Supporting Information

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SI Text

Methods of Microwear Sampling and Imaging. To avoid coating original material or subjecting it to analysis under vacuum, high-resolution epoxy replicas were prepared for scanning electron micrography by using methods known to reproduce microwear with high fidelity (1, 2). Occlusal surfaces of teeth were cleaned nonabrasively with a combination of liquid acetone/ethanol and ethomeen-based solvent gels (3, 4) by using techniques developed at the Natural History Museum Palaeontology Conservation Unit for cleaning without abrasion. Molds were prepared by using polyvinylsiloxane impression medium (Speedex Light; Coltene Whaledent). Casts were made by using Araldite 20/20 epoxy resin. Replicas were coated with gold (Emitech K500X sputter coater).

Imaging for the main analyses of within- and between-tooth variation used a Hitachi S-3600N scanning electron microscope (SEM; secondary electron, topographic mode) with settings standardized at: accelerating voltage, 15 kV; working distance, 18 mm; and automatic contrast and brightness. Standardization is important for comparability of datasets (5). For image capture, the orientation of the occlusal surface of the teeth was standardized, with the long axis of the tooth row and the flat occlusal surfaces of the teeth perpendicular to the electron beam. SEM images were captured at a magnification of 300, providing a sampling site field of view of 417 $\times$ 312 μm, comparable with that commonly used in analysis of occlusal microwear in mammals (6, 7). Microwear was sampled at 11 different sites on 1 distal tooth of *Edmontosaurus* right maxilla NHM R3638 (tooth 2) and at 1 central site on each of 9 further teeth from the same tooth row. Additional data were obtained from 1 central site from 1 tooth in each of the 3 additional specimens (right maxilla NHM R3653, left maxilla NHM R3654, and right dentary NHM R3658). Sampling sites were selected to maximize the chances of obtaining in vivo microwear and to minimize postmortem artefacts. The latter are less problematic than might be supposed, because physical and chemical postmortem processes tend to obliterate microwear features rather than create artefacts (8, 9). To evaluate alternative statistical approaches to testing for differences in feature orientation between sites, microwear was also sampled at 7 sites along a vertical transect across *Edmontosaurus* right maxilla NHM R3638 (tooth 2). Images for this analysis were acquired by using an Alicona IFM (infinite focus microscope; an optical, focus variation-based technique). Sampling site field of view was 285 $\times$ 216 μm; illumination coaxial. The 3D surface data acquired during this sampling were also used for assessments of scratch depth. Digital scanning electron micrographs and IFM images were downsampled to 900 pixels wide by 675 pixels high by using Adobe Photoshop 7. Microwear data were generated by using the custom software package Microware 4.02 (10), running on a Dell Latitude D505 computer running Windows XP Professional (Microsoft), with a 15-inch active matrix TFT display set at a screen resolution of 1024 $\times$ 768 pixels, resulting in an onscreen magnification of approximately 630$\times$ for SEM and 1000$\times$ for IFM.

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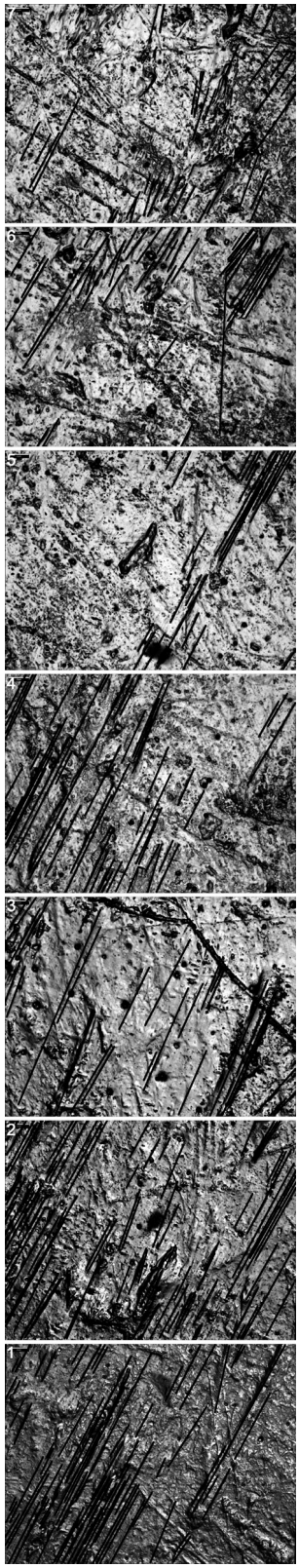

Fig. S1. Transect from apex (site 1) to base (site 7) across the functional surface of second tooth from posterior, right maxilla specimen NHM R3638 (see Fig. 1 for locations of sample sites). Class 2 microwear features are marked. Field of view is 285 μm wide.

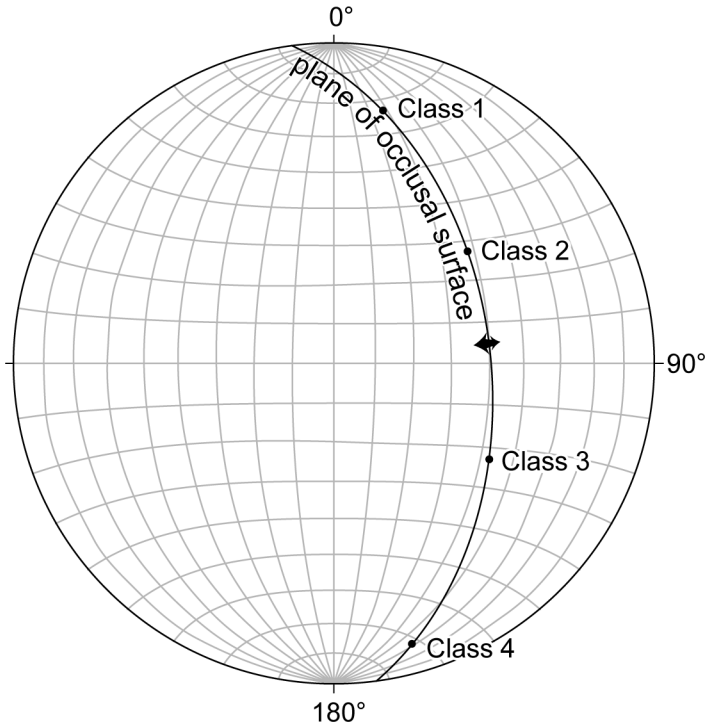

Fig. S2. Equal area stereographic projection showing tooth occlusal surface inclined at 50° from horizontal, raking 7.5° from anterior, and containing microwear classes 1–4 (in vivo orientations). Microwear data were scored in images acquired from horizontally oriented surfaces, and they were reoriented by using standard sterographic techniques. Arrow shows trend and plunge in tooth surface of pure orthal movement. Pure lateral translation, relative to sagittal plane, would be along the 90° axis of stereonet.

Table S1. Analysis of variation in orientation between sites, within tooth 2 of maxilla NHM R3638 (8 dentine sites, 3 enamel sites)

	Enamel sites			Dentine sites							
Class 1	T2–1	T2–4	T2–5	T2–2	T2–3	T2–6	T2–7	T2–8	T2–9	T2–10	T2–11
n	10	14	10	0	17	13	24	2	5	4	22
Angular dispersal, *R*	0.972	0.980	0.950		0.944	0.953	0.931	0.988	0.970	0.945	0.935
Rayleigh test (*Z*, *P*)	9.45, <<0.001	13.45, <<0.001	9.02, <<0.001		15.17, <<0.001	11.82, <<0.001	20.81, <<0.001	1.95, 0.146	4.71, 0.002	3.57, 0.016	19.23, <<0.001
Rao spacing (*U*, *P*)	273.15, <0.01	293.66, <0.01	266.63, <0.01		283.93, <0.01	272.15, <0.01	268.91, <0.01		256.15, <0.01	218.20, <0.05	269.55, <0.01
Mean orientation (mean vector, μ)	13.72	13.36	20.62		26.45	15.80	19.98	33.09	29.21	22.23	21.65
Class 2											
n	32	29	25	141	154	82	120	99	64	61	55
Angular dispersal, *R*	0.957	0.988	0.887	0.978	0.937	0.949	0.948	0.970	0.969	0.982	0.929
Rayleigh test (*Z*, *P*)	29.31, <<0.001	28.30, <<0.001	19.67, <<0.001	134.78, <<0.001	135.12, <<0.001	73.78, <<0.001	107.86, <<0.001	93.22, <<0.001	60.14, <<0.001	58.85, <<0.001	47.48, <<0.001
Rao spacing (*U*, *P*)	272.85, <0.01	311.75, <0.01	249.02, <0.01	293.99, <0.01	271.05, <0.01	299.01, <0.01	279.01, <0.01	291.43, <0.01	285.25, <0.01	302.85, <0.01	271.43, <0.01
Mean orientation (mean vector, μ)	59.45	56.05*	67.67	66.53	65.98	64.71	60.94	62.24	63.14	56.39*	61.26
Class 3											
n	17	14	34	74	66	12	10	40	38	15	34
Angular dispersal, *R*	0.939	0.963	0.936	0.942	0.913	0.990	0.894	0.979	0.898	0.902	0.923
Rayleigh test (*Z*, *P*)	14.99, <<0.001	12.99, <<0.001	29.76, <<0.001	65.73, <<0.001	54.97, <<0.001	11.76, <<0.001	8.00, <<0.001	38.36, <<0.001	30.64, <<0.001	12.22, <<0.001	28.97, <<0.001
Rao spacing (*U*, *P*)	274.16, <0.01	274.17, <0.01	265.51, <0.01	268.96, <0.01	269.90, <0.01	305.41, <0.01	238.61, <0.01	304.43, <0.01	258.46, <0.01	258.07, <0.01	275.02, <0.01
Mean orientation (mean vector, μ)	122.82	116.93	116.93	108.76	112.64	114.91	128.37	107.27	122.74	110.95	122.29
Class 4											
n	6	14	8	11	9	1	17	8	16	14	9
Angular dispersal, *R*	0.895	0.942	0.979	0.913	0.906	1.000	0.965	0.945	0.929	0.938	0.870
Rayleigh test (*Z*, *P*)	4.80, 0.003	12.42, <<0.001	7.67, <<0.001	9.16, <<0.001	7.39, <<0.001	1.00, 0.512	15.83, <<0.001	7.15, <<0.001	13.81, <<0.001	12.31, <<0.001	6.81, <<0.001
Rao spacing (*U*, *P*)	237.79, <0.01	271.09, <0.01	276.56, <0.01	251.73, <0.01	246.11, <0.01		284.47, <0.01	253.90, <0.01	267.39, <0.01	263.08, <0.01	245.17, <0.01
Mean orientation (mean vector, μ)	159.05	163.15	149.96	162.86	160.49	148.11	158.70	161.19	159.56	164.34	150.83

Mean of means (μ of μ) and confidence intervals are calculated from tooth 2 dentine sites only (8 sites: sites 2, 3, 6, 7, 8, 9, 10, and 11). Class 1: mean of means, 24.14; 99% confidence interval, 11.18–36.33. Class 2: mean of means, 62.63; 99% confidence interval, 56.79–68.56. Class 3: mean of means, 115.84; 99% confidence interval, 103.16–129.7. Class 4: Mean of means, 158.23; 99% confidence interval 147.97–168.67. *Mean orientation values fall outside 99% confidence intervals.

Table S2. Analysis of variation in orientation between teeth (1 site per tooth, 10 teeth, maxilla NHM R3638) and between jaw elements NHM R3658, R3654, and R3653 (data for right dentary R3658 and left maxilla R3654 transformed to allow direct comparison with right maxillae R3638 and R3653; see Fig. 1)

	T1–1	T2–3	T3–1	T5–2	T9–1	T15–1	T17–1	T18–1	T20–1	T23–1	R3658, T1–1	R3654, T2–1	R3653, T6–1
Class 1													
n	25	17	51	13	32	40	9	13	13	24	11	22	5
Angular dispersal, *R*	0.948	0.944	0.947	0.895	0.937	0.954	0.966	0.946	0.868	0.893	0.943	0.955	0.956
Rayleigh test (*Z*, *P*)	22.46, <<0.001	15.17, <<0.001	45.78, <<0.001	10.40, <<0.001	28.08, <<0.001	36.37, <<0.001	8.40, <<0.001	11.63, <<0.001	9.80, <<0.001	19.14, <<0.001	9.79, <<0.001	20.06, <<0.001	4.57, 0.003
Rao spacing (*U*, *P*)	278.46, <0.01	283.93, <0.01	287.92, <0.01	253.06, <0.01	275.80, <0.01	277.05, <0.01	272.56, <0.01	262.90, <0.01	256.03, <0.01	271.82, <0.01	269.06, <0.01	284.76, <0.01	240.50, <0.01
Mean orientation (mean vector, μ)	14.58	26.45	13.85	25.34	21.58	12.49*	19.86	24.82	20.80	22.05	22.59	23.16	17.37
Class 2													
n	233	154	34	54	84	99	22	26	18	100	23	27	36
Angular dispersal, *R*	0.979	0.937	0.975	0.945	0.984	0.909	0.939	0.959	0.906	0.903	0.866	0.994	0.910
Rayleigh test (*Z*, *P*)	223.25, <<0.001	135.12, <<0.001	32.34, <<0.001	48.22, <<0.001	81.26, <<0.001	81.83, <<0.001	19.39, <<0.001	23.90, <<0.001	14.79, <<0.001	81.53, <<0.001	17.24, <<0.001	26.70, <<0.001	29.84, <<0.001
Rao spacing (*U*, *P*)	309.04, <0.01	271.05, <0.01	294.57, <0.01	269.37, <0.01	300.75, <0.01	313.03, <0.01	271.33, <0.01	290.98, <0.01	269.57, <0.01	278.38, <0.01	258.67, <0.01	316.52, <0.01	272.13, <0.01
Mean orientation (mean vector, μ)	58.89	65.98	59.98	65.94	71.60	79.37*	56.97	65.28	59.07	62.96	57.85	68.46	66.36
Class 3													
n	18	66	12	3	0	4	0	4	3	4	12	8	27
Angular dispersal, *R*	0.855	0.913	0.932	0.736		1.000		0.915	1.000	0.945	0.937	0.948	0.944
Rayleigh test (*Z*, *P*)	13.15, <<0.001	54.97, <<0.001	10.42, <<0.001	1.63, 0.21		4.00, 0.007		3.35, 0.023	3.00, 0.033	3.57, 0.016	10.55, <<0.001	7.19, <<0.001	24.05, <<0.001
Rao spacing (*U*, *P*)	251.22, <0.01	269.90, <0.01	249.69, <0.01			269.21, <0.01		209.14, <0.05		223.30, <0.01	260.38, <0.01	257.76, <0.01	278.25, <0.01
Mean orientation (mean vector, μ)	121.47	112.64	116.23	122.43		90.71*		125.77	109.33	129.88	115.16	119.36	123.16
Class 4													
n	18	9	55	17	9	20	7	29	16	29	5	2	53
Angular dispersal, *R*	0.900	0.906	0.935	0.922	0.954	0.947	0.946	0.972	0.969	0.966	0.986	0.997	0.962
Rayleigh test (*Z*, *P*)	14.57, <<0.001	7.39, <<0.001	48.04, <<0.001	14.46, <<0.001	8.19, <<0.001	17.94, <<0.001	6.27, <<0.001	27.42, <<0.001	15.02, <<0.001	27.08, <<0.001	4.86, 0.002	1.99, 0.14	49.00, <<0.001
Rao spacing (*U*, *P*)	260.40, <0.01	246.11, <0.01	288.66, <0.01	273.08, <0.01	257.71, <0.01	278.75, <0.01	259.99, <0.01	285.65, <0.01	272.76, <0.01	290.71, <0.01	260.93, <0.01		290.37, <0.01
Mean orientation (mean vector, μ)	151.89*	160.49	166.10	159.67	163.77	164.47	167.49	164.19	164.00	168.63	163.72	157.75	157.29

Mean of means (μ of μ) and confidence intervals calculated from 10 teeth on maxilla NHM R3638 only. Class 1: mean of means, 20.13; 99% confidence interval, 13.2–27.26. Class 2: mean of means, 64.56; 99% confidence interval, 55.4–74. Class 3: mean of means, 115.62; 99% confidence interval, 94.16–138.72. Class 4: mean of means, 163.17; 99% confidence interval, 156.44–169.45.
*Mean orientation values fall outside 99% confidence intervals.