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ORGANOCHLORINE RESIDUES IN DALL'S AND TRUE'S PORPOISES COLLECTED FROM NORTHWESTERN PACIFIC AND ADJACENT WATERS

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Abstract: The levels of organochlorine residues (PCB and *p, p'*-DDE) in the adult male *Dalli* and *Truei* porpoises collected from North Pacific, Bering Sea and Japan Sea are reported. Different levels of these compounds were observed in the individuals with respect to sex and location, indicating the fact that man-made organics can be used as chemical indicators in tracing out certain ecological and physiological events in long-life marine animals. Considerably lower levels of these chemicals were detected in the blubber samples of adult females when compared with the adult males from the same area, indicating parturition and lactation as the possible major routes of excretion in females. On the basis of different ranges and means of PCB and DDE concentrations, certain suggestions are also made about the different feeding grounds and the geographical ranges of Dall's and True's porpoises in the present study area.

1. Introduction

Small cetaceans accumulate very high amounts of persistent chemicals through feeding (TANABE *et al.*, 1984) and also they can excrete and transfer large quantities of these pollutants over generation through lactation (ADDISON and BRODIE, 1977; GASKIN, 1982; TANABE *et al.*, 1982).

Because of the recent interest shown by the commercial fishing and various governmental agencies, a number of reports are available on the organochlorine levels in marine mammals. On reviewing these reports WAGEMANN and MUIR (1984) have stated that the available data are fairly unsystematic to preclude certain delineation of various factors, but there is no dispute that man-made organics occur in cetacean tissues, sometimes in what are considered by any standard to be significant quantities (GASKIN, 1982). To our knowledge most of the data available on the levels of organochlorines in marine mammals are from a few specimens collected in one particular area and/or isolated and stranded samples. But, for coming to certain conclusions on the ecological and physiological aspects of marine mammals by using these organics as chemical tracers, extensive data are necessary about the levels of these compounds in the animals collected from different localities, so that some solid conclusions can be drawn about the possibility of the use of organochlorines as chemical tracers. For example in the case of odontocete

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cetacean, Dall's porpoise, in spite of many available reports on the ecology and biology (KASUYA, 1976; MOREJOHN, 1979; MIYAZAKI, 1983; KASUYA and JONES, 1984; KASUYA and SHIRAGA, 1985), some doubts still exist on the taxonomy, migration, segregation, age determination and reproductive behaviour of the two prominent colour types of this species, *Dalli* type (*Phocoenoides dalli dalli*) and *Truei* type (*Phocoenoides dalli truei*). At the same time, some successful attempts have been made to use chlorinated hydrocarbons as chemical indicators of global pollution and for elucidating certain ecological aspects of marine mammals (TANABE *et al.*, 1983). Organochlorines are highly persistent and when once absorbed, largely remain in the organisms' bodies, especially in fat-rich tissues. In higher organisms the levels of organochlorines depend on various environmental, ecological and physiological parameters. By estimating the levels of persistent chemicals in the fat tissues of animals, certain ecological and physiological aspects such as population structure, migration, feeding habits, breeding cycles, etc., can be evaluated. From all the above reports we thought that it may be possible to answer certain questions on the ecology of Dall's porpoises by finding out the levels of highly persistent man-made organics in their bodies. So, the present study is an attempt to use the levels of PCBs and DDE in the blubber of Dall's porpoises collected from North Pacific and surrounding waters to elucidate their population structure and migration pattern.

2. Materials and Methods

The specimens of *Dalli* and *Truei* were collected widely from the geographical range of these organisms (Table 1) in various sampling and fishing trips in the years from 1979–1985.

The samples of various organs and tissues of the specimens caught were transported to the laboratory in a frozen condition and were kept at $-20°C$ until analysis.

Since the organochlorines were always reported to be accumulated in very high concentrations in the blubber tissues of marine mammals (TANABE *et al.*, 1981, 1983; GASKIN, 1982; HIDAKA *et al.*, 1983), only the blubber tissues of the adult specimens were used for the present study. Required amounts (about 5 g) were subjected to alkaline alcohol digestion following the method of WAKIMOTO *et al.* (1971). PCBs and DDT compounds thus brought into solution were transferred to 100 m*l* hexane in a separatory funnel. The hexane layer was concentrated to 5 m*l* and was subjected to silica-gel and fuming sulfuric acid clean-up. The final solution is again concentrated to a minimal quantity. Aliquots of these solutions were injected into gas chromatograph (Shimadzu GC 9A) equipped with a ^{63}Ni electron capture detector. Concentrations of individually resolved peaks of PCB isomers and congeners were added up to find out the total PCB concentration. The *p, p'*-DDE values reported here include *p, p'*-DDT also since DDT is converted to DDE during alkaline alcohol digestion.

Operating conditions of gas chromatograph for PCBs are as follows. Temperature program 180° to 230°C at a rate of 0.5°C/min. Both injector and detector temperatures were kept at 250°C. For DDE the column temperature was 230°C isothermal. Injector and detector temperatures were the same as for PCBs. The column consisted of 30 m length $\times$0.23 mm inside diameter glass capillary WCOT – OV 101 for both PCB and DDE analyses. Nitrogen was used both as carrier and make-up gas.

3. Results and Discussion

The sampling data, biometry, concentrations of PCBs and DDE and their ratios in the blubber samples of all the specimens analysed are shown in Table 1.

In almost all the reports available on marine mammals, the females were reported to have considerably lower concentrations of organochlorines than males (GASKIN, 1982). This may be due to the prominent excretion via milk (TANABE *et al.*, 1982). We have also observed wide variations in the concentrations of both compounds between the male and female samples (Table 1). All the female specimens used in this study are adults which were pregnant and have record of previous pregnancies when caught, except for only one specimen which was a resting female. So, such low concentrations of both compounds can be attributed to the excretion of organochlorines via lactation.

As stated by KASUYA and JONES (1984) the parturition and lactation are almost continuous in these animals, so such a decrease in organochlorine levels may be rapid. The ratios of the average values of these chemicals between the females and males of Dall's porpoises collected from the same location (northern North Pacific-Table 1) are very low (PCB: female/male=0.25; DDE: female/male=0.31), indicating a little faster clearance of PCBs than DDT compounds.

Table 1. Sampling data, biometry and concentrations of PCBs and DDE (μg/g on wet weight basis) in the blubber samples of adult Dalli and Truei porpoises from North Pacific and surrounding seas.

No.	Date of collection	Latitude	Longitude	Body length (cm)	Body weight (kg)	Gonad wt. (g)		Concentration		Ratio (PCB/ DDE)
						L	R	PCB	DDE	
Bering Sea-*Dalli* Male:										
1	810722[a]	57°02′N	179°01′W	204	167	310	340	6.00	8.59	0.70
2	810719	57°00′N	179°59′W	213	156	195	205	6.30	9.97	0.63
3	850825	57°30′N	176°18′W	199	184	307	362	2.91	4.13	0.70
4	850826	57°30′N	178°10′W	203	183	400	330	4.41	8.77	0.50
5	850830	56°27′N	175°00′W	200	169	187	171	4.26	8.56	0.49
Aleutian Chain-*Dalli* Male:										
1	790618	49°24′N	174°28′E	199	157	—	—	9.74	15.2	0.64
2	790628	50°06′N	172°47′E	212	182	—	—	9.23	12.8	0.72
Northern North Pacific-*Dalli* Male:										
1	840522	39°27′N	162°42′E	200	144	105	100	7.05	6.64	1.06
2	840521	39°27′N	164°46′E	203	145	130	120	10.2	8.56	1.19
3	840601	37°58′N	174°37′E	205	148	255	235	9.66	9.50	1.02
4	840605	38°01′N	172°26′E	205	155	115	120	8.85	9.23	0.96
5	840605	37°37′N	173°08′E	205	167	190	180	13.3	12.3	1.08
6	840523	37°15′N	163°46′E	210	149	130	120	14.9	14.0	1.06
7	840917	42°02′N	175°52′E	200	168	127	120	13.8	15.1	0.92
8	840913	44°57′N	158°00′E	202	159	146	156	11.7	11.7	1.00
9	840526	44°22′N	169°09′E	202	165	160	150	16.0	14.6	1.10
10	840811	44°59′N	163°12′E	219	166	153	182	11.9	11.9	1.00
11	840811	45°01′N	164°02′E	220	185	179	181	11.2	11.9	0.95
12	840516	46°49′N	164°29′E	200	149	105	95	13.2	14.6	0.90
13	840527	47°37′N	169°13′E	212	166	175	175	13.1	14.0	0.94

Table 1 (continued).

No.	Date of collection	Latitude	Longitude	Body length (cm)	Body weight (kg)	Gonad wt. (g) L	Gonad wt. (g) R	Concentration PCB	Concentration DDE	Ratio (PCB/DDE)
Northern North Pacific–*Dalli* Female:										
1	840521	40°07′N	162°54′E	179	111	P[b]		3.23	4.43	0.73
2	840609	41°28′N	163°35′E	180	125	P		3.71	5.34	0.70
3	840609	41°47′N	164°57′E	185	136	P		3.95	4.60	0.86
4	840605	38°00′N	172°24′E	193	117	R		2.35	2.54	0.92
5	840518	46°47′N	162°59′E	194	126	P		1.02	1.31	0.78
6	840608	41°20′N	165°51′E	195	146	P		3.26	3.94	0.83
Western North Pacific–*Truei* Male:										
1	840614	41°20′N	151°09′E	201	153	140	135	16.7	22.4	0.75
2	840614	41°21′N	151°08′E	204	146	125	125	13.0	13.9	0.94
3	840511	38°27′N	147°12′E	206	141	102	102	13.8	16.3	0.85
4	840614	41°09′N	150°46′E	206	145	150	130	13.6	14.3	0.95
5	840615	40°13′N	149°46′E	209	160	185	200	14.2	12.4	1.15
6	840615	40°02′N	149°15′E	210	163	230	130	22.6	23.1	0.98
7	840512	38°32′N	150°18′E	216	159	90	87	19.4	27.5	0.71
8	840512	38°29′N	151°41′E	220	164	104	90	14.7	15.6	0.94
Pacific Coast of Hokkaido–*Dalli* Male:										
1	841014	42°08′N	143°28′E	204	148	112	117	13.2	32.7	0.40
2	841014	42°02′N	143°28′E	204	164	115	116	11.2	27.6	0.41
3	841014	42°01′N	143°26′E	212	173	90	85	13.5	36.8	0.37
Japan Sea–*Dalli* Male:										
1	850704	44°55′N	140°34′E	190	—	—	—	12.5	35.4	0.35

a : First two digits indicate the year, second two digits the month and the third two digits the date of collection.

b : P=Pregnant; R=Resting.

—: Data not available.

We would like to suggest that, because of such a lactational excretion the data obtained from female specimens should not be used as indicators of pollution or in determining the ecological aspects of marine mammals such as segreation and migration. A clear difference could be seen in the concentrations of both the compounds in the individuals of male animals collected from different localities (Table 1). The ranges and mean values show that the concentrations of both PCB and DDE in the male specimens from different localities very widely from each other (Table 2).

The *Dalli* male porpoises living in the northern North Pacific showed distinctly different PCB concentrations and PCB/DDE ratios when compared with the Bering Sea specimens (Table 1). The low concentrations in the specimens caught in Bering Sea can naturally be expected by the fact that the concentrations of PCB and DDE in the water of Bering Sea was comparatively lower than northwest Pacific (TANABE and TATSUKAWA, 1980). The two *Dalli* specimens collected just below Aleutian chain had slightly higher concentrations than Bering Sea *Dalli* individuals, but those two values are comparable to those obtained from northern North Pacific *Dalli* specimens (Table 1).

The individuals collected from northern North Pacific consisted exclusively of *Dalli* type and they have comparatively higher concentrations of both the compounds than the

Table 2. Ranges and mean concentrations of PCBs and p, p'-DDE (μg/g on wet weight basis) in Dall's and True's porpoises collected from different areas and in other species of small cetaceans from temperate waters of North Pacific.

Species	Location	*n*	Concentration Range / Mean PCB	Concentration Range / Mean DDE	Ratio (PCB/DDE)	Reference
Dall's porpoise	Bering Sea	5	2.91–6.00 4.78	4.13–9.97 8.00	0.49–0.70 0.60	Present study
Dall's porpoise	Aleutian Chain	2	9.23–9.74 9.49	12.8–15.2 14.0	0.64–0.72 0.68	Present study
Dall's porpoise	Northern North Pacific	13	7.05–16.0 11.9	6.64–15.1 11.9	0.90–1.19 1.00	Present study
True's porpoise	Western North Pacific	8	13.0–22.6 16.0	12.4–27.5 18.2	0.71–1.15 0.91	Present study
Dall's porpoise	Pacific Coast of Hokkaido	3	11.2–13.5 12.6	27.6–36.8 32.4	0.37–0.41 0.39	Present study
Dall's porpoise	Japan Sea	1	12.5	35.4	0.35	Present study
Dall's porpoise	California	1	94	256	0.38	O'SHEA *et al.*, 1980
Dall's porpoise	Japan	1	3.40	8.58	0.39	O'SHEA *et al.*, 1980
Dall's porpoise	Bering Sea	1	5.60	5.20	1.10	TANABE *et al.*, 1983
Dall's porpoise	Northern North Pacific	3	3.50–6.80 5.10	3.70–8.70 6.80	0.87–1.00 0.93	TANABE *et al.*, 1983
Dall's porpoise	Pacific Coast of Japan	1	11.0	14.0	0.79	TANABE *et al.*, 1983
Striped dolphin	Off Taiji, Japan	4	15.0–23.0 21.0	21.0–33.0 29.0	0.70–0.73 0.71	TANABE *et al.*, 1983
Melon-headed whale	Off Miyazaki, Japan	5	15.0–19.0 18.0	22.0–29.0 27.0	0.66–0.68 0.67	TANABE *et al.*, 1983
Pacific white-sided dolphin	Off Iki-island, Japan	5	32.0–44.0 38.0	57.0–99.0 76.0	0.41–0.56 0.51	TANABE *et al.*, 1983

Bering Sea group and comparatively lower concentration than those of northwestern North Pacific *Truei* populations (Table 1). It is interesting to note that eventhough the *Truei* individuals have already been shown as a separate group having restricted geographical ranges in the area off the Pacific coast of Japan and off the east coast of Kuril Islands (KASUYA, 1978), many of the concentration values of PCB and DDE in these specimens are overlapping with the values observed in the northern North Pacific *Dalli* individuals which are distributed over a wide geographical range (Table 1).

In the male *Dalli* specimens collected from the Pacific Coast of Hokkaido concentrations of PCBs are more or less similar to North Pacific *Dalli* males, whereas the DDE concentrations are very high, as a result of which the PCB/DDE ratios are very low (Table 1). This trend is the same as the one noticed in the single male *Dalli* specimen collected from Japan Sea. TATSUKAWA *et al.* (1979) noted very high concentrations of DDT compounds in Japan Sea which may be the cause of the increased use of DDT in developing nations around this region. This DDT might have been brought into Japan Sea, by a branch of Kuroshio current which flows into the area, and hence the increased concentrations of this chemical in the *Dalli* male individual.

From our results, it is clear that the concentrations of both the chemicals have some

kind of pattern in the specimens analysed from different localities. Since the organochlorine levels in higher animals depend on their food organisms it seems that the *Dalli* individuals living in Bering Sea and North Pacific have different feeding grounds within their restricted geographical ranges. The *Truei* individuals in western North Pacific also have a separate geographical range of feeding ground eventhough there may be some overlapping with northern North Pacific *Dalli* individuals. The *Dalli* individuals in Japan Sea and Pacific Coast of Hokkaido seem to share a common area of feeding.

Comparison of the data obtained in the present study with the available reports on the organochlorine levels in the blubber samples of adult male specimens of other marine mammals collected from the waters near Japanese coast (TANABE *et al.*, 1983) revealed that these levels vary with other species from the same location (Table 2). O'SHEA *et al.* (1980) reported very high concentrations of both the chemicals in the Dall's porpoise caught near California and very low concentration in the specimens collected near Japan (Table 2), indicating the effect of differential migratory areas and feeding grounds according to the species and populations.

The number of specimens analysed in the present study is not large, especially of those from Hokkaido and Japan Sea. However, by the observations made on the differential levels of these chemicals in the porpoises collected from various locations and by comparison with previous data, we hope that the man-made organics in the bodies of long-life marine organisms can be used as chemical tracers in determining certain life parameters like feeding grounds, migration, etc.

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