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Record Number: 339

File Name (TITLE): Radiological Analysis of Biological Samples ...

Document Number (ID): UWFL-18

DATE: 3/1949

Previous Location (FROM): CIC

AUTHOR: L. Donaldson, et al

Addditional Information:

OrMIbox: 19

CyMIbox: 12

UNIVERSITY OF WASHINGTON

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SEATTLE, WASHINGTON 98105

0149060

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REPORT NO. UWFL-18

UWFL-18

RADIOLOGICAL ANALYSIS OF BIOLOGICAL SAMPLES COLLECTED AT ENIWETOK MAY 16, 1948

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March 1949

Radiological Analysis of Biological Samples Collected At Eniwetok May 16, 1948.*

by

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Introduction

On May 16, 1948, the day following the Runit Island test, a collection of marine organisms was made from the reef area about one and one-fourth miles north of the test site. This collection was used as a point of reference for the contamination studies planned for later in the season.

Arrangements for the expedition to make the collection were handled by Captain James S. Russell, U.S.N., Test Director, and Colonel James P. Cooney, M.C.

The collection was made by Dr. Lauren R. Donaldson assisted by Dr. David B. Langmuir, Dr. Paul Aebersold, Mr. James Pickard, Commander Christian Engleman, U.S.N. with Captain Mallory as radiation monitor.

Collecting Area

The collecting area was chosen some distance (one and one-fourth miles) from the target area so as to be outside of the area of greatest fall-out but still within the general fall-out pattern. Samples of aquatic life were obtained from the waters on both sides of the exposed reef. At low tide the material collected was in water 2 to 4 feet deep.

* This report is based on work performed under Contract No. W-28-094-eng-33 with the Atomic Energy Commission.

Collecting Methods

Samples were collected from areas surrounding isolated coral heads. After selecting a coral head with a variety of forms about it a small quantity of powdered derris root, 2 to 3 pounds of 5% rotonone, was worked into the water. At the warm temperatures that prevailed fishes were immobilized and died in a few minutes. Attached and sedentary forms were collected in the vicinity of the same coral head to complete the sample.

The material collected was first preserved in 4% formalin, then transferred to 70% alcohol for shipment to the Applied Fisheries Laboratory for ashing and counting. Some surface activity was undoubtedly lost by this method of handling.

Preparation of Material for Counting

To reduce the material to a convenient form for counting, small samples, usually about one gram in weight were placed on one inch stainless steel plates and reduced to an ash. The samples were heated to 120° C. on a hot plate to start the reduction. After heating sufficiently to char, a drop of olive oil was added to reduce sputtering and give better distribution of the material on the plate. The trays with the tissue residue were then placed in a muffle furnace and the temperature raised to 370° C. After two hours of heating the temperature was raised to 500° C. and maintained until a white ash was obtained. A drop of nitric acid was then added and the samples set aside to cool. After cooling the plates were mounted on cards and covered with cellophane for counting.

Counting Methods

The beta-gamma activity was determined by counting in a Victoreen unit, the scaler being Model X-327, at the Applied Fisheries Laboratory, University of Washington. Counting was started as soon as material could be returned from the test site, processed and ashed. The first counts were made on May 22, 1948, while other trays were not counted until September 1, 1948.

Some of the counts of activity exceeded the capacity of the scaler. Where such high counts were obtained the amount of material on a plate was reduced or the material set aside to decay before counting. From decay curves the earlier count could be calculated.

The samples were corrected for background, for weight of samples and for geometry. The background counts averaged 17.0 per minute. Using a U. S. Bureau of Standards Ra D + E standard of approximately 108 disintegrations per second the geometry of the unit was calculated as being 18.0 per cent. No correction was made for scattering, for self-absorption, for absorption by air, and by counter window or for the probability of ionization.

Calculation of Counts

The activity counts obtained were converted to millimicrocuries per kilogram of sample and recorded in Table I. To convert counts per minute - per gram, to millimicrocuries per kilogram the following formula was used:

$$m\mu c/kg = \frac{\text{net count per minute}}{(\text{sample wt.})(\text{geometry})(2.2)}$$

Table I. Beta-Gamma Activity of Fish Tissues and Miscellaneous Invertebrates from May 16, 1948, Eniwetok Collection Expressed as Millimicrocuries per Kilogram of Wet Tissue and Arranged as to Date Counted.

Fish / Tissue	skin	muscle	bone	liver	gut	gill	ovary	soft parts	entire organism	date counted
squirrel	80	93	2190	263	15000	2070				5-22
surgeon	11400	96	847	4050	141000	4240				5-22
squirrel	1810	134	233	727	82200	1940				5-23
grouper	149	21	25	280	2530	808				5-24
squirrel	307	38	2	151	14400	439				5-25
grouper	1160	65	105	290	38500	873				5-26
damsel	157	960	7400	20900	69200	1290	50000			5-26
Average	2150	201	1540	3810	51800	1670				-
parrot	1170	151	955	1650	50000+*	27100				6-12
wrasse	291	48	100	364	390	300				6-12
V grouper	99	16	55	73	1190	834				6-18
squirrel	174	46	116	221	22500	271				6-18
goby									468	6-18
lizard									586	6-18
Average	434	65	306	577	18500	6860				
Congereel	354	6	0	10	11	0				8-30
grouper	12	2	7	11	0	82				8-30
squirrel	37	7	2	72	2120	8				8-31
cardinal	643	0	51	35	1450	25				9- 1
lizard	0	10	19	0	111	32				9- 1
surgeon	2120	30	95	32	3420	406				9- 1
Average	528	9	29	27	1180	92				
Invertebrates										
crustacean									10400	5-23
oyster								35400		5-23
sea urchin									2060	5-23
snail									314	6-13
snail									702	6-13
snail									2360	6-13
snail									1760	6-18

* above capacity of scaler

If the number of dis_integrations per second for one curie is 3.7×10^{10} and this value is corrected for conversion to minutes and then the equation above is converted to millimicrocuries the resulting value is the 2.2 that appears in the denominator of the equation.

The per cent error in counting was insignificant because of the relatively high rate of disintegration.

Discussion of Results

The data recorded in Table I indicates an appreciable uptake of active material by aquatic forms collected about one and one-fourth miles north of Runit Island on the day following the test.

The fish material ashed and counted during late May, based on seven specimens, had the greatest concentration of active materials in the gut, where an average of 51,800 millimicrocuries per kilogram of material was found. The counts in the liver of 3810 m/uc/kg indicate that absorption is taking place. Surface contamination with the material possibly adhering to the mucous cover of the body is indicated by the 2150 m/uc/kg found as an average count in the skin. The gills (1670 m/uc/kg), the bone (1540) and the muscle (201) had decreasing amounts of activity.

Fish material ashed and counted during mid-June, late August and early September had counts with about the same distribution of activity in the various tissues but with reduced amounts suggesting a rapid rate of activity decay.

Reduction of Activity by Decay

Selected samples of the May 16 collection from Eniwetok were used to determine the rate of activity decay. Counting started on some of this

material on May 22 and is being continued with the latest counts having been made on February 19, 1949. The material used in this study of activity decay is listed in Table II. The beta-gamma counts expressed as counts per minute per gram of wet tissue are recorded in Table III with the essential data plotted in Figure 1.

The data show a very rapid decay of the energy from mid-May to mid-September. From September to mid-February the counts of all the samples continued to decrease but at a much slower rate. Fitting a straight line to the last three points of the curve i.e. for November 27, January 1 and February 19, the half-life period is approximately 180 days.

The slope of the curves at the beginning and at the end tempts one to postulate that the predominant active materials may be Na^{24} and Ca^{45}.

Table II. Description of samples used for a study of activity decay.

sample no.	wet weight of sample	tissue	organism
XE 51	0.824 gram	gut	parrot fish
XE 38	0.960 gram	gut	black damsel fish
XE 11	0.353 gram	gut	black surgeon fish
XE 17	0.177 gram	gut	red striped squirrel fish
XE 40	0.205 gram	ovary	black damsel fish
XE 45	0.265 gram	gut	brown spotted grouper
XE 19	0.487 gram	soft parts	oyster
XE 5	0.545 gram	gut	red striped squirrel fish
XE 21	0.448 gram	entire organism	sea urchin

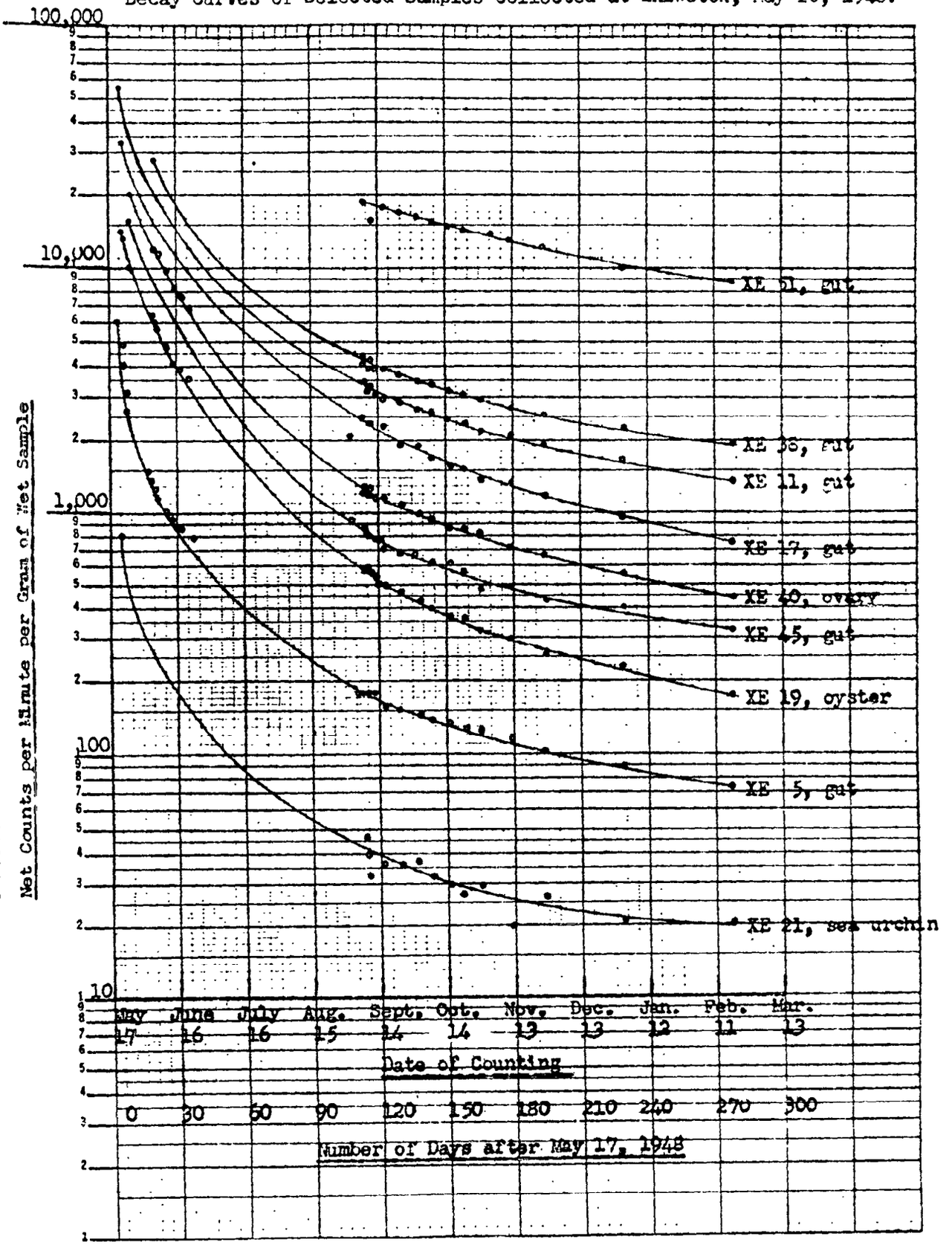
Table III. Beta-Gamma Decay of Selected Samples from May 16, 1948, Eniwetok Collections Expressed as Counts per Minute Per Gram of Wet Tissue.

Sample No. / Date counted	XE-5	XE-11	XE-19	XE-38	XE-40	XE-45	XE-51	XE-17	XE-20	XE-21	XE-26	XE-37	XE-79	XE-1	XE-3
5-22-48	5934	55980												32	868
5-23-48	4857		14004					32542	4096	814					731
5-24-48	4061		13082						3533						606
5-25-48											5699				515
5-26-48	3095		9930		19878	15245			2680			8288			448
5-27-48	2668								2213			8032			407
6- 4-48	1488														
6- 5-48	1330		6462						1360			4210			259
6- 7-48	1239		5934	27500	11878				1287			3662			152
6- 8-48	1138		5544		11156				1218			3369			145
6-12-48	1013		4830		9663				1099			2564			145
6-15-48	945		4020		8215				919			2204			145
6-18-48	852		3833		7420				888			1973	1039		145
6-22-48	789		3499		6834				868			1682			134
9- 1-48															6
9- 2-48						910		2069*			322				
9- 7-48	174												238	20	
9- 8-48	174	3416	571	4215	1210	853	18475	2443	200	47	265	241	207	21	0
9- 9-48	175	3292	577	4063	1220	821	15794**	2365	166	39	278	275		22	0
9-10-48	176	3195	590	4084	1268	798	16414**	2355	180	32	271	183	214	14	1
9-11-48		3234	565	3970	1213	775	13290**								
9-13-48		3091	516	3924	1173	758	17218**								
9-14-48		3086	500	3971	1174	759	13109**								
9-17-48	156	2989	490	3878	1161	703	17815	2144	155	36	246	179	223		
9-24-48	153	2814	460	3618	1062	680	16470	1946	145	36	224	147	140		
10- 1-48						666									
10- 2-48	146	2685	431	3491	983		16325	1906	150	38	224	148	162		
10- 8-48	138	2607	397	3332	922	618	15233	1702	135	32	165	119	137	29	2
10-16-48	134	2450	365	3189	849	579	15031	1584	132	29	165	115	138		
10-22-48	127	2341	358	3094	874	666	14260	1537	118	27	180	142	107		
10-30-48	127	2196	320	2959	833	477	13897	1379	113	30	180	136	137		
11-12-48	113	2062	296	2762	711	485	12926	1329	110	20	190	89	101		
11-27-48	101	1930	256	2613	658	428	11943	1160	94	27	133	88	102	10	1
1- 1-49	88	1637	225	2214	556	400	9857	955	80	21	108	65	54		
2-19-49	74	1366	173	1808	443	321	8641	747	66	20	74	44	45		

* hydroscopic, reprocessed.

** averaged, 15200.

Decay Curves of Selected Samples Collected at Eniwetok, May 16, 1948.



Summary

Marine organisms were collected on May 16, 1948, from the shallow waters of the reef about one and one-fourth miles north of Runit Island for the purpose of determining the beta-gamma radiation.

Samples of about one gram wet weight were reduced to an ash for counting. In the fish samples the skin, muscle, bone, liver, gut, and gills were sampled. The entire organism for most invertebrates was used as a sample. A total of 118 samples were prepared and counted.

The greatest concentration of active material was found in the gut but some distribution of radioactive elements to the tissues had started in the short time (one and one-half days) between the fall-out and time of collection.

Decay studies on selected samples show a very rapid rate of initial change. A straight line fitted to the last three points in the decay curves, i.e. for November 27, 1948, January 1, 1949, and February 19, 1949, give a half life period of approximately 180 days.