

*Geochemistry, Geophysics, Geosystems*

Supporting Information for

**Applicability of Object Detection to Microfossil Research: Implications from Deep Learning Models to Detect Microfossil Fish Teeth and Denticles Using YOLO-v7**

**K. Mimura<sup>1,2</sup>, K. Nakamura<sup>3,2,1</sup>, K. Yasukawa<sup>3,2</sup>, E. C. Sibert<sup>4,5</sup>, J. Ohta<sup>3,6,1</sup>, T. Kitazawa<sup>2</sup>, Y. Kato<sup>2,1,7</sup>**

<sup>1</sup>Ocean Resources Research Center for Next Generation, Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino, Chiba 275-0016, Japan.

<sup>2</sup>Department of Systems Innovation, School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan.

<sup>3</sup>Frontier Research Center for Energy and Resources, School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan.

<sup>4</sup>Department of Earth & Planetary Sciences, Yale University, P.O. Box 208109, New Haven, CT 06511, USA

<sup>5</sup>Department of Geology & Geophysics, Woods Hole Oceanographic Institution, 266 Woods Hole Rd MS 22, Woods Hole, MA 02543, USA.

<sup>6</sup>Volcanoes and Earth's Interior Research Center, Research Institute for Marine Geodynamics, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2-15 Natsushima-cho, Yokosuka, Kanagawa, 237-0061, Japan.

<sup>7</sup>Submarine Resources Research Center, Research Institute for Marine Resources Utilization, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2-15 Natsushima-cho, Yokosuka, Kanagawa, 237-0061, Japan.

**Contents of this file**

Figure S1

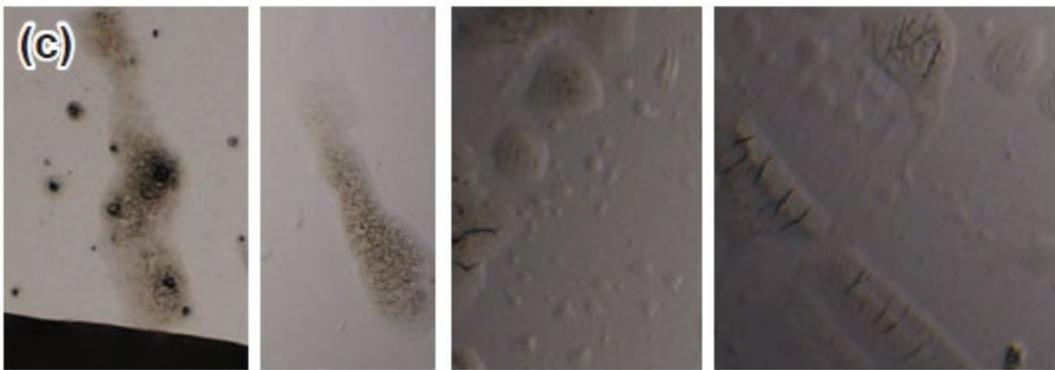
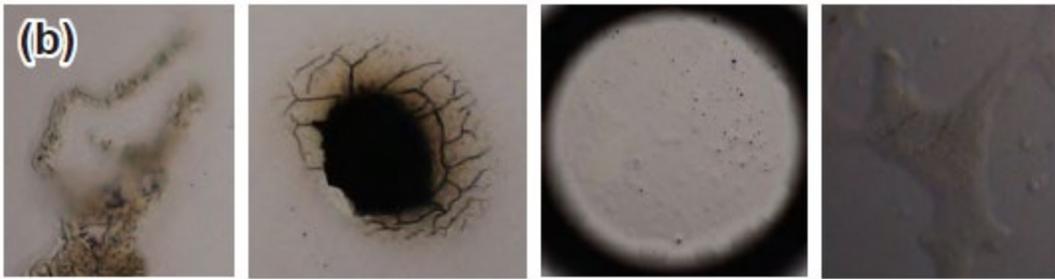
Tables S1 to S2

**Additional Supporting Information (Files uploaded separately)**

Caption for Table S3: Total number of ichthyoliths counted by manual observation and those detected by four models trained in this study. The total counts after manual checks are also shown.

## **Introduction**

Figure S1 contains some images showing examples of particles or patterns misdetected by a model trained with the original dataset. Table S1 shows locations and water depths of the sites analyzed in this study. Table S3 shows the total number of ichthyoliths counted by manual observation and those detected by four models trained in this study. Please note that Tables S3 is provided in a separate file.



**Figure S1.** Examples of particles or patterns that were misdetected as (a) tooth, (b) denticle and (c) saw-toothed by a YOLOv7-X model trained on “original\_all” dataset.

Cruise	Site	Hole	Latitude	Longitude	Water depth [m]
DSDP Leg 76	576	B	32°21.37' N	164°16.52' E	6,219
ODP Leg 185	1149	A	31°20.52' N	143°21.07' E	5,818
		B	31°20.52' N	143°21.06' E	5,818
IODP	U1366	C	26°03.08' S	156°53.67' W	5,130
Expedition 329	U1370	D	41°51.12' S	153°06.38' W	5,073
KR13-02	PC04	-	21°56.11' N	152°39.51' E	5,720
MR14-E02	PC11	-	22°59' N	154°01' E	5,647

**Table S1.** Locations and water depths of the analyzed sites.

iteration	1 (#8)	2	3	4	5	Average	1SD	1SE	
Precision	tooth	0.868	0.861	0.89	0.881	0.921	0.884	0.023	0.010
	denticle	0.852	0.771	0.805	0.828	0.869	0.825	0.039	0.017
	saw-toothed	0.8	0.89	0.873	0.875	0.781	0.844	0.050	0.022
	<b>average</b>	<b>0.84</b>	<b>0.844</b>	<b>0.856</b>	<b>0.861</b>	<b>0.857</b>	<b>0.852</b>	<b>0.009</b>	<b>0.004</b>
Recall	tooth	0.859	0.884	0.868	0.871	0.938	0.884	0.031	0.014
	denticle	0.776	0.837	0.816	0.786	0.816	0.806	0.025	0.011
	saw-toothed	0.8	0.894	0.7	0.7	0.811	0.781	0.082	0.037
	<b>average</b>	<b>0.811</b>	<b>0.872</b>	<b>0.795</b>	<b>0.786</b>	<b>0.855</b>	<b>0.824</b>	<b>0.038</b>	<b>0.017</b>
f1 score	tooth	0.863	0.872	0.879	0.876	0.929	0.884	0.026	0.012
	denticle	0.812	0.803	0.810	0.806	0.842	0.815	0.016	0.007
	saw-toothed	0.800	0.892	0.777	0.778	0.796	0.808	0.048	0.021
	<b>average</b>	<b>0.825</b>	<b>0.858</b>	<b>0.824</b>	<b>0.822</b>	<b>0.856</b>	<b>0.837</b>	<b>0.018</b>	<b>0.008</b>

**Table S2.** Standard deviation and standard error of evaluation parameters calculated by iteration of training under the same condition for five times.

(Tables S3 is provided in a separate file.)