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MERCURY CONTENT OF SEVERAL PREDACIOUS SPECIES IN THE ANDAMAN SEA

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Summary

*During April 1975 thirty-six muscle samples of six predacious species from the Andaman Sea were collected for an analysis of their total mercury concentrations. The total mercury levels ranged from 0.026 to 0.234 ppm in yellowfin tuna (**Neothunnus albacora**), from 0.027 to 0.233 ppm in bigeye tuna (**Parathunnus sibi**), and from 0.057 to 0.478 ppm in four species of shark. The statistical analysis also showed positive linear regression and there was correlation between the mercury concentration and the weight of yellowfin tuna, bigeye tuna, and shark. The rates of total mercury accumulation in yellowfin and bigeye tuna were not significantly different. A comparison between in total mercury level in the Andaman yellowfin and the Central Pacific yellowfin tuna is discussed.*

Introduction

In recent years the mercury content of fish has posed two major problems, first, in instances such as the tuna, swordfish and shark fisheries, and also in the recreational fishery of the great lakes, where mercury levels were greater than the established levels acceptable for human consumption; and second, the more serious problem in Minamata Bay, Japan, where mercury reached a level sufficiently high to kill fish, shellfish, and persons who consumed those contaminated organisms.

There is a great deal of literature on mercury in the environment and two comprehensive summaries were recently published, the second dealing specifically with mercury in fish[1,2]. Although some information on mercury in tissues of predacious species of the Pacific ocean are available[3-6], information is yet to be provided for the Indian ocean.

Various species of tuna and shark are indigenous to the Andaman Sea which is a part of the Indian Ocean. Tuna and shark are abundant and important components in the Andaman Sea food web. Tuna and shark might be used as species to monitor levels of accumulative contaminants in the marine environment. Additionally tuna and shark are used for local consumption and exported after processing to other regions of the world. For both reasons, information is required on the quantitive status of potentially toxic contaminants in tuna and shark of the Andaman Sea.

Materials and Methods

Sample collection

The long-line fishing was conducted in 10 stations covering the southern part of the Andaman Sea (Fig. 1). This was done on a period of Cruise No. 1/1975 of R.V. Fishery Research No. 2; 1–11 April 1975. The catch consisted of various predacious species of the Andaman Sea, for instance, yellowfin tuna *(Neothunnus albacora)*, bigeye tuna *Parathunnus sibi)*, great blue shark *(Isurus guntheii)*, black tip shark *(Bulamia ftallamzami)*, hammerhead shark (*Sphyrna tades)*, and longtail shark *(Alopius sp.)*. Muscle tissue samples from 16 yellowfin tuna, 8 bigeye tuna, and 12 sharks were collected and preserved in a freezer at a temperature of approximately −20° C. For assay the muscle samples were thawed and a portion was used for total mercury determination.

Total Mercury Determination

The total mercury residue in the samples was determined by the flameless atomic absorption technique. The Mercometer Model 2006–1 (Anti-Pollution Technology Corporation, Holland, Michigan) of the Department of Marine Science, Chulalongkorn University was used for measuring the mercury concentration. The sensitivity of the mercometer is .001 ppm total mercury. The details of the method are as follows. The size of muscle tissue is 0.1–2.0 g (wet); the sample was weighed into a 250 ml Pyrex digestion bottle; twenty ml of 1:1 concentrated redistilled HNO_3 and concentrated reagent grade H_2SO_4 were added to the sample; the samples were predigested in open containers with this concentrated acid solution at 95 $\pm$ 2 °C for 20 minutes or until the digest was clear; ten ml of saturated $K_2S_5O_8$ solution and 50 ml of distilled water were added while swirling to all nonaqueous samples; the sample containers were loosely capped with ground glass stoppers and digested at 95 $\pm$ 2 °C for 2 hours in a water bath. After removal from the water bath the samples were cooled to room temperature and quantitatively transferred with distilled water into a 500 ml 3-neck distillation flask. Twenty ml of reducing solution (20 g $NH_2OH.HCl$, 20 g NaCl, 33 g $SnCl_2.H_2O$, 1 g hydrazine sulfate, and 9 ml concentrated H_2SO_4 diluted to one liter) was added; the bubbler gas dispersion tube was inserted in one neck and the others plugged with ground-glass stoppers. The solution was swirled gently for 30 seconds. After swirling, bubbling with purified air, which had had mercury vapour removed, was commenced.

Results

The total mercury residue concentration in the muscle tissues of tuna and shark of the Andaman Sea are shown in Table I. Total mercury levels ranged from 0.026 to 0.234 ppm in yellowfin tuna, from 0.027 to 0.223 ppm in bigeye tuna, and from 0.057 to 0.478 ppm in the four species of shark. The statistical methods[7] were used for analysing these data. The analysis showed positive linear regression and correlation between the mercury concentration and the weight for yellowfin tuna ($t = 7.173$, d.f. $= 14$, $r = .927$, Fig. 2), bigeye tuna ($t = 6.290$, d.f. $= 6$, $r = .920$, Fig. 3),

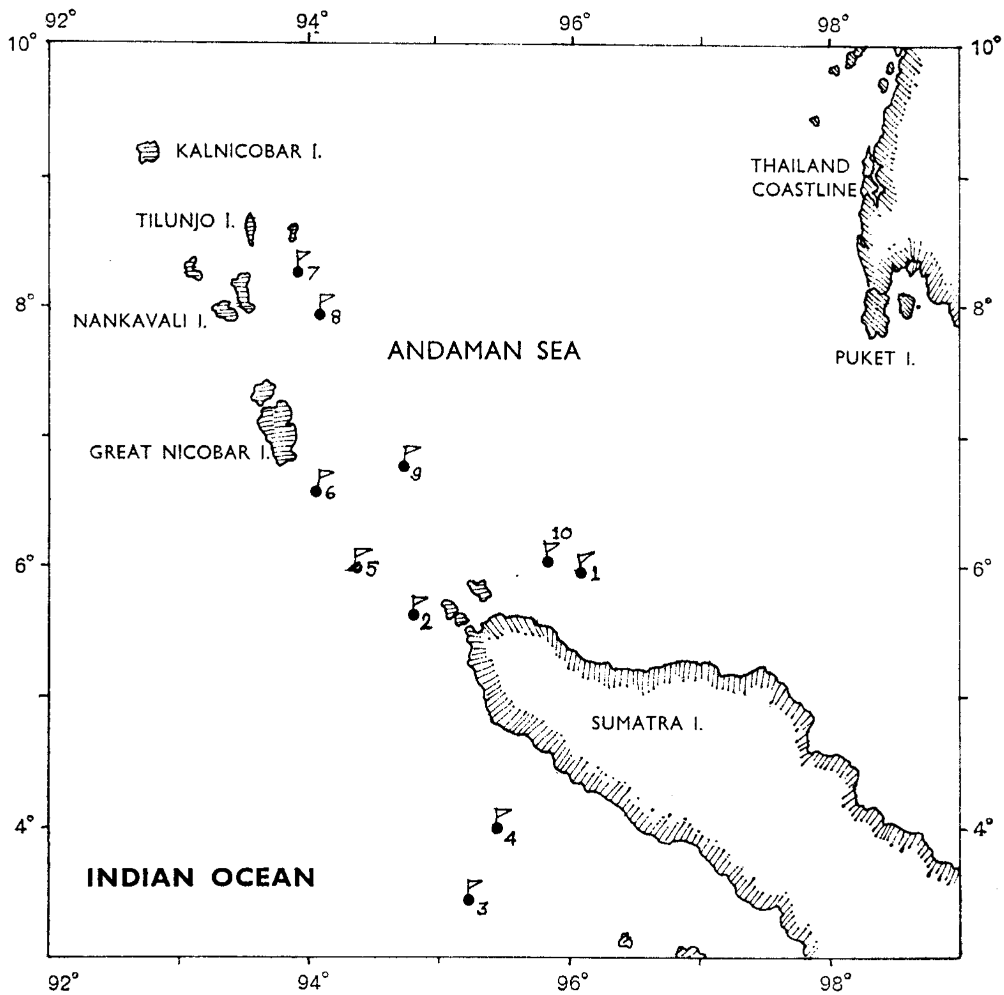

Fig. 1. Sampling stations for tuna and shark in the Andaman Sea.

TABLE I: TOTAL MERCURY RESIDUES IN THE MUSCLE TISSUES OF TUNA AND SHARK OF THE ANDAMAN SEA.

Taxon	Station	Sex	Total Length cm.	Weight kg.	Total Mercury ppm
Yellowfin tuna *Neothunnus albacora*	2	M	78	7	0.026
	2	F	119	28	0.098
	1	F	119	28	0.111
	5	F	139	33	0.091
	8	M	129	36	0.100
	5	M	145	39	0.144
	1	M	151	40	0.175
	3	M	146	40	0.140
	9	M	147	43	0.136
	5	M	155	45	0.155
	5	M	147	47	0.193
	5	M	147	47	0.152
	5	M	152	52	0.154
	4	M	153	52	0.186
	5	F	167	59	0.201
	5	M	170	70	0.234
Bigeye tuna *Parathunnus sibi*	5	F	56	3	0.027
	2	M	73	6	0.071
	5	M	90	10	0.052
	4	F	98	15	0.097
	5	M	112	23	0.145
	5	M	123	26	0.178
	9	M	118	29	0.177
	7	M	148	55	0.223
Great blue shark *Isurus guntheii*	5	M	139	22	0.057
	5	F	128	23	0.068
	7	F	202	80	0.250
	8	M	235	120	0.450
Black tip shark *Bulamia ftallamzami*	9	F	225	45	0.359
	1	F	192	45	0.137
	8	M	210	50	0.353
	8	F	234	70	0.409
Hammerhead shark *Sphyrna tades*	9	M	173	36	0.067
	7	F	189	57	0.159
	10	F	206	60	0.478
Longtail shark *Alopius sp.*	4	M	275	50	0.216

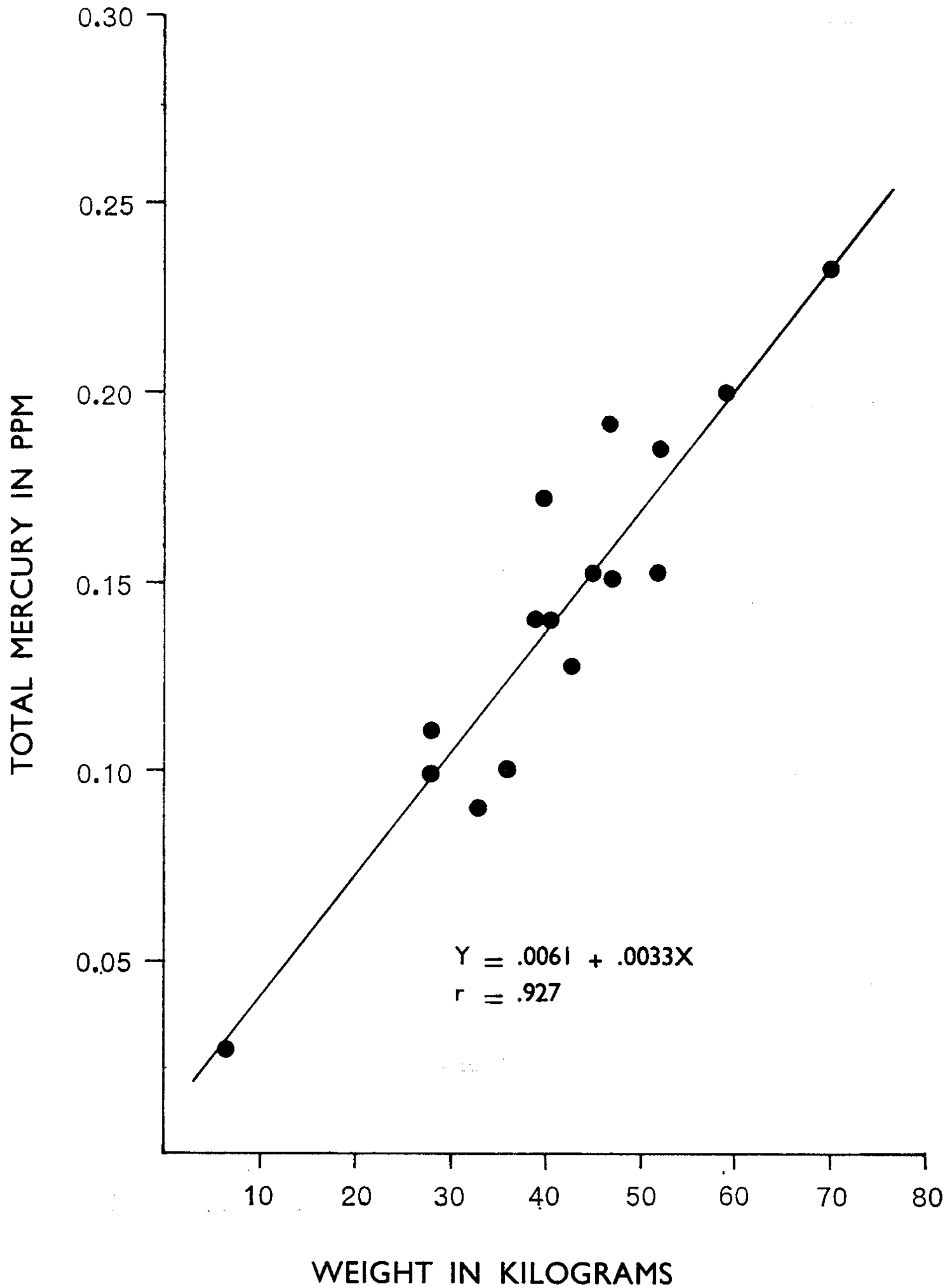

Fig. 2. Relationship between weight of yellowfin tuna *(Neothunnus albacora)* and the total mercury residue concentrations in the muscle tissues.

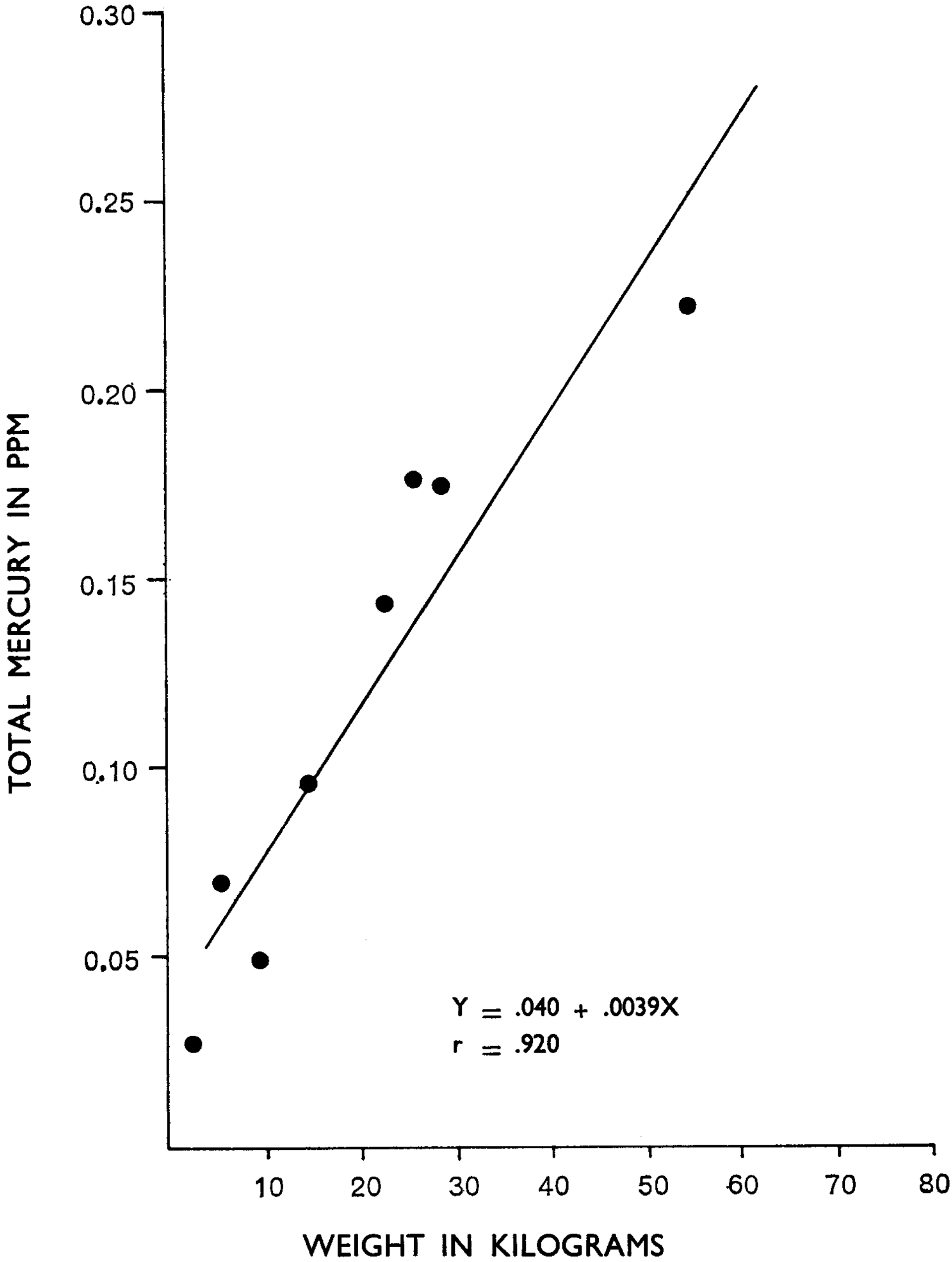

Fig. 3. Relationship between weight of bigeye tuna *(Parathunnus sibi)* and total mercury residue concentrations in the muscle tissues.

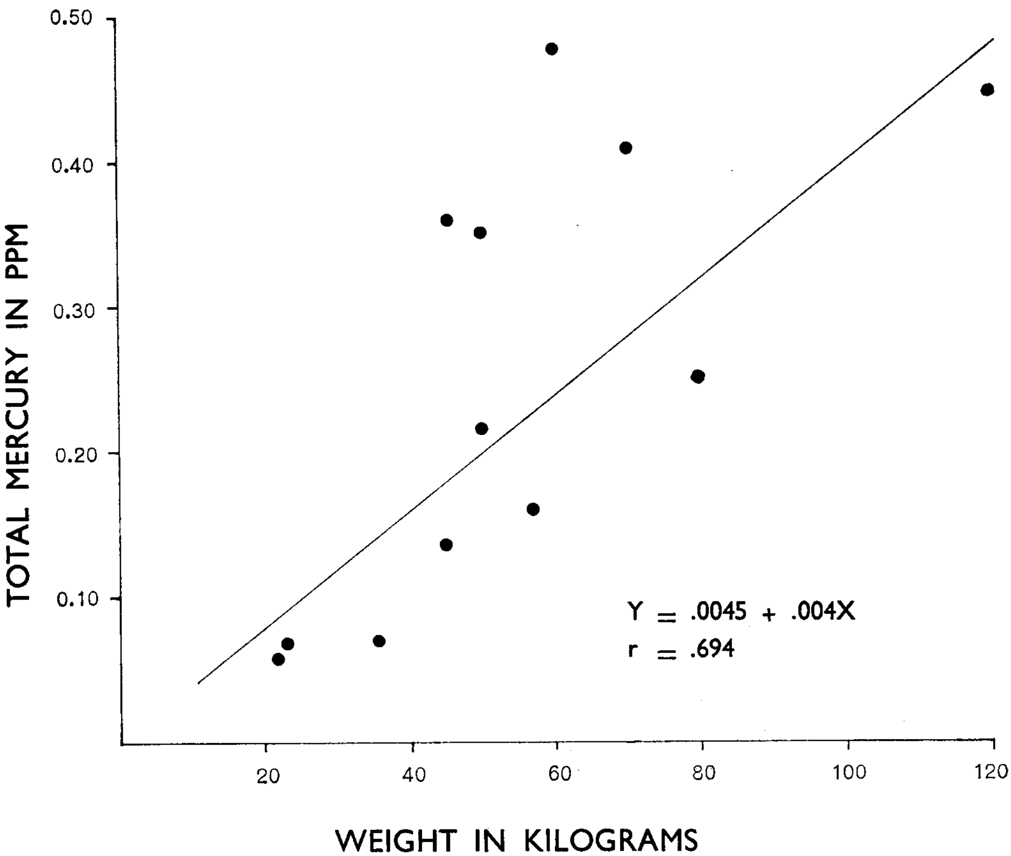

Fig. 4. Relationship between weight of shark and total mercury residue concentrations in the muscle tissues.

and shark ($t = 7.142$, d.f. $= 10$, $r = .694$, Fig. 4). The data of four shark species were considered together because each species had a few variables. Therefore, it could be concluded that the mercury concentration in a fish body increases as their size increases.

Furthermore, an analysis of the covariance between the weight/total mercury regressions of yellowfin and bigeye tuna revealed that the rates of mercury accumulation of these two species were not significantly different. The mean mercury concentration of bigeye tuna was a little higher than of yellowfin tuna when the sizes of fish were the same.

As regards the sex, it should be noted that yellowfin tuna and bigeye tuna muscle tissue samples include a small number of females. The mercury residue concentration of female tuna did not seem to deviate significantly from the male. For the composite samples of the four species of shark, the number of female muscle samples were slightly more than those of males. The total mercury concentration of male and female shark of the same size did not seem to differ greatly.

Discussion and Conclusion

From this investigation, it appears that the mercury residue concentrations in yellowfin tuna, bigeye tuna, and shark of the Andaman sea increases as their size increases. A linear relation between age or weight of carnivorous fish is well documented[4, 8-11]. However, Johnels and Westermark[12] found that for low levels of mercury in fish (below 0.2 ppm) no increase, or a very moderate increase, in mercury content was found to occur as fish weight increased. As the mean level of mercury increased they found that the mercury level in relation to the weight increased noticeably. At extremely high levels of mercury, caused by manifest contamination, they found no relation to age or weight. Greeson[13] and Wallace *et al.*[14] interpret this as indicating that there is a threshold level of mercury in the environment, above which fish cannot eliminate mercury from their muscular tissues as fast as it is incorporated and above which accumulation thus occurs.

Although the mercury accumulation rate of yellowfin and bigeye was not significantly different, the mean mercury concentration of bigeye tuna was a little higher than that of yellowfin tuna. The higher mercury concentration in bigeye tuna may be due to a physiological factor. In general, the size of bigeye tuna is smaller than yellowfin tuna; this circumstance will give a better chance for mercury to accumulate at a higher concentration in bigeye than in yellowfin tuna.

Rivers *et al.*[6] reported the mercury level in various marine fish species of the Central Pacific Ocean. This also included 22 yellowfin tuna. The method they used for total mercury detection was the same as that used in this investigation. Therefore, it is very interesting to compare the mercury levels of yellowfin tuna between the two regions of the world. The analysis of covariance between the weight/total mercury regressions of the Andaman and Pacific yellowfin tuna revealed that the rates of mercury accumulation of these two races are not significently different. Nevertheless, the mean mercury concentration of the Pacific yellowfin is a little higher than of the Andaman yellowfin when the size of fish are the same. The higher mercury level in the Pacific yellowfin may be due to an environmental factor. Goldberg[15] suggested that the jet streams can carry pollutants from the industrial areas of the northern hemisphere in a concentrated band around the globe. The Central Pacific Ocean is the area that lies on the belt of the jet stream. Therefore, it is suspected that the jet stream might carry mercury from industrial countries like Japan and the People's Republic of China to the Central Pacific Ocean and precipitate it beneath. Gardner[16] also found that the mercury concentration in the seawater and suspended matter of the East China Sea was high when compared with other areas of the world's oceans. Hence, the mercury concentration in seawater of the Central Pacific Ocean should be higher than of the Andaman Sea. The Andaman Sea is not influenced by the jet stream. This circumstance might cause higher mercury concentration in the Pacific yellowfin than in the Andaman yellowfin.

The total mercury level of the yellowfin and bigeye tuna and the shark of the Andaman Sea as reported in this article are well below the United States Food and Drug Administration tolerance limit of 0.5 ppm. By calculating the linear regression equations, it is found that, above a weight of 100 kg, mercury concentration will be higher, for a given weight, among bigeye than yellowfin tuna, reaching 0.5 ppm level in the former at about 118 kg, in the latter at about 150 kg. The mercury level in shark may reach 0.5 ppm at a weight of 124 kg. Nevertheless, tuna and shark weighing more than 100 kg is very rare in the Andaman Sea.

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บทคัดย่อ

ในระหว่างเดือนเมษายน พ.ศ. 2518 ได้มีการวิเคราะห์หาสารปรอทในเนื้อเยื่อกล้ามเนื้อ 36 ตัวอย่าง จากปลาชนิดที่ล่าเหยื่อที่เป็นสัตว์ของทะเลอาดามัน ระดับความเข้มข้นของสารปรอทในปลาทูน่าครีบเหลือง *(Neothunnus albacora)* อยู่ในพิกัด 0.026–0.234 ppm ปลาทูน่าตาโต *(Parathunnus sibi)* อยู่ในพิกัด 0.027–0.223 ppm และปลาฉลามทั้งสี่ชนิดอยู่ในพิกัด 0.057–0.478 ppm ผลการวิเคราะห์ข้อมูลทางสถิติได้แสดงให้เห็นว่า เมื่อปลานี้มีน้ำหนักมากขึ้นหรืออีกในนัยหนึ่งมีอายุมากขึ้น ระดับความเข้มข้นของปรอทในตัวปลาจะสูงขึ้นไปด้วย อัตราการสะสมสารปรอทในปลาทูน่าครีบเหลืองและปลาทูน่าตาโตนั้นไม่แตกต่างกันโดยมีนัยสำคัญ ในบทอภิปรายได้มีการเปรียบเทียบระดับความเข้มข้นของสารปรอทในปลาทูน่าครีบเหลือง ระหว่างทะเลอาดามันและมหาสมุทรแปซิฟิคตอนกลาง