Element profiles of feathers identify Knot populations, but the mystery of arsenic emerges

Lida Goede

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The two elements mercury and selenium occur in much higher concentrations in the eighth primary of *islandica* than of *canutus* Knots. Amongst *islandica* Knots a difference is noted between the arsenic feather concentration of birds caught on spring migration in northern Norway and birds caught elsewhere in the area of distribution. The general meaning of this finding is that these Norwegian Knots spend some time of the year at a location different from those used by the other *islandica* Knots. However it is yet impossible to pinpoint this region.

A.A. Goede, Interfaculty Reactor Institute, Delft University of Technology, Mekelweg 15, 2629 JB Delft, The Netherlands.

Element concentrations of feather tissue can be a useful tool in identifying similarities and differences in the regions in which the birds have been for some time (e.g. breeding, wintering, etc.). In order to do so, two conditions have, however, to be met. First, it is essential to know how a particular element found its way to the feather and second, only similar feather tissue samples can be compared.

For example, it is known that mercury (Hg) is deposited from the body into the feather at the time of moult. After the growth of the feather is completed, its mercury concentration will not change. Therefore feather samples collected at any time of the year can be compared. If the bird has accumulated mercury in its organs it starts to dump the element into the feathers as soon as moult begins, so the first feathers grown will have the highest concentrations. As a result, flight feathers differ individually, body feathers differ from flight feathers and shaft material from vane material in mercury concentrations. So only similar feather tissue should be compared.

Selenium (Se) is deposited in quite a different way. Whilst preening, the bird (at least a marine wader) contaminates its feathers with selenium present in secretion products. Therefore the selenium feather concentration increases with time. In addition, not all feathers and feather parts are preened with the same intensity. This results in differences in concentration. When selenium is used as a tracer, the same feather tissue of the same age has to be used for comparisons.

To illustrate the 'fingerprint' function that these two elements can perform, the mercury (Figure 1) and selenium (Figure 2) concentrations in the vane of primary no. 8 of *islandica* and *canutus* Knots *Calidris canutus* (the sample origins and sizes are given in Table 1) confirm that these populations have distinctly different moulting and wintering grounds.

Arsenic (As) is another element with the potential to serve as an indicator of the whereabouts of a migrant bird. The *canutus* Knots show a wide range in arsenic concentrations, though 62% have less than 2 mg/kg in the feather vane (Figure 3). Also the *islandica* Knots have less than 2 mg/kg except for those captured on spring migration in Balsfjord, northern Norway, which have much higher concen-

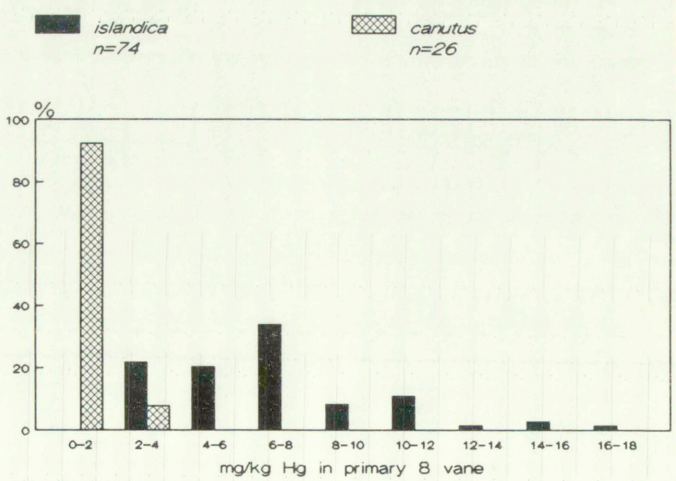

Figure 1. Mercury (Hg) concentrations in the primary no. 8 vane of adults Knots sampled in 1979-89.

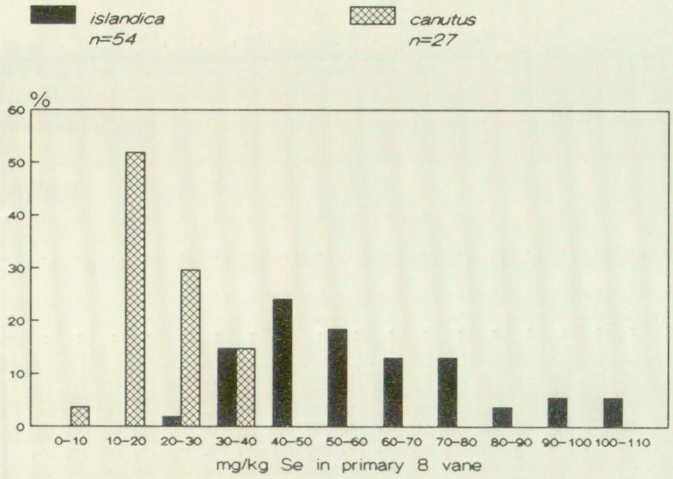

Figure 2. Selenium (Se) concentrations in the primary no. 8 vane of adult and juvenile Knots sampled from late April-June 1982-89.

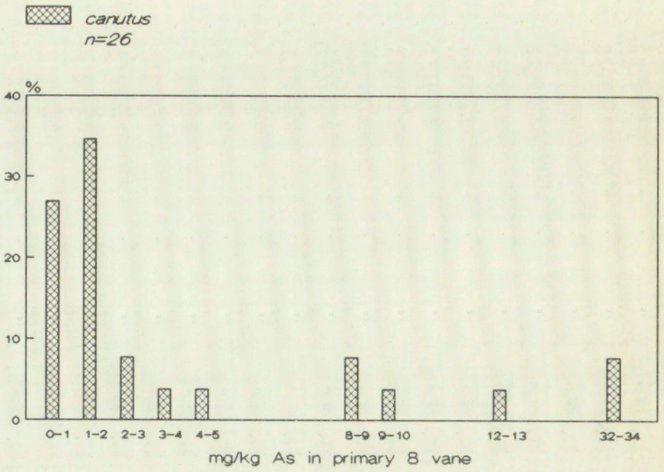

Figure 3. Arsenic (As) concentrations in the primary no. 8 vane of adult *canutus* Knots.

trations (Figure 4). An interpretation of this difference is not yet possible since the first condition is not met: the route(s) arsenic takes to reach the feather is not known. The Balsfjord Knots may have picked up the element on their breeding grounds, accumulating it in the body and later disposed of it by deposition in the feather tissue during moult. If so, then the difference in arsenic concentration denotes a difference in breeding area. Another possibility is that the feathers became contaminated externally with arsenic on the wintering grounds or during spring migration. Whatever the reason, it is clear that at some time of the year the Balsfjord Knots use a location different from those used by the other *islandica* Knots sampled so far. Maybe it is just Balsfjord, but the brief span of their stay before capture argues against this possibility.

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Table 1. Area of origin and sample sizes of Knots' primaries no. 8, that were used in the analyses of element concentrations. The analyses were performed with instrumental neutron activation.

Subspecies	Origin	Date	Sample size		
			Juven.	Full grown	Adult
islandica	Alert, Ellesmere, Canada	May-June 1987			12
	Vatnsfjördur, NW. Iceland	25-28 May 1988			5
	Balsfjord, Norway	12 May 1985		1	23
	Wadden Sea, Germany	26 May 1989	13		
		19 March 1987			11
	Wadden Sea, Netherlands	30 October 1979			21
		22 October 1982			2
canutus	Sidi Moussa, Morocco	23 April 1982	1		1
	Wadden Sea, Germany	19 May 1987			5
		26 May 1989			20

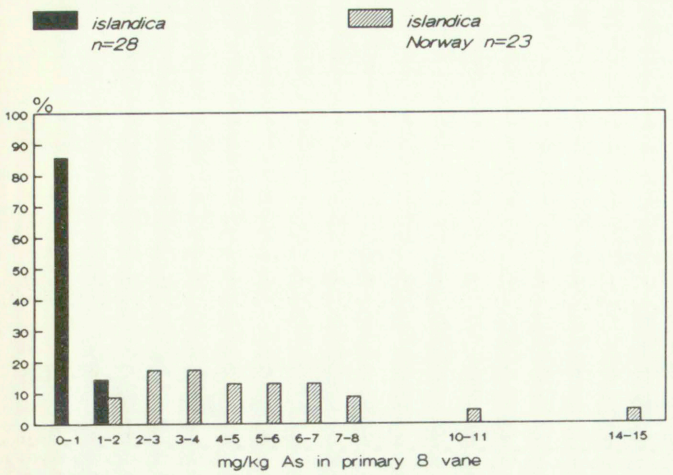

Figure 4. Arsenic (As) concentrations in the primary no. 8 vane of adult *islandica* Knots.

POSTSCRIPT

From P.S. Tomkovich I received some primaries no. 3 he collected from waders caught on Taymyr Peninsula, Siberia, during summer 1990. Since there are no other data available on primary 3 concentrations, these data have to be interpreted in isolation and cannot be compared directly with the primary 8 data (Goede 1991). The data set shows both relatively high and low selenium concentrations (Figure 5), indicating that the birds have been exposed to these elements outside their joint breeding area. In Knots and Curlew Sandpipers (Figure 5A) there seems to be a bipartition in the results. One group of birds has relatively high arsenic and low selenium concentrations (respectively >14 mg/kg and <7 mg/kg), another group has relatively low arsenic and high selenium concentrations (respectively <5 mg/kg and >7 mg/kg). Both in western and in southern Africa the wintering areas of Knots and Curlew Sandpipers overlap (Cramp & Simmons 1983) and the bipartion in the two groups may be associated with individuals wintering in either of the two regions. This hypothesis would also explain the wide range in arsenic concentrations found in primary 8 of *canutus* birds (Figure 3): it may be rooted in the different African wintering areas they used.

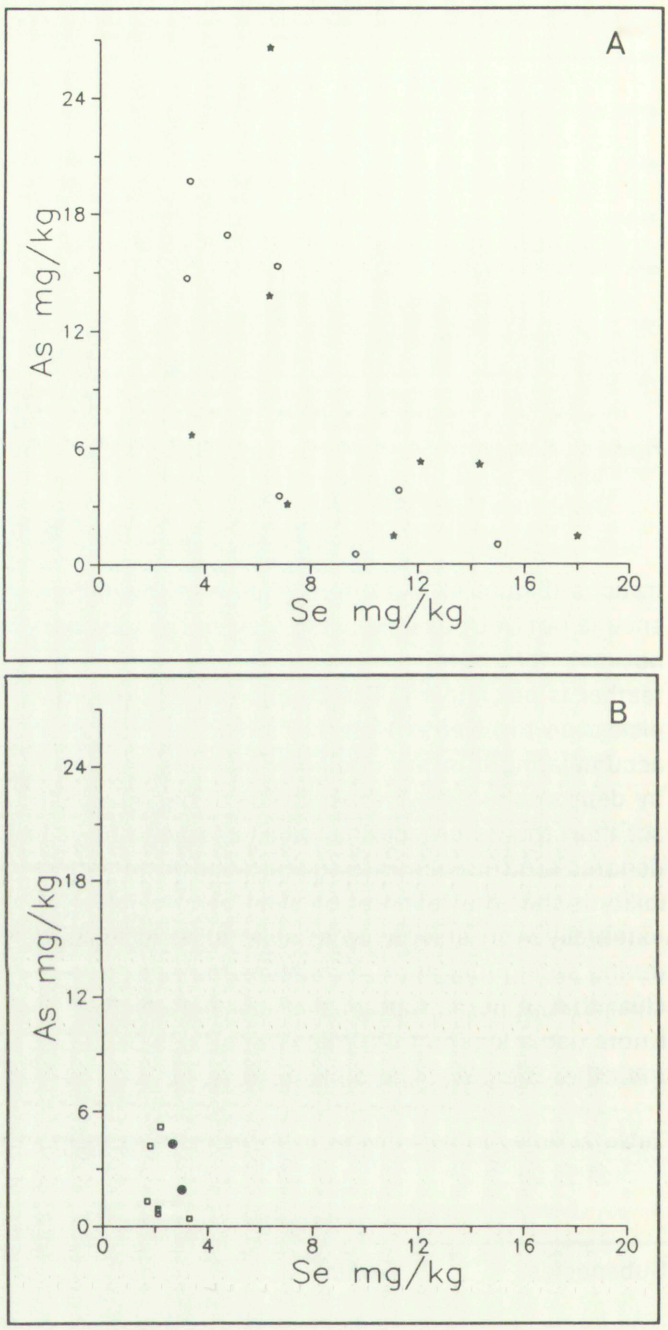

Figure 5. Selenium (Se) and arsenic (As) concentrations in primary no. 3 of waders captured on Taymyr Peninsula, Siberia. A: open circles are Knots, asterisks are Curlew Sandpipers *Calidris ferruginea*. B: open squares are Grey Plovers *Pluvialis squatarola* and closed dots are Turnstones *Arenaria interpres*.

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