Transatlantic spread of seal virus

SIR—Kennedy *et al.*[1] refer to the "annual migration of porpoises from the Baltic to the North Sea and south to the English Channel" as a possible means whereby the current seal epizootic was spread, and say that "porpoises are known to cross the Atlantic Ocean, so marine mammals along the American continent could be at risk". They suggest that their finding of morbillivirus infection in two recently stranded harbour porpoises "may explain the declines in porpoise and dolphin populations in European waters in recent years".

These remarks are surprising because although migration was originally suggested as a possible explanation for the pattern of stranding records[2], more recent work indicates that UK harbour porpoise strandings mainly reflect the washing ashore of animals accidently killed during fishing operations[3]. Porpoises are known to be coastal and fairly sedentary animals. Morphometric and meristic evidence indicates separate eastern and western North Atlantic populations, and Dutch, Baltic and UK North Sea animals may form distinct sub-populations[4]. It therefore seems most unlikely that individual porpoises travel long distances, or cross the Atlantic Ocean.

Kayes[5] and I[3] have independently analysed the available sighting and stranding data for the southern North Sea from 1913, and conclude that they can neither support nor exclude the anecdotal evidence of decline in the porpoise and dolphin populations. The records of stranded porpoises have not shown the increase expected had debilitating viral infection long been present in the species. It seems that we need to look elsewhere for the vector of the current seal epizootic.

M. KLINOWSKA
Research Group in Mammalian Ecology and Reproduction, Physiological Laboratory, Cambridge CB2 3EG, UK

KENNEDY *ET AL.* REPLY—Our suggestion of a possible role for porpoises in spread of the seal virus[1] was only partly based on claims of migration and transatlantic crossing by porpoises[2,6]. We have no expertise in cetacean behaviour and thus accept Klinowska's contention that her own studies probably invalidate these earlier claims. However, morbilliviruses are highly infectious and one infected animal may be sufficient to infect a susceptible population. Furthermore, little is known about the movements of individual porpoises. So, regardless of specific migration patterns, porpoises must be considered as possible vectors of the virus for seals and other marine mammals. This does not imply that they are the only potential vectors.

Evidently, not all biologists agree that porpoises are "fairly sedentary animals" and that it is "unlikely that individual porpoises travel long distances", since Kayes[5] states that "they travel over considerable distances" and the possibility of Icelandic porpoises coming into contact with Irish and British porpoises has been mentioned[4]. Evidence[5] indicating that large-scale intermixing of eastern and western North Atlantic porpoise populations does not occur, does not preclude interchange of small numbers of porpoises enough for transatlantic spread of the virus.

Klinowska's interpretation of Kayes's critical review[5] of anecdotal evidence is surprising since Kayes states "the only reasonable conclusion that can be drawn from the available evidence is that both the harbour porpoise and bottlenosed dolphin had become rare in the southern North Sea by 1970". He also concludes that they have "become rare on the Atlantic coast of France, Spain and Portugal" and have "virtually disappeared from the Baltic Sea".

We do not know how long morbillivirus infection has been present in porpoises. If the virus has been present for a long time, one would expect many porpoises now to be immune and hence high present-day mortality would be unlikely. As detailed necropsies have been done on relatively few stranded porpoises, including those attributed to fishing-induced injury, the incidence of morbillivirus infection in this species to unknown. On the other hand, recent introduction of the virus to porpoises may be expected to produce high mortality, although not on the scale of the recent seal epizootic, as opportunities for lateral spread of the virus in porpoises are probably fewer than in seals. We have diagnosed morbillivirus infection and found distemper-like lesions in six porpoises from the Irish Sea in recent months. This suggests recent introduction of the virus to these porpoises. It will be of interest to know how the 1988 European stranding records compare with former years.

S. KENNEDY
J. A. SMYTH
P. F. CUSH
S. J. MCCULLOUGH
G. M. ALLAN
Veterinary Research Laboratories, Stormont, Belfast BT4 3SD, UK
S. MCQUAID
Department of Pathology, Queen's University, Belfast BT7 1NN, UK

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Preferences of Palaeozoic predators

SIR—We have examined the scars on Palaeozoic trilobites and report that those scars that we attribute to sublethal predation rather than undefined causes are significantly more frequently found on the right side of the trilobites, suggesting that predators preferred to attack that side.

The scars of healed injuries to trilobites are recognizable as broken areas of the exoskeleton that have become callused. When the scars are in the form of callused embayments on marginal areas (see figure) we attribute them to sublethal predation as they are unlikely to have been accidental breaks.

The areas most susceptible to accidental

Incidence of healed injuries on right, left or both sides of 158 trilobites

	Right side only n (%)	Left side only n (%)	Both sides n (%)
Sublethal predation scars:			
Cambrian trilobites	35 (73)	11 (23)	2 (4)
Post-Cambrian trilobites	21 (64)	11 (33)	1 (3)
All trilobites	56 (69)	22 (27)	3 (4)
Injuries of uncertain origin:			
Cambrian trilobites	15 (56)	10 (37)	2 (7)
Post-Cambrian trilobites	25 (50)	23 (46)	2 (4)
All trilobites	40 (52)	33 (43)	4 (5)
All injuries	96 (61)	55 (35)	7 (4)

Injuries were analysed using a binomial test in which the expected distribution on the left and right sides is 1:1. We analysed specimens showing injuries on one side (78 of 81), and counted specimens showing multiple injuries on the same side only once. Observed right–left ratios of predation scars are 3.2:1 for Cambrian trilobites ($P < 0.001$, $n = 46$); 1.9:1 for post-Cambrian trilobites ($P < 0.055$, $n = 32$); and 2.6:1 for Cambrian and post-Cambrian trilobites ($P < 0.001$, $n = 78$). Injuries of uncertain origin are not statistically significant ($P > 0.100$) for Cambrian ($n = 25$), post-Cambrian ($n = 48$) or pooled ($n = 73$) trilobites. Specimens not in the University of Kansas collection are described in refs 6, 7.