

Character of dioxin contamination of the South Vietnam

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It is known that a significant part of the South Vietnam is contaminated by 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and other polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) which occur as negligible admixtures in herbicide 2,4-D, a component of Agent Orange and other herbicide compositions, sprayed by USA air forces during the war 1962-1971. PCDDs and PCDFs were found in Vietnam in human milk and fat tissues¹⁻³⁾ and also in soil and foodstuffs^{4,5)}.

It is also known that PCDD and PCDF are accumulated mainly in human fat tissues and can be retained there a long time^{6,7)}. So it is not surprising that PCDD and PCDF were detected in human milk, blood and fat tissues of the generation participating the war^{2,3)}. But PCDD and PCDF are contained in breast milk of women were born and grewed up after the war. Consequently there is a source of contamination that leads to permanent dioxin exposure. To clear the nature of this source is very important for estimation of people exposure and for investigation of ecosystem hardly polluted by dioxins. Vietnam is especially interested in such point of view because the source of dioxin contamination is distinctly determined in the time and in the place.

To clarify the nature of sources of the dioxins that intake into human body we have investigated the data on the character of the dioxin contamination of water, soil, sediments, foodstuffs and breast milk in the South Vietnam. Often a PCDD/PCDF congeners distribution pattern is very characteristic for the contamination source. So, herbicide 2,4,5-T is characterized mainly by 2,3,7,8-TCDD, for herbicide 2,4-D the isomers 1,3,6,8- and 1,3,7,9-TCDD are characteristic⁷⁾. Sodium pentachlorophenolate used as bactericide and fungicide also contains some characteristic congeners - 1,2,3,4,7,8-HxCDD, 1,2,3,4,6,7,8-HpCDD, 1,2,3,4,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, OCDD, OCDF⁸⁾.

It seems evident that due to the comparatively small scale of industry and transport the only possible source of dioxin contamination of the Vietnam could be the defoliant sprayed during the war. Due to high stability of dioxins and negligible migration

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with natural water they can be saved in large quantity on the areas sprayed on a large scale by defoliants. It is considered that the area of the South Vietnam is contaminated by 170 kg 2,3,7,8-TCDD. Data for depth profile showed that 2,3,7,8-TCDD is localized mainly in the surface layer 10 cm and practically was not found in deeper layers. Estimation for area unit considering uniform distribution is about 163 mg/ga i.e. for 10 cm layer 2,3,7,8-TCDD concentration should be about 25 pg/g⁴⁾. Real concentration of 2,3,7,8-TCDD in soil samples is much lower. 2,3,7,8-TCDD was found only in 14 from 54 soil samples in Tay Nin province (from 1,2 to 38,5 pg, average - 14,0 pg/g), in Hue Fu Lock - in 4 from 6 samples (from 4,4 to 17,0, average - 8,6 pg/g), in Shong Be - only in one from 11 samples (6,0 pg/g). These results show that the most of sprayed 2,3,7,8-TCDD is leached from soil and is washed in the sea and underground layers in rain seasons⁴⁾.

In Vietnam soils other PCDDs and PCDFs except 2,3,7,8-TCDD also were found^{4, 9)}. In some soil samples in Tay Nin comparatively high PCDFs concentrations were found. PCDF congeners distribution in that samples is similar to that of in Arochlor 1254 and 1260. In particular PCDFs are contained in herbicide 2,4-D¹⁰⁾.

The results of our investigation of PCDD and PCDF contamination of soils, foodstuffs and breast milk in Tay Nin and Dong Nay provinces which were hardly sprayed by defoliants during the war, showed that the contamination level in isolated areas where were the defoliants storage or charge places, is very high, and 2,3,7,8-TCDD dominates in these samples⁵⁾. Soil in towns and villages, fields and near road areas also contains PCDDs and PCDFs including 2,3,7,8-TCDD. Foodstuffs (milk, meat, soya oil, fish) and breast milk also contain PCDDs and PCDFs. Therewith some samples contain in high level HpCDD and OCDD which are not typical for defoliants used.

The village Bien My in Shong Be province is one of the regions which were intensively sprayed by defoliants during the war. In soil samples taken in various places in the village PCDDs and PCDFs were found. In the Fig.1 is presented the PCDD and PCDF congener distribution in soil samples from the center of the village and from the field near the village and also in egg (V-11) and in cow milk (V-12) samples. The both soil samples contain 2,3,7,8-TCDD that is the indicator of the residuous defoliants pollution. However in soil sample from the center of the village Bien My OCDD and OCDF dominate and PCDD/PCDF distribution in this sample is quite different to the samples containing the residues of defoliant stored. Soil sample from the field so as foodstuffs also contain OCDD and OCDF.

Matsuda et al.⁴⁾ also found that OCDD and OCDF concentration in soil samples was high compare to other PCDDs and PCDFs. These congeners could not be related to defoliants especially as they were found in Hanoy soil. Thus they were assigned to be natural generation analogously to Hashimoto et al.¹¹⁾ established spontaneous dioxin generation in the nature when have found HpCDD and OCDD in kerns of sediments more 8000 years age. But against of this proposal is the fact that high concentrations of HpCDD and OCDD was found firstly in surface soil level and secondly in the areas intensively sprayed by defoliants previously, and far exceed the concentrations of HpCDD and OCDD in other regions. The profile

of congener distribution of PCDDs and PCDFs in Vietnam soil samples is very similar to that of in various combustion products. Therefore domination of these compounds in soil samples of Dong Nay and Shon Be provinces in parallel with 2,3,7,8-TCDD occurring in these samples could be explained by combustion of the trees and brushes cut down when roads and electro-lines were aying. Among with strow after crop trimming was combusted also. Consequently dioxins could be formed during combustion of chlorinated compounds residues.

It is characteristic that in the center of the village Bien My contamination of these "secondary" dioxins is much higher then in the near. It supports the proposal about crucial importance of economical activity in the "secondary" dioxins formation.

Factor analysis was performed for the number of soil, foodstuffs, breast milk samples from Tay Nin and Shong Be provinces of the South Vietnam. It cleared that the proposal of some different contamination sources find a support. Fig.2 shows factor loadings for the first two factors. In the rihgt side are points which correspond to the congener distribution typical for combustion products (e.g. V_{20} , V_{21}). These points correspond to the soil samples from villages, vista with electric line, fields, where bushes, wood and strow were continously combusted. The point V_{12} (cow milk) and other points in the left down corner correspond to the samples with relatively high concentration of 2,3,7,8-TCDD. Therefore it can be considered that the first factor describes the congener distribution caused by combustion processes: they are all group in the right side.

Some samples - breast milk from the village Bien My (V_{23}), egg (V_{11}) and water samples from the village Tan Bien (V_3 , V_7) - have a congener distribution different from that of in defoliantes but not corresponds to combustion products. HxCDD, PnCDF, HxCDF, HpCDF dominate in these samples. To this group goin a number of foodstuff samples - meat - V_{24} , egg - V_{22} , soya oil - V_{14} .

Therefore the character of dioxin contamination of the South Vietnam points that amongh the "primary" pollution caused by the dioxin contained in the defoliantes sprayed there is a "secondary" pollution caused by combustion of wood, strow and plant residious, contaminated by residious of chlorinated pesticides. There is a additional nonclarified source possible from other chlorinated materials exept defoliantes (may be PCB, sodium pentachlorophenolate or something like it).

So the total amounts of dioxin in the South Vietnam consist of the "primary" dioxins, which been contained in the sprayed defoliantes, and the "secondary" dioxins, formed later due to thermal transformations of the part of sprayed chlorinated herbicides as a result of wood fair and economical activity. These "secondary" dioxins not only add to the total dioxin contamination of the South Vietnam but also lead to extension of the contamination area because dioxin transfer in atmosphere with combustion products is much more effective then by soil leaching.

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REFERENCES

- 1) Westing A.H., Pfeiffer E.W., Dioxins in Vietnam, Science (ISSN:0036-8075), v.270, p.217. October '95.
- 2) Schecter A., Le Cao Dai, Le Thi Bich Thiy, Agent Orange and the Vietnamese: the persistence of elevated dioxin levels in human tissues. American Journal of Public Health (ISSN:0090-036), v.85, April'95, p.516-522.
- 3) Olie K., Schecter A., Constable J.D., Kooke R.M.M., Serne P., Slot P.C., de Vries P., Chlorinated dioxins and dibenzofuran levels in food and wildlife samples in the north and south of Vietnam, : Chemosphere, 1989, v.19,493-496.
- 4) M.Matsuda, H.Funeno, Hoang Trong Quynh, Hoang Dinn Cau, T.Wakimoto PCDDs/PCDFs Pollution in Vietnam Soils. Organohalogen Compounds, v.20(1994), 41-45.
- 5) E.S.Brodsky, N.A.Klyuev, V.S.Soyfer, V.G.Jilnikov, E.I.Soboleva, Chan Suan Thu, Nguen Suan Net, PCDD and PCDF containing in soil and foodstuff samples and character of dioxincontamination of the South Vietnam, Proceedings of the Institute of Ecology and Evolution Russian Academy of Sciences, Moscow, (in press).
- 6) PCB's, PCDD's and PCDF's: Prevention and Control of Accidental and Environmental Exposures. Ed's: J.H.Rantanen et al., WHO, Kopenhagen, N.23. 1988.
- 7) Polychlorinated dioxins and dibenzofurans. Eds C.Rappe, H.-R. Buser, B.Dodet, I.K.O'Neil. Lyon: IARC, WHO, 1991, 426 p.
- 8) E.S.Brodsky, N.A.Klyuev, V.G.Jilnikov, Determination of tetrachlorinated dibenzo-p-dioxins, dibenzofurans and related compounds in the commercial herbicide 2,4-D. J. Anal. Chem. (Rus.), 1992, v.47, N.8, 1497-1503.
- 9) Hashimoto S., Wakimoto T., Tatsukawa R., PCDDs in the sediments accumulated about 8120 years ago from Japanese coastal areas, : Chemosphere, 1990, v.21, 825-835.
- 10) J.J.Ryan, R.J.Norstrom, Occurrence of polychlorinated dibenzo-p-dioxins and dibenzofurans in humans and major exposure routs. in: Environmental carcinogens. Methods of analysis and exposure measurement. Vol.11 - Polychlorinated dioxins and dibenzofurans. Eds: C.Rappe, H.R.Buser, B.Dodet, I.K.O'Neil. IARC, Lion, 1991. Chapter 4. P.51-104.
- 11) Lingjin Li, Yudong Chen, Chung Chiu, G.Poole, W.Miles, Ke Jiang, PSDD/Fs in sediment samples from chinese schistosomiasis areas and potential human health effects. "DIOXIN'95", Short Papers. Organogalogen Compounds, Vol. 23 (1995), pp.155-158.

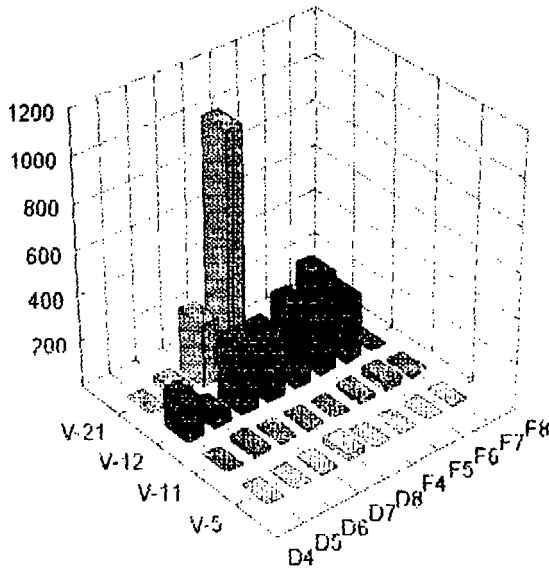


Fig.1. PCDD and PCDF congener distribution in soil samples from the center of the village (V-21) and from field near the village (V-5), in egg (V-11) and in cow milk (V-12).

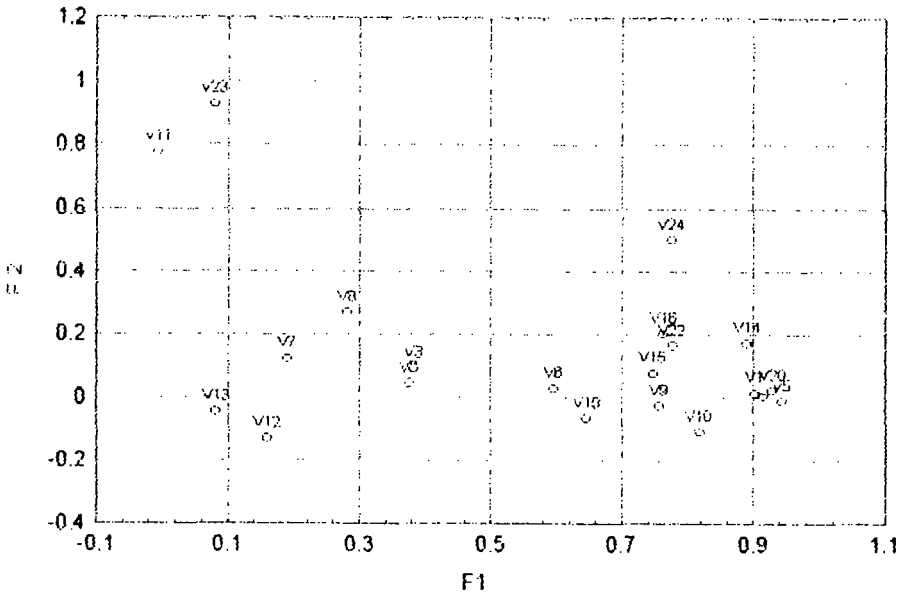


Fig.2. Factor loadings for the first two factors for PCDD and PCDF distribution in soil, foodstuffs and breast milk samples.