowing for the MMA-syndrome, mastitis, metritis, neonatal diarrhoea, arthritis and scrotal hernia.

of the summer months than in the winter months.

In Model 2, the outside maximum temperature on the farrowing day, and the "farrowing density" (i.e. no. of farrowings during the last 15 days) were used instead of the month-effect employed in Model 1. These variables had, however, no significant effect.

Effects of litter number

The effect of litter number on the incidence of 6 important diseases is shown in Table 3. Though the incidence of the diseases varied from litter to litter there was no systematic effect of litter number. A tendency to decreasing incidence rates for the MMA-syndrome and mastitis was, however, observed.

Discussion

The incidence rate of most of the recorded diseases was less than 1 % per farrowing, the majority of the recordings being due to 6 frequent conditions, namely the MMA-syndrome, mastitis, metritis, neonatal diarrhoea, arthritis and scrotal hernia.

The incidence of the MMA-syndrome varied from 16.5 to 18.5 % in the 3 year period. This is higher than recorded in some other studies (1.0 % to 13.1 %). *Bäckström* (1973) reported an incidence of 7,0 % in a study on 28000 sows. In a Danish study, the MMA-syndrome was reported to occur in 9.5 % of all farrowings (*Jorsal* 1983). In another study on 27000 sows in Missouri, USA (*Threlfall & Martin* 1973) agalactia occurred in 13.1 % of farrowings. The incidence of dystocia in the present study (1.54 to 2.0 %) is of the same magnitude as reported by *Jorsal* (1983). The incidence of neonatal diarrhoea (5.3 % to 5.8 %) and arthritis (2.5 % to 5.3 %) corresponds well with the study of *Svensmark* (1984, 1989). Incidences of the latter 2 conditions are probably somewhat underestimated in the present study because of the difficulties associated with satisfactory disease recording in piglets. The actual incidences in herds in Norway are therefore probably higher than those in Denmark. This may reflect the higher incidence rate of the MMA-syndrome in Norway, as resistance in piglets against diarrhoea and arthritis is impaired, should the sow become ill during the suckling period.

The recording of diseases by means of a health card system will usually give good estimate of disease incidence. A good feedback of information to the farmers is, however, necessary if the number of cases recorded is to comprise a high proportion of cases actually occurring. The significance of efficient registration routines was obvious for some of the diseases. For example, a distinct increase in the number of recorded cases of scrotal hernia was observed from 1984 to 1985. This was the result of an intensive information campaign, carried out at the end of 1984, which aimed to improve the registration of congenital defects, especially scrotal hernia, rather than an expression of a true increase in incidence.

The difference between total number of treatments and number of first treatments within the lactation period varied from disease to disease.The need for repeated treatments arises either because of new attacks of the same disease, or because of lack of effect of the first treatment. The latter situation is usually the case as regards the MMA-syndrome. In some of the herds there was evidence of problems associated with microbial drug resistance.

An increase in disease frequency with increasing age may be due either to decreased disease resistance, or more probably to environmental effects and stress resulting from increased production. In the present study, a tendency to decreased incidence of the MMA-syndrome and mastitis with increa-

sing age were seen. It has, however, to be born in mind that, when working with population data, the genuine changes in disease frequencies may have been masked by selection pressure against individuals prone to disease.

As regards the time of treatment, mastitis differed a little from the other 2 diseases in sows in that there was a slower decrease in frequency after farrowing, 3 to 7 treatments being recorded until day 47 after farrowing. This period covered the suckling period on most of the farms. No increase in incidence, however, was observed at weaning, 4 to 7 weeks after farrowing.

The MMA-syndrome, which has a multifactorial etiology, was the most frequently recorded disease in this study. There was no obvious explanation for this high incidence.

The random variation in disease incidence from month to month during the registration period is considerable. The low disease frequency in December as well as the high frequency in January is also remarkable. The latter fluctuations may be explained partly by systematic differences in recording routines between these months.

Several diseases tended to increase during the summer months. The reason for a higher incidence during the summer months is not known, though stress-factors such as high ambient temperature, or increased number of farrowings (increased infectious pressure), may play a role. Comparable increases in disease incidence have been reported previously for the MMA-syndrome (*Ringarp* 1960, *Bäckström* 1982, *Jorsal* 1983), and for neonatal diarrhoea (*Svensmark* 1984).

Acknowledgements

The present study, which was supported by the Norwegian Pig Breeders' Association, would not have been possible without the excellent help given by farmers and veterinarians in the county of Hedmark.

References

Bäckström L: Environment and health in piglet production. A field study of incidence and correlations. Acta vet. scand. 1973, Suppl. 41, 1–240.

Bäckström L., Mattson J., Wallin O., Vilson B: Praktikjournal försöket i Skaraborgs län 1971–1973. (The health recording study in Skaraborg län 1971–1973). Sven. Vet. Tidn. 1975, 27, 292–300.

Bäckström L., Connors J., Price W., Larson R., Mörkoc A: Mastitis-metritis-agalactia (MMA) in the sow. A field survey of MMA and other farrowing disorders under different gestation and farrowing housing conditions. In: Proc. 7th International Pig Veterinary Society Congress, Mexico, 1982, p. 175.

Grondalen T., Gjestvang MS: Herd variations in "normal" piglet mortality in Norwegian herds. In: Proc. 9th International Pig Veterinary Society Congress, Barcelona, 1986, p. 459.

Jorsal SE: Morbiditet hos søer. Epidemiologiske undersøgelser i intensive sobesætninger med særligt henblik på farefebersyndromet. (Morbidity in sows. Epidemiological studies with a special reference to the MMA-complex). Ph. D.-thesis, Copenhagen 1983.

Jorgensen B: Epidemiologiske og statistiske analyser af sygdomsdata fra svineavlens forsøgsstationer. (Epidemiological and statistical analyses of disease records from pig testing stations). Ph.D.-thesis, Copenhagen 1986.

Karlberg K: Fruktbarhet og ufruktbarhet hos purke. Feltundersøkelser. Postmortelle funn. (Reproduction and reproductive disorders in sows. A field survey. Post mortem findings. Thesis 1981. Oslo: Inst. for reproduksjonsfysiologi og -patologi. Norges Veterinærhøgskole.

Landsradet for husdyrkontrollen: Husdyrkontrollen i Norge, 1985. (The Norwegian Herd Performance Recording Scheme). Med statistikk fra kukontrollen, geitekontrollen, sauekontrollen og purkekontrollen. Landsrådet for husdyrkontrollen, 1986.

Lilienfeld AM., Lilienfeld DE: Foundations of epidemiology. New York: Oxford University Press, 1980.

Lingaas F, Rønningen K: Epidemiological and genetical studies in Norwegian pig herds. I. Design of a disease recording system. Acta vet. scand. 1990, *31*, 243–249.

Ringarp N: Clinical and experimental investigations into a post-parturient syndrome with agalactia in sows. Acta Agric. Scand. 1960, Suppl. 7, 1–166.

SAS Institute Inc.: SAS User's guide: Statistics, Version 5 Edition, Cary, NC: SAS Institute Inc., 1985, 956 pp.

Simensen E, Karlberg K: A survey of preweaning mortality in pigs. Nord. Vet.-Med. 1980, *32*, 194–200.

Svensmark B: Diarre hos grise. Epidemiologiske undersøgelser i intensive sobesætninger med særligt henblik på rotavirus-associeret diarre. (Diarrhoea in pigs. Epidemiological studies in intensive sow herds with a special reference to rota-viral diarrhoea). Ph.D.-thesis, Copenhagen 1984.

Svensmark B, Jorsal SE, Nielsen K, Willeberg P: Epidemiological studies of piglet diarrhoea in intensively managed Danish sow herds. I. Preweaning diarrhoea. Acta vet. scand. 1989, *30*, 43–53.

Threlfall WR, Martin CE: Swine agalactia in Missouri. Vet. Med. Small Anim. Clin. 1973, *68*, 423.

Willeberg P, Gerbola MA, Madsen A, Mandrup M, Nielsen EK, Riemann HP, Aalund O: A retrospective study of respiratory disease in a cohort of bacon pigs. Nord. Vet.-Med. 1978, *30*, 513–525.

Aalund O, Willeberg P, Mandrup M, Riemann H: Lung lesions at slaughter: Associations to factors in the pig herd. Nord. Vet.-Med. 1976, *28*, 487–495.

Sammendrag

Epidemiologiske og genetiske studier av sjukdommer i norske svinebesetninger.
II. Sjukdomsinsidens og sesongvariasjon.

Den foreliggende epidemiologiske undersøkelsen bygger på individuelle sjukdomsregistreringer fra 70 svinebesetninger i Hedmark. De fleste sjukdommene hadde en insidens på mindre enn 1 %, mens hovedtyngden av registreringene var forårsaket av 6 hyppige sjukdommer; MMA-syndromet, mastitt, metritt, spedgrisdiare, leddbetennelse og pungbrokk. De ble påvist en årstidseffekt på insidensen av flere sjukdommer. MMA-syndromet hadde en incidens på 17,5 %, som er den høyeste rapporterte insidensen for denne sjukdommen i et populasjonsstudium.

(Received July 10; accepted February 8, 1990).

Reprints may be requested from: Frode Lingaas, Department of Animal Genetics, Norwegian College of Veterinary Medicine, P. O. Box 8146 Dep., N-0033 Oslo 1, Norway.