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THE SALTON SEA SAMPLING PROGRAM: BASELINE AND TOXICITY STUDIES

R. E. TULLIS

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BASELINE & TOXICITY STUDIES ON SALTON SEA FISHES

PART I

This report provides baseline data on several of the Salton Sea fishes. Morphometric (dimensions) and meristic (counting elements) data are presented as a baseline to evaluate any accumulation and physiological stresses that the fishes may experience as a result of geothermal development. Trace elements were analyzed in selected tissues or whole fish. The trace elements evaluated were K, Cu, Fe, Cu, Zn, Br, Rb, Sr, and Pb. The major fishes studied were corvina (Cynoscion xanthulus), gulf coaker (Bairdiella icistius, and molly (Poecilia latapinna). Other fishes occasionally tested were Tilapia sp. and sargo (Anisotremus davidsonii). These data are important if environmentally sound progression of geothermal development is to occur at the Salton Sea.

METHODS:

The fishes used for trace element analysis were collected primarily at one location in the Salton Sea. Corvina, gulf croakers and sargo were collected from the Salton Sea State Park area with gill nets graded approximately from a 2-inch to 5-inch stretch. Tilapia sp. and mollies were collected by bag seine at Cleveland Street. In addition, mollies were taken at Red Hill Marina and 82nd Street. This change in location was due to their periodic absence at Cleveland Street. Fish were collected on four sampling periods: October 19, 1976; January 12, 1977; April 27, 1977; and July 13, 1977.

The procedure for collection and handling of gill netted fish was as follows. Gill nets were set in shallow water (-2 to -4 meters) at 1800 hours and were retrieved the next morning at 0600 hours. The fish were removed from the nets, individually placed in separate polyethylene bags and frozen in dry ice for transfer to California State University, Hayward.

Prior to dissection and tissue preparation, morphometric and meristic data were recorded for all species except mollies. Muscle, liver, kidney, and bone samples were taken from each fish using ultra clean plastic utensils (to avoid metal contamination) and placed in glass beakers and weighed. The samples were then dried at 60°C for at least 48 hours, cooled, and weighed. The samples were taken from less than 200°C to 450°C in increments of 50°C/hour in a muffle furnace. The samples remained in the furnace until all organic material was ashed. Approximately 15g wet muscle was required to provide enough ash for analysis. Considerably more liver, approximately 30g, was needed, perhaps due to the large amounts of oil present. Slightly less bone, 10g, was required. In some instances (e.g. kidney, liver) the tissue from two or more fish was pooled to provide an adequate sample. The small size of the mollies required that most samples consist of a pool of two or more fish.

Upon completion of the ashing process, each sample was transferred to a glass vial and sent to Lawrence Livermore Laboratory for trace element analysis by x-ray fluorescence.

RESULTS AND DISCUSSION:

1. Morphometrics and Meristics

Dorsal fin ray counts were made to determine if there was any deviation from normal counts (Tables 1-3). It is commonly believed that abnormalities in meristics may indicate that the fishes are under severe physiological stress. There were almost no abnormal dorsal fin ray counts in our samples of corvina and gulf croaker. Spine counts appear to be lower in the sargo. This is possibly a result of higher temperatures during development or may simply be a founder effect from the initial stocking that took place.

Liver indices were calculated for corvina, gulf croaker, and sargo (Figure 1). The liver indices in corvina and the gulf croaker appear to be lowest in October, possibly representing a loss of storage products after spawning.

Gonado-somatic indices were calculated for corvina, gulf croaker and sargo (Figure 2). The gulf croaker gonads increased in April and then decreased significantly by July. This seems to strongly indicate spawning had occurred during that time period. In corvina the time of spawning is less well defined. Corvina is thought to spawn in the latter part of the summer and to occasionally have multiple spawnings. Our sampling began in October, probably after spawning. The last sampling date was in July which does show a slight increase in the gonad maturation. There were only two sampling dates in which sargo were observed for these parameters.

2. Stomach Contents

Macroscopic examination of stomach contents were made on corvina, gulf croaker, and sargo (Table 4). Corvina fed exclusively on fish, most likely

the gulf croaker. Sargo fed on barnacles (Balanus amphitrite) and occasionally on amphipods. The gulf croaker fed on worms (Neanthes succinea) and fish. It is thought that the gulf croaker feeds almost exclusively on worms. However, in the July sample Neanthes succinea made up only 11% of the stomach contents while fish made up the other 89%. It must be remembered that percentages listed in Table 4 are frequency of occurrence of prey items. It is not known why all sixteen gulf croakers sampled in April had empty stomachs, though the nearness of their spawning period may have had some influence.

3. Trace Elements

The main emphasis of this study is to establish baseline information on the amounts of trace elements in various tissues of fishes in the Salton Sea. The trace elements and their amounts are listed in Tables 5 through 13. There seems to be no definite seasonal variation in the amounts of trace elements in the fish. Although there may be a relationship between increased amounts of trace elements with increased fish weight, the size range of fish sampled within a species was not great enough to test this relationship. The amounts of K, Rb, Sr, and Zn all seem to be within the ranges reported to other researchers. Lead, on the other hand, does seem to be elevated when compared to the marine environment.

Much of the speculation in this past year's research will be clarified by a more extensive sampling effort for various size ranges of fish in the coming year.

PART II

Geothermal brine residue can collect and accumulate in the Salton Sea by seepage and runoff. Little is known of the toxic effects of this brine to the fish populations within the sea. Therefore, experiments were carried out to determine concentrations of brine that would produce fish mortality and other physiological abnormalities.

1. Tolerance of Poecilia latipinna to varying salinities of Salton Sea Water (SSW).

Mollies collected at Cleveland Street canal, Salton Sea, were placed in three different concentrations of SSW: 22‰, 34‰, and 39‰. Two week observation time demonstrated no significant mortality in the three salinities; 34‰ was considered the control since this was the ambient salinity at the collection site (Fig. 3).

2. Toxicity of normal geothermal brine to the mollie, Poecilia latipinna.

Mollies collected at Cleveland Street Canal, Salton Sea, were acclimated to 22‰ SSW at 20°C for 2 weeks. Groups of 16 fish were then transferred to each of seven 28 liter containers of 22‰ SSW and acclimated for an additional 2 days. To each of six containers a specific amount of geothermal brine was added to bring the concentrations of each of the containers the following brine concentration levels: 0.25% , 0.50‰ , 1.0% , 2.5% , 5% , and 7.5% ; the seventh container received no brine and was the control. Results are plotted in Figure 3.

3. Toxicity of "clean" geothermal brine to the mollies.

In increasing concentrations of SSW-brine solutions (as noted above) a very noticable accumulation of iron oxides occurs; the SSW becomes turbid and discolored. By treating the 5% SSW-brine solution with NaOH under vigorous aeration for 2 hours and readjusting the pH with HCl, the oxides precipitated out thus leaving a clear medium. It is assumed that the brine solution contains all the brine components except the iron oxides. When fish were observed for mortality in 22‰ SSW with 5% "clean" brine as compared to 5% normal brine (see above), there was a significant decrease in mortality (Figure 3).

4. Zinc toxicity in Mollies

Since zinc is a major component of the geothermal brine in the Salton Sea, toxicity produced by the zinc was observed relative to fish mortality. The control SSW again was 22‰; zinc concentrations in the five experimental containers measured 5, 10, 15, 20, and 30 ppm. Over a two week observation period, mortality for the experimentals was no different from the controls (no zinc); absolute values over the two weeks did not exceed 2 fish whereas each container had 16 fish. However, it was noticed that fish exposed to the zinc secreted a translucent, whitish mucous; the controls did not. This similar observation was also made on the fish in the higher brine concentrations (above).

5. Effect of SSW concentration on zinc-exposed mollies.

This experiment was designed to demonstrate the effect of varying ambient salinities on fish that had prior exposure to 20 ppm zinc. Two groups of fish were acclimated for 2 weeks to 22‰ SSW; to one group was added zinc, as zinc sulphate, at the ppm level. There was no significant mortality during the acclimation period. At the end of two weeks each group was subdivided into three groups each and placed in either one of three separate non-zinc-containing salinities as illustrated below:

The freshwater contained 50 mg NaCl + 25 mg CaCl₂/l; the temperature was 18-20°C. The fish from the control, non-zinc-exposed group showed no mortality during the succeeding week. On the other hand, the zinc-exposed group that had been placed in freshwater for the preceding 2 weeks did show significant mortality; 50% mortality was reached in about 5 days with no mortality thereafter (Figure 4). Zinc-exposed fish that were placed in 11‰ SSW showed no mortality; 10% of the fish in 45‰ SSW died on the first day with no deaths thereafter (Figure 4). Only one group, the zinc-exposed fish in freshwater, demonstrated a true toxic reaction to a salinity stress; the other groups tolerated the imposed salinity stress.

6. Oxygen consumption of mollies in varying brine concentration.

Again, mollies were acclimated to 22‰ SSW; brine solutions of 0%, 1%, 2.5%, and 5% were made. Oxygen consumption of the fish (Winkler method) was determined one hour following a two hour exposure to the various brine solutions. No significant differences were observed, but there was a trend for the fish in 5% and 2.5% brine solutions to utilize less oxygen.

Figure 1 Liver indices. Liver index equals weight of liver (10^3)/weight of fish. Total bar represents sampling range; enclosed rectangle equals standard deviation; center point is mean value.

Figure 2 Gonado-somatic indices. Gonado-somatic index equals weight of gonad (10^3)/weight of fish. Total bar represents sampling range; enclosed rectangle equals standard deviation; center point is mean value.

Figure 3 Mortality of *Poecilia latipinna* exposed to geothermal brine in Salton Sea water.

Figure 4 *Poecilia latipinna* exposed to zinc, then salinity stressed.

1) Sixty fish exposed to 20 ppm Zn^{++} in 22‰ Salton Sea water.

2) Fish removed from Zn^{++} and divided into groups of 20 and placed into (a) fresh water (b) 45‰ sea water (c) 11‰ sea water.

TABLE 1: MORPHOMETRIC AND MERISTIC DATA FOR LIST SAMPLING PERIOD (OCTOBER)

<u>Fish Species</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std Length</u>	<u>Go-So¹ Index</u>	<u>Liver² Index</u>	<u>Fin³ Ray Count</u>
<u>Cynosion xanthulus</u>	A	802.0g	35.5cm	.014g	.008g	IX + I, 21
	B	1019.0	39.5	.016	.007	IX + I, 20
	C	737.0	37.0	.011	.004	IX + I, 21
	D	810.0	39.0	.022	.010	IX + I, 20
	E	760.5	38.0	.003	.008	IX + I, 20
	F	861.5	38.5	.017	.014	IX + I, 21
	G	799.3	38.5	.003	.007	IX + I, 20
	H	1032.0	40.0	.015	.011	VIII + I, 20
	I	751.3	35.0	.011	.007	IX + I, 20
	J	737.9	36.5	.014	.010	IX + I, 19
	K	846.0	38.5	.024	.012	IX + I, 20
	L	1352.5	45.5	.006	.007	IX + I, 20
	M	878.4	39.0	.018	.009	IX + I, 19
	N	674.6	33.0	.012	.013	IX + I, 21
	P	810.9	36.5	.012	.010	IX + I, 20
	Q	878.3	38.0	.030	.018	IX + I, 20

¹Gonadal-Somatic Index = $\frac{\text{Gonad Wt.}}{\text{Fish Wt.}}$

² = $\frac{\text{Liver Wt.}}{\text{Fish Wt.}}$

³ — All counts are for dorsal fins

1st Roman numeral = # spines

2nd Roman numeral = # spines in 2nd dorsal fin

Arabic numerals = soft rays

TABLE 1: (continued)

<u>Bairdiella</u> <u>icistius</u>	Fish No.	Body Wt.	Std Length	Go-So ¹ Index	Liver ² Index	Fin ³ Ray Count
	A	248.1	23.0	.022	.008	XII, 25
	B	301.2	25.5	.027	.006	XII, 27
	C	288.1	25.0	.033	.005	XII, 27
	D	282.6	24.5	.031	.010	XI, 28
	E	279.9	23.5	.030	.007	XII, 29
	F	276.1	23.5	.068	.004	XII, 29
	G	210.6	24.5	.038	.007	XII, 27
	H	276.4	24.0	.037	.003	XI, 25
	I	332.0g	26.0cm	.027g	.006g	XI, 28
	J	328.1	26.5	.029	.008	XII, 24
	K	232.7	23.5	.060	.005	XI, 26
	L	318.4	25.5	.034	.009	XI, 25
	M	265.9	23.2	.071	.010	XI, 24
	N	246.6	23.0	.023	.009	XII, 24
	P	262.3	23.5	.038	.007	X, 28
	Q	215.4	21.0	.065	.009	XI, 27

TABLE 1: (continued)

<u>Anisotremus</u> <u>dauidsonii</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std</u> <u>Length</u>	<u>Fin³</u> <u>Ray Count</u>
				<u>XII, 13</u>
	A	64.2	13.0	
	B	46.5	11.5	XI, 12
	C	63.8	12.0	XII, 12
	D	39.4	11.0	XII, 13
	E	48.8	11.5	XI, 13
	F	46.6	11.0	XI, 13
	G	46.1	11.0	XI, 13
	H	48.4	11.5	XI, 14
	I	257.2	19.5	XII, 13
	J	43.0	11.0	XII, 13
	K	47.8	11.6	XI, 15
	L	48.5	11.0	XII, 13
	M	44.8	11.0	X, 12
	N	58.7	11.5	XII, 14

TABLE 2: MORPHOMETRIC AND MERISTIC DATA FOR 2ND SAMPLING PERIOD (JANUARY)

<u>Fish Species</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std Length</u>	<u>Go-So¹ Index</u>	<u>Liver² Index</u>	<u>Fin³ Ray Count</u>
<u>Cynosion xanthulus</u>	A	900.5g	37.5cm	.013g	.022g	IX + I, 21
	B	993.1	40.0	.006	.020	IX + I, 21
	C	962.4	40.0	.017	.018	IX + I, 20
	D	950.0	39.5	.016	.020	IX + I, 21
	E	1048.0	40.0	.009	.015	IX + I, 20
	F	882.0	38.0	.013	.019	IX + I, 20
	G	1002.3	39.0	.012	.012	IX + I, 20
	H	1196.4	42.0	.005	.018	IX + I, 20
	I	1038.4	41.0	.012	.020	IX + I, 20
	J	954.5	40.0	.012	.017	IX + I, 20
	K	922.1	38.0	.015	.018	IX + I, 21
	L	1014.9	40.5	.018	.028	IX + I, 21
	M	1108.2	41.5	.007	.009	IX + I, 20
	N	953.1	37.5	.021	.032	IX + I, 20
	P	1093.7	41.5	.009	.026	IX + I, 20
	Q	1175.3	40.0	.009	.017	IX + I, 19
<u>Bairdiella icistus</u>	A	378.0	26.0	.069	.023	IX, 28
	B	237.3	22.0	.016	.022	XII, 24
	C	130.2	18.0	.028	.015	XI, 28

TABLE 2: (continued)

<u>Anisotremus</u> <u> davidsonii</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std</u> <u>Length</u>	<u>Go-So</u> ¹ <u>Index</u>	<u>Liver</u> ² <u>Index</u>	<u>Fin</u> ³ <u>Ray Count</u>
	A	968.8	29.5	.071	.021	XII, 14
	B	819.2	28.0	.029	.031	XII, 13
	C	592.4	23.5	.027	.022	XI, 14
	D	770.2	27.5	.016	.024	XI, 14
	E	474.2	24.0	.029	.019	XII, 14
	F	963.1	29.0	.035	.025	XII, 14
	G	835.3	27.5	.026	.029	XII, 12
	H	868.4	28.0	.067	.021	XII, 14
	I	1015.9	29.5	.025	.029	XII, 13
	J	757.4	27.5	.022	.026	XI, 15
	K	760.7	27.5	.019	.019	XII, 14
	L	813.9	28.5	.029	.016	XII, 11
	M	635.1	26.5	.009	.012	XII, 13
	N	1012.4	29.5	.026	.051	XII, 12
	P	714.6	25.5	.020	.021	XII, 12
	Q	562.2	26.0	.006	.017	XI, 15

TABLE 2: (continued)

<u>Tilapia sp.</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std Length</u>	<u>Go-So¹ Index</u>	<u>Liver² Index</u>	<u>Fin³ Ray Count</u>
	A	43.8	14.5			XV, 13
	B	117.8	13.5			XV, 12
	C	76.5	12.5			XV, 12
	D	166.2	16.0			XVII, 11
	E	151.9	15.0			XVI, 11
	F	159.9	16.0			XVI, 11
	G	67.4	12.5			XV, 11
	H	65.3	11.5			XVI, 12

TABLE 3: MORPHOMETRIC AND MERISTIC DATA FOR 3RD SAMPLING PERIOD (APRIL)

<u>Fish Species</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std Length</u>	<u>Go-So¹ Index</u>	<u>Liver² Index</u>	<u>Fin³ Ray Count</u>
<u>Cynosion xanthulus</u>	A	1012.1g	40.0cm	.011g	.013g	IX + I, 20
	B	976.8	39.5	.006	.021	IX + I, 20
	C	988.7	40.0	.011	.020	IX + I, 21
	D	994.0	40.5	.006	.014	IX + I, 20
	E	1297.5	45.0	.011	.011	VIII + I, 21
	F	976.7	41.0	.009	.017	VIII + I, 20
	G	1037.5	42.0	.012	.023	IX + I, 20
	H	881.5	39.0	.015	.019	IX + I, 18
	I	854.9	37.5	.040	.020	IX + I, 22
	J	815.0	36.5	.009	.019	IX + I, 21
	K	987.9	39.5	.009	.019	IX + I, 21
	L	1022.3	41.0	.013	.020	IX + I, 20
	M	1061.6	41.0	.010	.014	IX + I, 20
	N	760.5	37.5	.004	.012	IX + I, 19
	P	776.4	38.0	.009	.015	IX + I, 20

TABLE 3: (continued)

<u>Bairdiella</u> <u>icistus</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std</u> <u>Length</u>	<u>Go-So</u> ¹ <u>Index</u>	<u>Liver</u> ² <u>Index</u>	<u>Fin</u> ³ <u>Ray Count</u>
	A	313.9	23.0	.068	.014	XI, 30
	B	294.2	23.5	.082	.022	XI, 26
	C	465.9	25.5	.102	.031	XI, 26
	D	378.4	24.5	.097	.026	XI, 27
	E	421.3	25.5	.113	.019	XI, 26
	F	369.5	25.5	.065	.025	XI, 27
	G	490.6	27.5	.094	.020	XI, 28
	H	500.0	28.5	.065	.016	--
	I	501.1	28.5	.079	.017	XI, 26
	J	482.7	27.5	.097	.025	XI, 24
	K	393.9g	27.5cm	.071g	.029g	XI, 26
	L	329.2	24.5	.088	.029	XI, 25
	M	349.2	26.5	.068	.012	XII, 28
	N	321.5	24.0	.109	.024	XI, 26
	P	355.5	25.5	.095	.023	XII, 26
	Q	473.2	28.0	.076	.022	XI, 26

TABLE 3: (continued)

<u>Anisotremus</u> <u>davidsonii</u>	<u>Fish No.</u>	<u>Body Wt.</u>	<u>Std</u> <u>Length</u>	<u>Go-So</u> ¹ <u>Index</u>	<u>Liver</u> ² <u>Index</u>	<u>Fin</u> ³ <u>Ray Count</u>
	A	344.6	22.5	.064	.020	XII, 12
	B	292.7	19.5	.056	.022	XII, 13
	C	273.8	20.5	.061	.018	XII, 13
	D	243.7	19.5	.059	.012	XII, 13
	E	462.5	23.0	.058	.028	XII, 13
	F	185.0	17.5	.079	.013	XII, 13
	G	248.7	18.5	.087	.019	XI, 14
	H	251.1	19.0	.103	.031	XII, 13
	I	230.1	18.5	.101	.008	XI, 10
	J	130.5	15.5	.021	.013	XII, 14
	K	252.6	19.0	.078	.029	XII, 14
	L	173.4	16.5	.105	.024	IX, 13
	M	150.0	15.5	.069	.026	XII, 12
	N	112.8	14.5	.018	.016	XII, 13

TABLE 4: % FREQUENCY OF FOOD ITEM IN STOMACH OF CORVINA GULF CROAKER, AND SARGO

Species Sampled	Sample Date	Total # of fish sampled (n)	% of n w/o food in stomach	Fish	% of food type in stomachs with food		
					<u>Balanus</u> <u>amphitrite</u>	<u>Neanthes</u> <u>succinea</u>	<u>Amphiroda</u>
Corvina	Oct.	16	50	100	--	--	--
	Jan.	16	69	100	--	--	--
	Apr.	15	27	100	--	--	--
	Jul.	16	38	91	9	--	--
Gulf Croaker	Oct.	16	44	22	--	78	--
	Jan.	3	67	100	--	--	--
	Apr.	16	100	--	--	--	--
	Jul.	15	33	89	--	11	--
Sargo	Oct.	--	--	--	--	--	--
	Jan.	16	44		73	1	18
	Apr.	14	79	--	100	--	--
	Jul.	--	--	--	--	--	--

TABLE 5: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN MUSCLE OF CYNOSION XANTHULUS

[illegible]

TABLE 6: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN LIVER OF OYNOSION XANTHULUS

[illegible]

TABLE 7: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN BONE OF CYNOSION XANTHULUS

Sampling Period		K	Ca	Fe	Cu	Zn	Br	Rb	Sr	Pb
Oct.	$\bar{x}$	--	--	45.104	--	35.036	2.941	3.738	409.586	--
	$\pm$ S.D.	--	--	15.482	--	5.400	0.938	0.503	59.048	--
	N	--	--	14	--	14	14	13	14	--
Jan.	$\bar{x}$	2573.	166181.	30.516	--	30.105	4.196	0.396	391.615	--
	$\pm$ S.D.	1227.	45204.	11.413	--	8.417	1.153	0.167	111.659	--
	N	15	15	15	1	15	15	15	15	--
Apr.	$\bar{x}$	5141.	174113.	38.992	2.045	33.647	4.464	0.623	463.640	--
	$\pm$ S.D.	943.	14068.	26.908	--	2.681	0.610	0.158	36.076	--
	N	15	15	15	1	15	15	15	15	--

TABLE 8: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN POOLED KIDNEY SAMPLES OF CYNOSION XANTHULUS

[illegible]

TABLE 9: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN MUSCLE OF BAIRDIELLA ICISTUS

[illegible]

TABLE 10: TRACE ELEMENT CONCENTRATION (g/gdry) IN BONE OF BAIRDIELLA ICISTUS

Sampling Period		K	Ca	Fe	Cu	Zn	Br	Rb	Sr	Pb
Oct.	$\bar{x}$	--	--	248.675	1.383	32.196	2.084	1.111	564.588	1.818
	$\pm$ S.D.	--	--	203.805	0.672	4.541	0.381	0.094	90.740	--
	N	--	--	16	2	16	16	3	16	1
Jan.	$\bar{x}$	9877.	167933.	79.593	1.601	38.247	2.888	1.180	558.733	--
	$\pm$ S.D.	701.023	29513.	2.988	0.635	5.230	0.489	0.086	141.695	--
	N	3	3	3	2	3	3	3	3	--
Apr.	$\bar{x}$	10700.	186151.	119.783	--	38.054	2.519	1.445	779.319	--
	$\pm$ S.D.	2316.	30984.	182.338	--	7.669	0.439	0.327	117.205	--
	N	16	16	16	--	16	16	16	16	--

TABLE 11: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN MUSCLE OF ANISOTREMUS DAVIDSONII

[illegible]

TABLE 12: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN BONE OF ANISOTREMUS DAVIDSONII

Sampling Period		K	Ca	Fe	Cu	Zn	Br	Rb	Sr	Pb
Oct.	$\bar{x}$	--	--	66.016	--	72.643	4.401	6.666	624.383	2.249
	$\pm$ S.D.	--	--	55.041	--	10.046	1.188	0.489	23.322	0.239
	N	--	--	12	--	12	12	12	12	3
Jan.	$\bar{x}$	6710.	182983.	1208.	1.935	62.597	4.86	1.221	766.400	1.120
	$\pm$ S.D.	1242.	21992.	1163.	0.590	18.686	1.299	0.470	120.796	--
	N	12	12	12	3	12	12	12	12	1
Apr.	$\bar{x}$	24659.	183048.	147.541	3.534	70.228	4.383	3.738	591.380	--
	$\pm$ S.D.	35809.	55151.	78.916	2.783	23.940	3.440	6.702	192.920	--
	N	14	14	14	2	14	14	14	14	--

TABLE 13: TRACE ELEMENT CONCENTRATION ($\mu\text{g/gdry}$) IN POOLED FISH SAMPLES OF POECILIA LATAPINNA (= MOLLINIENSIA)

Sampling Period		K	Ca	Fe	Cu	Zn	Br	Rb	Sr	Pb
Oct.	$\bar{x}$	--	--	1168.	10.215	78.415	5.685	9.853	255.193	2.286
	$\pm$ S.D.	--	--	420.	2.236	7.218	1.193	1.224	15.295	0.869
	N	--	--	14	14	14	14	14	14	13
Jan.	$\bar{x}$	16095.	72695.	156.129	7.459	88.868	4.724	4.725	420.175	0.547
	$\pm$ S.D.	1130.	6420.	55.658	4.095	8.241	0.813	0.385	94.740	--
	N	16	16	16	16	16	16	16	16	1
Apr.	$\bar{x}$	24307.	86191.	858.311	10.263	132.511	5.542	9.976	507.133	--
	$\pm$ S.D.	25059.	91292.	1725.758	11.298	136.578	5.847	12.305	456.766	--
	N	9	9	9	9	9	9	9	9	--

NOTICE

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