 indoors and out. It has been the practice on the farm to spread the bedding from the lambing pens, after six months storage, on to the pasture. Pastures were grazed simultaneously by sheep, dry cows and in-calf heifers, and some weeks later by milking cows alone.

Acknowledgements. — The authors would like to thank Mr N. Arnott of the Stramontage Veterinary Practice, Kendal, for his referral of the original samples, and for subsequent blood sampling. The authors from the CVL are grateful to Adrian Buckle, Jane Plutcher, Mark Horigan, Mavis Field and Matthew Rose for diligent technical support, to Kate Thompson and Dr David Buxton of the Moredun Research Institute for the immunoperoxidase staining, and to J. S. Storz of Louisiana State University for kindly providing the Colo-4 isolate.

References


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Antibodies to herpesviruses have been detected in the harbour seal (Osterhaus and others 1985, Osterhaus 1988), California sea lion (Zalophus californianus) (Kennedy-Stoskopf and others 1986), Weddell seal (Leptonychotes weddellii) and crab-eater seal (Lobodon carcinophaga) (Hunter and others 1991). While antibodies to influenza A virus have been detected in the harbour seal and grey seal (Halichoerus grypus) (Geraci and others 1982, 1984). In addition, antibodies to canine distemper virus (CDV) and PVD have been detected in eight different seal species, including the hooded seal (Cystophora cristata) from Canadian waters (Heide-Jorgensen and others 1992) and the harp seal (Markussen and Have 1992). The present investigation was performed to examine the presence of serum antibodies against seal herpesviruses, influenza A virus, CDV and PVD in the harp and hooded seal.

Serum samples from harp and hooded seals were collected in the Barents Sea ('East Ice') and north of Jan Mayen ("West Ice") in April/May 1991 and 1992. sera were collected from harp seals in both areas and from hooded seals north of Jan Mayen. One hundred samples (30 in 1991 and 70 in 1992) from hooded seals and 183 samples (43 in 1991 and 140 in 1992) from harp seals were analysed. Age distribution among the seals was not recorded, but most of the hooded seals were between one and four years old and most of the harp seals were adults (four years and older). Sera were heat-inactivated for 30 minutes at 56°C before analysis. A virus neutralisation assay using seal kidney monolayer cell cultures with seal herpesvirus was performed as described by Osterhaus and others (1985). Serum antibody titres ≥10 were considered positive. An ELISA was used to investigate the presence of antibodies against influenza A viruses according to methods described by de Boer and others (1990). Serum antibody titres ≥2 were considered positive. Neutralising antibodies in serum against the Ondersteboorp strain of CDV and a Danish isolate of PVD were analysed according to Markussen and Have (1992). Serum antibody titres ≥10 were considered positive.

Neither clinical signs nor pathological changes were recorded during sampling, although the lungs and hearts from 26 per cent of hooded seals but from only 1·5 per cent of harp seals were infected with the parasite Dipetalonema spirocauda. The results of the serum analyses are shown in Tables 1 and 2. These show that both the harp and hooded seals had antibodies against herpesvirus, influenza A virus and morbillivirus. Major differences in seroprevalence were not observed between harp seal populations from the Barents Sea and from north of Jan Mayen.

Harp seal antibodies against herpesvirus and influenza A virus were not previously been observed in harp and hooded seals, although sera from 102 harp and seven hooded seals from eastern Canada were examined for antibodies against influenza A virus (Geraci and others 1984).

The prevalence of CDV and PVD antibodies in the harp seal in the present study is similar to that observed in 1987 and 1989 by Markussen and Have (1992). As found in these previous studies, the mean neutralising serum titre in the harp seal against PVD (mean, 303; titre range, 10 to >1280) was higher than the mean neutralising titre against CDV (mean, 116; titre range 10 to >1280) (data not shown). The same trend was found in sera from hooded seals and indicated that these seal species had been infected with a virus more closely related to PVD and CDV.

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HERPS, influenza A and morbillivirus have caused mortality in seals, especially in the harbour seal (Phoca vitulina) (Geraci and others 1982, Osterhaus and others 1985, Osterhaus and Vedder 1988). More than 18,000 harbour seals died of a newly discovered phocine distemper virus (PVD) infection during the seal epizootic in European waters in 1988 and, according to earlier assumptions, the harp seal (Phoca groenlandica), may have been a vector for the infection in that epizootic (Goodhart 1988, McGourty 1988, Heide-Jorgensen and others 1992, Visser and others 1995a).

### TABLE 1: Examination of serum samples for antibodies against seal herpesviruses, influenza A virus, canine distemper virus (CDV) and phocine distemper virus (PVD) in the harp seal (Phoca groenlandica)

<table>
<thead>
<tr>
<th>Year</th>
<th>Area</th>
<th>Number</th>
<th>Seal herpesvirus</th>
<th>Influenza A virus</th>
<th>CDV</th>
<th>PVD</th>
</tr>
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<tbody>
<tr>
<td>1991</td>
<td>W</td>
<td>43</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>27</td>
<td>7</td>
<td>36</td>
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<td></td>
<td>32</td>
<td>14</td>
<td>29</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>% seropositive</td>
<td>% seropositive</td>
<td>% seropositive</td>
<td>% seropositive</td>
</tr>
<tr>
<td>1992</td>
<td>E</td>
<td>70</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
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<td>29</td>
<td>41</td>
<td>6</td>
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</tr>
<tr>
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<td></td>
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<td>36</td>
<td>65</td>
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<tr>
<td></td>
<td></td>
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<td>% seropositive</td>
<td>% seropositive</td>
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<td>% seropositive</td>
</tr>
<tr>
<td></td>
<td>W</td>
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<td>+</td>
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<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
</tbody>
</table>

W 'West Ice', E 'East Ice'
+ Number seropositive, − Number seronegative

S. Stuen, J. M. Arnetto, Centre of Veterinary Medicine, N-9005 Tromsø, Norway
P. Have, Sute Veterinary Institute for Virus Research, Lindholm, DK-4771 Kalvehave, Denmark
A. D. M. E. Osterhaus, Seal Rehabilitation and Research Centre, Piteåburen, The Netherlands
A. Moustgaard, PO Box 278, N-8301 Svolvær, Norway
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