

A Study of Human Migration Using Dental Fluorine Analysis

Tomoya Aono (Tohoku University of Art & Design), Kazuhisa Yoshimura (Kyushu University, Radioisotope Center), Minoru Yoneda (The University Museum, The University of Tokyo), Junmei Sawada (Niigata University of Health and Welfare), Haruka Yamaguchi (University of Tokyo), Sadayuki Masuyama (Tahara-City Board of Education)

1. The Goal of This Study: Identification on Human Migration Using Dental Fluorine Analysis
Since the enamel in permanent human teeth is formed during infancy, differences in the concentration of fluorine contained in food and drinks consumed in infancy is recorded and retained in the teeth. In addition, since the fluorine concentration in spring and river water is heavily influenced by elution from fluorine minerals in the ground such as fluorite, regional differences owing to differences in geology are abundantly clear in human teeth. The current study utilizes fluorine concentration to examine whether there are any differences between where a person was born and raised and where he/she was buried, with the goal of clarifying human migration and marriage systems.

We looked at 32 different sets of human teeth dating from the early Jomon period to the epi-Jomon period (about 7,000 to 2,000 years ago) excavated from five sites around Funka Bay in Hokkaido and Mikawa Bay in Aichi Prefecture (Figs. 1 and 2). The methodology involved collecting about 1 mg of enamel from the buccal distal portion of the second small molar on the lower of the human jaw bone. We also measured the fluorine concentration of spring water collected in the vicinity of the target site in Hokkaido, and were able to confirm that only the area around the Usumoshiri site had a high concentration of fluorine. In this presentation, we conclude that it is possible to identify migrants using the marked differences in the amount of fluorine found in the enamel of their teeth.

2. Sampling Method

- ① Second small molar on the lower of the human jaw bone targeted, photo of material was taken prior to processing.
- ② Soil and tartar were removed using a sand blaster.
- ③ Mold created and replication carried out.
- ④ Buccal distal portion of crown enamel drilled, and
- ⑤ 1 mg of material taken from the surface and inner layers.

3. Fluorine Analysis Method

The sample (about 1 mg) and water (1 mL) were placed in a 30 mL polypropylene bottle, and 0.5 mL of the H⁺-form cation-exchange resin (Dowex 50W-X8, 100–200 mesh; Dow Chemicals, Midland, USA) slurry was added using a 5 mL polyethylene syringe. After shaking for three hours, this mixture was transferred to a syringe tube fitted with a 0.45- μ m membrane filter unit (Advantec, Tokyo), and the filtrate was subjected to analysis by ion chromatography. An AS14A separation column (4 x 200 mm), an AG12A guard column (4 x 50 mm) and a membrane suppressor AMMS 300 were connected to a Dionex ICS-90 model equipped with a conductivity detector (Thermo Fisher Scientific, Sunnyvale, USA), and a 1.0 mmol/L NaHCO₃–8.0 mmol/L Na₂CO₃ mixed solution was used as the eluent (Dionex Corporation 2002). The sample introduction loop was 30 μ L. The analysis of fluoroapatite (FAP, Ca₁₀(PO₄)₆F₂, Fujifilm Wako Pure Chemical Co., Osaka, Japan) was carried out simultaneously to monitor the reliability of the analysis. The repeat measurement error for the same sample solution was within ± 0.002 (1 σ) in terms of the F/P atomic ratio. It is recommended that analytical values be reported as F/P ratios, but here they are expressed in terms of mass percentages of fluoride to facilitate comparison with other values obtained in past literature.

4. Results (Table 1, Figure 3)

① The fluorine concentration in human teeth found at the Ikawazu Shell Mound, Aichi Prefecture (where the fluorine concentration of spring water around the ruins is low) was 0.022% or less in 14 out of 18 cases, with the two cases having a high fluorine concentration, between 0.043 and 0.048%.

② At Funka Bay in Hokkaido, the fluorine concentration of human teeth was roughly divided into two groups. At the Usumoshiri site, where the concentration of fluorine in the surrounding spring water was high, there were three cases of high fluorine concentration, while there were also two cases of individuals with lower fluorine concentrations.

■ This research is funded by JSPS Grant-in-Aid for Challenging Research (Exploratory) 19K21657 "Clarification of human movements and marriage systems using dental fluorine analysis (Principal Investigator: Aono)".

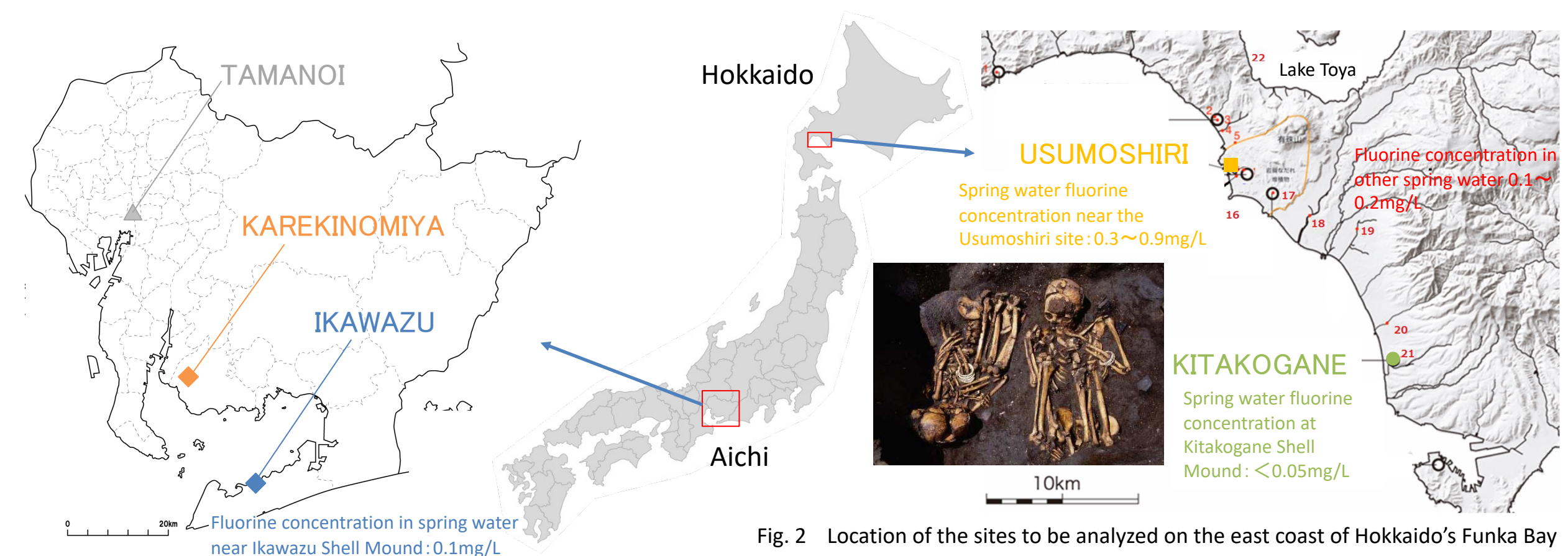


Fig. 1 Location of ruins to be analyzed in Aichi Prefecture

Table 1. Human tooth attributes and fluorine concentration

Site	Sample no.	Tooth position	Year excavated	Human bone no.	Period (Jomon)	Age	Sex	F content estimated using F/P ratio(%)	
IKAWAZU (IK)	1	LP2r	1984	1-2	Final	middle adult	male	0.005	
	2	LP2r	1984	2	Final	middle adult	male	0.026	
	3	LP2l	1984	4	Final	old adult	female	0.043	
	4	LP2r	1984	5-1	-	middle adult	female	0.022	
	5	LP2r	1984	6-1	Final	middle adult	female	0.019	
	6	LP2l	1984	6-5	Final	middle adult	male	0.014	
	7	LP2l	1984	6-8	Final	middle adult	female	0.014	
	8	LP2r	1984	9	Final	middle adult	male	0.022	
	10	LP2r	1984	12-2	Final	middle adult	female	0.020	
	12	LP2l	1984	14	Final	middle adult	male	0.048	
	13	LP2r	1984	15-2	Final	middle adult	male	0.005	
	14	LP2l	1984	16	Final	middle adult	male	0.016	
	16	LP2r	1984	1-1	Final	middle adult	male	0.018	
	17	LP2r	2010	1	Final	young adult	male	0.016	
	18	LP2r	2010	3	Final	young adult	female	0.007	
	19	LP2r	2010	5	Final	middle adult	?	0.005	
	20	LP2l	2008	2	Late	adolescent	?	0.021	
	21	LP2l	2008	3	Final	adolescent	male	0.028	
	KAREKINO MIYA (KR)	1	LP2r	1969	2	Final	young adult	male	0.013
		2	LP2r	1969	3	Final	adolescent	male	0.047
		3	LP2l	1973	8	Final	成人	male	0.033
4		LP2l	1980	20	Final	middle adult	male	0.042	
TAMANOI (TM)	1	LP2l	2002	SK27	Final	middle adult	female	0.005	
	2	LP2r	2002	SK52-53	Final	young adult	male	0.013	
	3	LP2l	2010	SK05	Final	adult	female	0.070	
USU MOSHIRI (UM)	1	LP2r	1986	4	Epi	adult	male	0.012	
	2	LP2l	1987	7F	Epi	adult	female	0.035	
	3	LP2l	1987	7M	Epi	adult	male	0.030	
	4	LP2r	1988	16A	Epi	adult	female	0.027	
	5	LP2r	1988	16B	Epi	adult	female	0.010	
KITAKOGANE (KK)	1	LP2r	1969	1	Early	adult	不明	0.026	
	2	LP2l	1971	4	Early	middle adult	male	0.012	

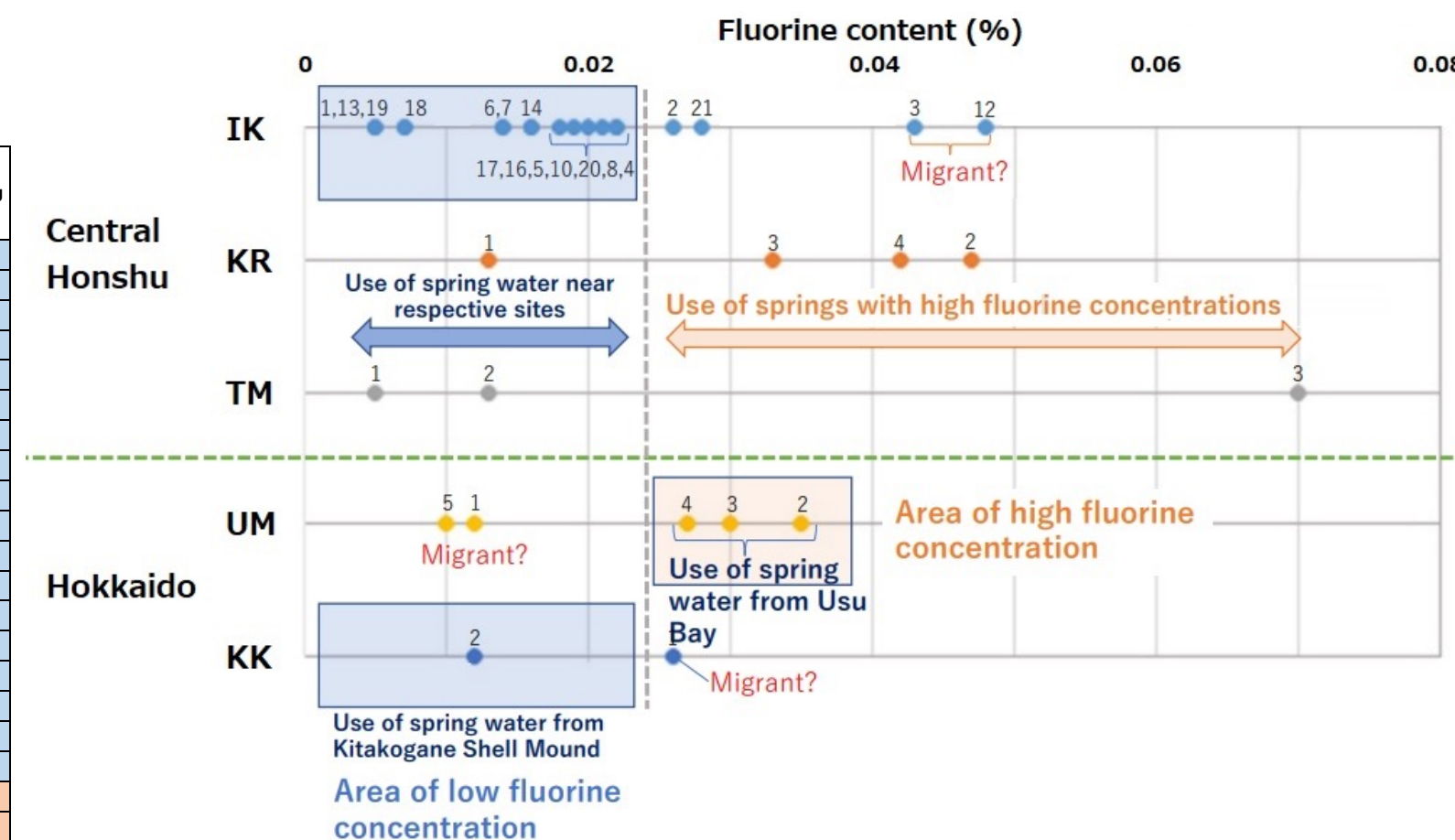


Fig. 3 Estimating migrant numbers based on the fluorine concentration (%) in enamel

5. Discussion/conclusion: The fluorine analysis of human teeth revealed that individuals with different fluorine concentrations were present at the same site. In addition, by comparing the fluorine concentrations in human teeth with those of the spring water around the ruins, it was possible to estimate the number of individuals who had migrated from other areas. More analysis of spring water and human teeth needs to be carried out with data on the fluorine concentration in different regions collected and used in studying the movement of people across the Japanese archipelago.