

## HIGH LEVEL OF DIOXIN CONTAMINATION IN VIETNAMESE FROM AGENT ORANGE THREE DECADES AFTER THE END OF SPRAYING

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### Introduction

This is an update of our findings of current dioxin contamination in Vietnamese from Agent Orange phenoxyherbicide last applied over 30 years ago. Agent Orange, half 2,4-D and half 2,4,5-T phenoxyherbicides, contaminated with an average of 3 parts per million (ppm) of 2,3,7,8-tetrachlorodibenzo-p-dioxin, or TCDD, was very heavily sprayed in certain areas in the south of Vietnam between 1962 and 1971 during the US-Vietnam war.<sup>1-2</sup>

### Methods

Blood from each of the 43 persons sampled in 1999 and 2000 in the heavily sprayed southern Vietnamese city of Bien Hoa, population 390,000, located 35 km north of Saigon (now known as Ho Chi Minh City), was individually analyzed for dioxins. These were from a convenience sample of men and women aged 16 to 71 years willing to donate over 60 ml of whole blood as part of a Vietnam Red Cross dioxin survey. Comparison blood was from Hanoi. The dioxin analyses for all seventeen 2,3,7,8-chlorine substituted dioxins and dibenzofurans and 3 coplanar PCBs were conducted by high resolution gas chromatography-high resolution mass spectroscopy by a World Health Organization laboratory certified for analysis of dioxins.<sup>3-4</sup>

### Results

Except for the dioxin contaminant characteristic of Agent Orange, 2,3,7,8-TCDD, no other dioxins were elevated. For TCDD, elevated levels were defined as above 5 ppt, lipid. Of the 43 persons, 41 (95 %) had elevated TCDD. Hanoi blood had an average level of approximately 2 parts per trillion (ppt) TCDD. The range in Bien Hoa varied from 2.4 to 413 parts per trillion (ppt), with a median of 67 ppt, shown in Table 1. The high 413 ppt is a 206-fold increase above the Hanoi TCDD baseline. Bien Hoa, population 390,000, is 35 km north of Ho Chi Minh City, formerly Saigon. Although Agent Orange was sprayed in Vietnam, there was also a spill of Agent Orange which occurred in 1970 at Bien Hoa airbase. Elevated TCDD was found in children as well as adults, and northern Vietnamese recently moved to this southern part of Vietnam. Since almost all dioxin body burden comes from ingestion of contaminated animal fat, the findings are almost certainly due to consumption of dioxin contaminated fish and other animal products.<sup>5-6</sup> The markedly elevated levels of TCDD from Agent Orange from 1970's fish samples are presented to support this hypothesis, as seen in Figure 2. Very elevated TCDD levels from Agent Orange exposure were found, ranging from 18 to 810 ppt.<sup>7-8</sup> These levels are much higher than current US fish dioxin levels of 0.03 ppt to 0.15 ppt.<sup>9-10</sup> These Vietnam fish levels represent approximately a 120 to 27,000-fold excess above recently reported US fish dioxin levels. In 1970s,

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human milk levels of TCDD were recorded up to 200 to 1,850 ppt range.<sup>2, 11</sup> Food from the south of Vietnam sampled in the 1980's had somewhat higher levels of dioxin than did northern food but was not as contaminated with dioxins as the earlier Vietnam fish samples.<sup>12-13</sup> At this time, we have no current food dioxin data from Bien Hoa.

We previously reported very elevated TCDD in nearby soil where a spill of Agent Orange occurred on the Bien Hoa Air base, as high as 1 million ppt, and elevated TCDD in sediments in a nearby river.<sup>2</sup> These data suggest certain localized contamination of soil, ground water, river sediment, and fish from Agent Orange spills.

**Table 1.** Vietnamese blood dioxin levels, collected at Bien Hoa City, 1999-2000.

Sample	Year of Birth	TCDD level (ppt lipid basis)	Sample	Year of Birth	TCDD level (ppt lipid basis)
South Vietnam (individual samples)					
1	1962	2.4	23	1942	68.3
2	1950	3.4	24	1962	70.2
3	1952	5.1	25	1935	73.9
4	1962	5.6	26	1960	76
5	1980	5.7	27	1980	87
6	1942	7.1	28	1985	91
7	1950	7.8	29	1962	101
8	1930	20	30	1966	102
9	1947	21	31	1963	103
10	1939	22	32	1963	154
11	1955	23	33	1959	161
12	1955	24	34	1954	162
13	1942	29	35	1955	164
14	1955	30	36	1958	168
15	1982	35	37	1982	174
16	1955	38	38	1985	177
17	1952	39	39	1967	236
18	1979	50	40	1950	238
19	1981	57	41	1954	271
20	1981	62	42	1963	326
21	1983	63	43	1973	413
22	1958	67			
North Vietnam (individual samples)					
1	1930	1.6	4	1930	1.2
2	1924	1.9	5	1932	2.3
3	1939	1.4			
North Vietnam (pooled sample, n=100)					
Hanoi	1959-79	2.2			

TCDD, 2,3,7,8-tetrachlorodibenzo-p-dioxin

**Table 2.** TCDD levels in fish and shrimp from southern Vietnam, 1970-73.

Sample	Location	TCDD level (ppt wet weight)
Interior		
Carp (Cyprininae)	Dong Nai River	540
Catfish (Siluridae)	Dong Nai River	810
Catfish (Tachysuridae)	Dong Nai River	520
Catfish (Schilbeidae)	Saigon River	70
River Prawn (Palemonidae)	Saigon River	42
Ocean		
Croaker (Sciaenidae)	Can Gio Village	79
Prawn (Peneidae)	Can Gio Village	18

References: 7 and 8

## Discussion

The finding of elevated to very elevated levels of TCDD, the dioxin contaminant of Agent Orange, in almost all Vietnamese living in Bien Hoa city in the south of Vietnam who were sampled in 1999 and 2000 is almost certainly from current as well as previous dioxin contamination. The most likely route of exposure is from animal fats, especially fish. The proximity of the city to an airbase used for Agent Orange storage and as a base for Agent Orange spraying missions strongly suggests the origin of the TCDD to be from the Bien Hoa Airbase. The previously reported very high soil TCDD levels on small areas of the airbase, elevated levels in nearby river sediment, and history of a spill of Agent Orange, also all point to the airbase as the source of contamination. The very elevated fish TCDD levels (Figure 2) found in the past associated with Agent Orange spraying in the south of Vietnam in an area where very elevated breast milk TCDD (up to 1850 ppt TCDD, an approximately 925-fold elevation above current background levels) was found in women document previous very high level dioxin (with levels up to 27,000-fold above current US fish dioxin levels) contamination of fish in Vietnam from Agent Orange.<sup>9</sup>

The very high percent of people sampled from this city (95 %) with elevated to very elevated blood TCDD is noteworthy because Agent Orange was last sprayed in Vietnam thirty years prior to blood collection for this study. Since elevated levels were also observed in children born since spraying ended, in new residents formerly from the north where no Agent Orange was sprayed, and in soil and sediment in that location, this report documents the persistence of dioxins in the environment leading to uptake of dioxins three decades after the contamination ended.

The findings presented here also raise the issue of dioxins contamination of at least some Vietnamese food, now increasingly exported to other countries. Without measurement of dioxins in food from Vietnam which is consumed in Vietnam, as well as in exported food, data such as those presented in this article suggest that some Vietnamese food is currently contaminated with relatively high levels of TCDD. Although we believe such "hot spots" of contamination in Vietnam are relatively rare, because Agent Orange was sprayed in only certain areas in the south of Vietnam, further analysis

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of food from Vietnam is clearly indicated, whether the food is obtained in Vietnam or in countries to which it has been exported.

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