

## Dioxins in Vietnamese and in Vietnamese Environment: Early and Recent Investigations

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### Introduction

Agent Orange, a phenoxyherbicide mixture of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2,4-dichlorophenoxyacetic acid (2,4-D) was sprayed for reasons of defoliation in large amounts on about 10 % of Southern Vietnam during the Vietnam war between 1962-1971. 2,4,5-T was contaminated with the highly toxic and persistent 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in the low ppm-range (mg/kg). Previous studies have documented intake of TCDD from Agent Orange among US war veterans and in Vietnamese (Kahn et al., 1988, Schecter et al., 1995, Michalek et al., 1996; Schecter, 1990; Schecter et al., 1992). Samples collected between 1970 and 1973 documented elevated levels for TCDD from Agent Orange in milk samples from Southern Vietnamese woman as well as in fish and shrimp samples from areas in this region (Baughman et al., 1973).

This paper gives an overview on findings for dioxins in various environmental compartments, in food and in humans. Due to the fact that 2,3,7,8-TCDD is nearly the only dioxin congener relevant for 2,4,5-T many investigators looked primarily on TCDD.

### Results and Discussion

#### Early investigations

Baughman and Meselson (1973) and Baughman (1974) introduced a method to determine 2,3,7,8-TCDD in biological samples. In 10 out of 18 human milk samples, collected in 7 sprayed areas of South Vietnam in 1970, they found elevated levels for TCDD. In some cases extremely high values were found. On lipid weight basis, levels as high as 1450 pg/g for TCDD could be found. Seven of the 18 specimens had not detectable levels for TCDD, mean TCDD level of the positives was 484 pg/g and the range varied from 132 to 1450.

The highest value was measured in a nursing mother known to be a heavy fish consumer. Measurements in fish samples from the Dong Nai River performed by the same authors (1973) indicated very high values for TCDD between 520 and 840 pg/g fresh weight.

Schecter and Ryan (1987) reported on their findings of elevated levels for TCDD in human milk samples collected in 1973 and in 1985. From the 1973 collection in South Vietnam nine woman – living in areas where heavy spraying with Agent Orange was believed to have occurred - show a TCDD level below detection limit of 2-4 pg/g in 3 cases and levels of 50 to 232 pg/g on lipid basis in the remaining 6 specimens.

The results of the 1985 sample collection period are listed in table 1. All values in samples from South Vietnam are lower than in samples found in the early sampling period. For comparison, the samples from Hanoi – no spraying occurred in the North – did not show any TCDD contamination at adequate detection limits.

It is striking that the values decline in time when looking at the different sampling periods. This declining trend for PCDD/PCDFs in humans in the course of time was first observed for human milk in Germany by Fürst et al., 1992. On the other hand, it has to be taken into account that although 170 plus kg of TCDD were sprayed on 10 % of what was then South Vietnam and may have found its way into the food chain in the present as it did in the 1970s (Baughman), undoubtedly a great variation in environmental levels of TCDD exists. Thus, exposure from early and actual intake of TCDD varies greatly, even in the south of Vietnam.

Sample	Origin	TCDD-Concentration
Pool, n=4 No. SM 4 / 6 / 8	Ho-Chi-Minh City, S-Vietnam Children's Hospital	13 12 / 10 / n.d. (3)
Pool, n=3 No. TU 5 / 8	Ho-Chi-Minh City, S-Vietnam Obstetrical and Gyneco. Hospital	n.d. (5) 12 / n.d. (3)
No. TMS 1 / 2	Dong-Nai River (S-Vietnam)	n.d. (50) / n.d. (23)
Pool, n=3 No. BM 24	Hanoi (N-Vietnam) Swedish Hospital	n.d. (2) n.d. (3)

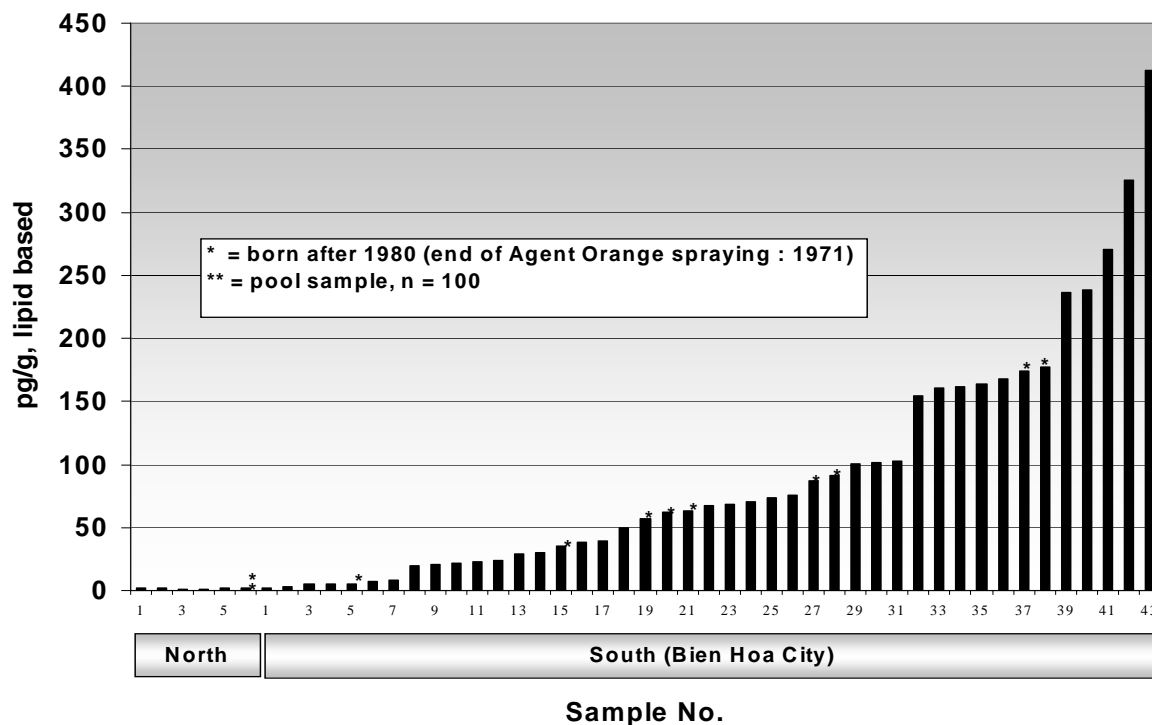
**Table 1** : 2,3,7,8-TCDD levels in human milk samples from Southern and North Vietnam, collected 1985, pg/g, lipid weight, n.d. = not detected, ( ) = detection limit, (Schecter and Ryan, 1987)

#### Areas of potential high contamination (hot spots)

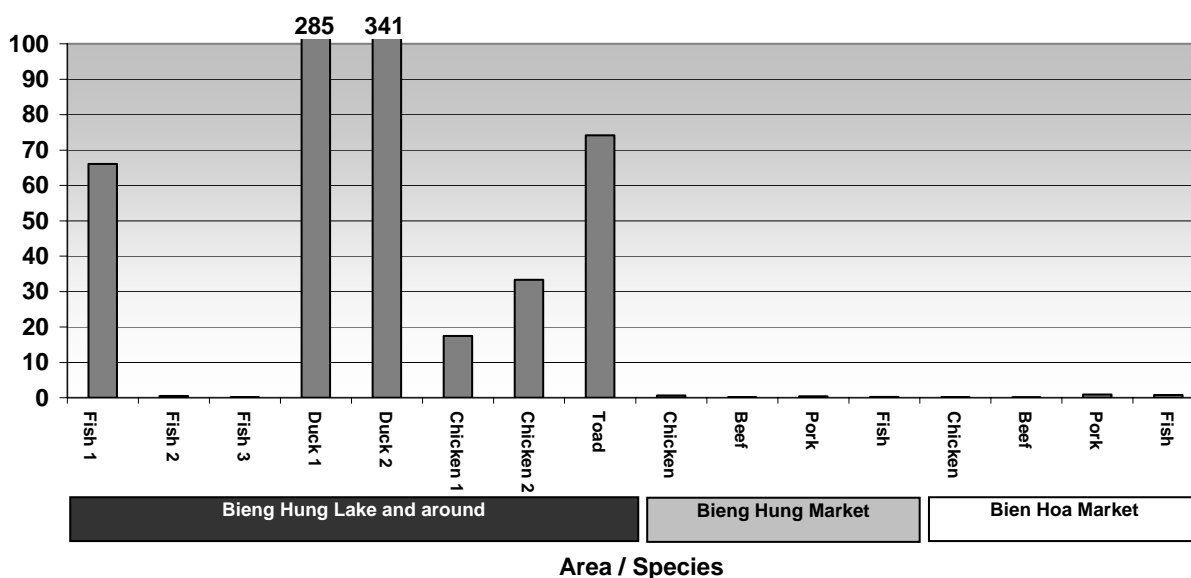
The exposure situation in areas of so called hot spots is still a matter of concern. In such areas a continuous exposure of humans must be considered. Recently, some specific dioxins reservoirs have been reported at by Dwernychuk et al. (2002) and by Schecter et al. (2001, 2002, 2003).

Schecter et al. focused on an area north of Ho Chi Minh City, Bien Hoa, a former US air base. From this area, blood samples and food samples were analyzed. The results are presented in figures 1 and 2. Out of 43 samples 36 samples showed TCDD values above 20 pg/g lipid. The highest concentration found was 413 pg/g lipid. This person is known to have a high fish consumption. The individual control samples from Northern Vietnam (Hanoi) show values between 1.2 and 2.3 pg TCDD/g lipid.

The results for the food samples collected "in and around" the nearby Bien Hung lake show mostly very high values for TCDD while values for samples from Bien Hung market and Bien Hoa market do not show striking values. Comparison data for food from Vietnam were recently published from Schecter et al., 2002 at between 0,001 and 0,05 pg TCDD/g wet weight.



**Figure 1** : 2,3,7,8-TCDD levels in Human Blood, Vietnam (Schecter et al., 2002)



**Figure 2 :** PCDDs/Fs in Vietnamese food (WHO-TEQs). Values in pg/g, wet weight based (Schecter et al., 2003)

More information about this area is shown by soil / sediment samples: Grab samples of soil were collected from the Bien Hoa air base, where Agent Orange has been stored and sediment samples from the nearby Bien Hung lake, respectively. The sampling site of 'Lake Bien Hung 2' samples are close to the former air base. The Bien Hung lake empties into the Dong Nai River (Schecter et al., 2001). The results for these analyses are presented in tables 2 and 3 respectively.

	Sample 1	Sample 2	Sample 3
<b>2,3,7,8-TCDD</b>	1,164,699	603,968	N.D.
<b>Total PCDDs</b>	1,645,017	714,740	39.4
<b>Total PCDFs</b>	146,721	38,852	N.D.
<b>TEQ (PCDDs/PCDFs)</b>	1,180,737	610,874	0.04

**Table 2 :** Levels of 2,3,7,8-TCDD and TEQ in soil samples collected from Bin Hoa Air Base, a former Agent Orange storage facility , concentration in ng/kg dry matter (Schecter et al. 2001)

In the soil samples the TCDD level varies from not detected to over 1 million ng/kg. This value in sample 1 is – to the best of our knowledge – the highest soil level for TCDD measured in Vietnam to date.

Area	Numbers	2,3,7,8-TCDD Concentration
<b>Hanoi</b>		n.d.
<b>Bien Hung Lake</b>	<b>1 A / 1 B / 1C</b>	10,4 / 14,5 / 1,6
	<b>2 A / 2 B / 2 C</b>	177 / 114 / 98,2
	<b>3 A / 3 B</b>	1,7 / 1,1
<b>Dong Nai River</b>	<b>A / B</b>	0,8 / 1,5

**Table 3 :** PCDDs/Fs in sediment samples, values in ng/kg dry matter, Vietnam (Schecter et al. 2001)

It is our conclusion that the examples presented here demonstrate the possible influence of consumption of contaminated food on the human body burden. It seems reasonable to conclude that this uptake was recent and occurred possibly many years after the spraying ended. These findings suggest that this substantial

contamination is probably from dietary intake of TCDD from contaminated food like e.g. fish, poultry or eggs consumed long after Agent Orange spraying which ended early in 1971.

The dioxin data for the 43 blood samples, 16 food samples, 3 soil samples and 10 sediment samples can not be considered as representative for the specific area of Vietnam. We recommend for further monitoring of the population, and the environment including food in a representative fashion.

Finally, it should be noted that due to the unexpected values found in the human samples collected in the Bien Hoa area special attention should be given to a potential exposure of babies during the breast feeding period.

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