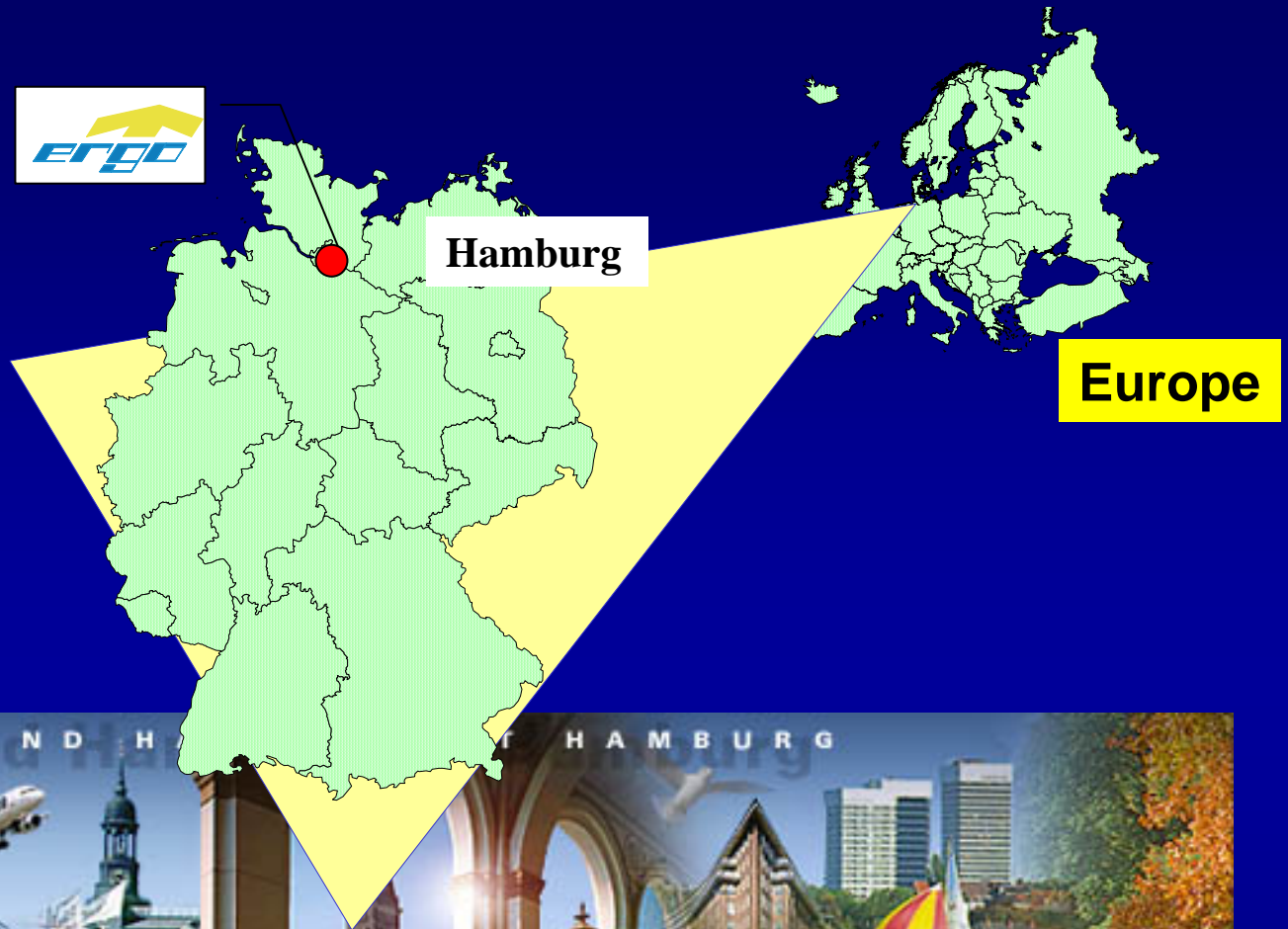


Dioxins in Vietnamese, Vietnamese Food and Environment: Potential Relevance of Hot Spots from Recent Findings



Olaf Päpke and Arnold Schecter
eurofins - ERGO Research, Hamburg, Germany
University of Texas, Dallas, USA





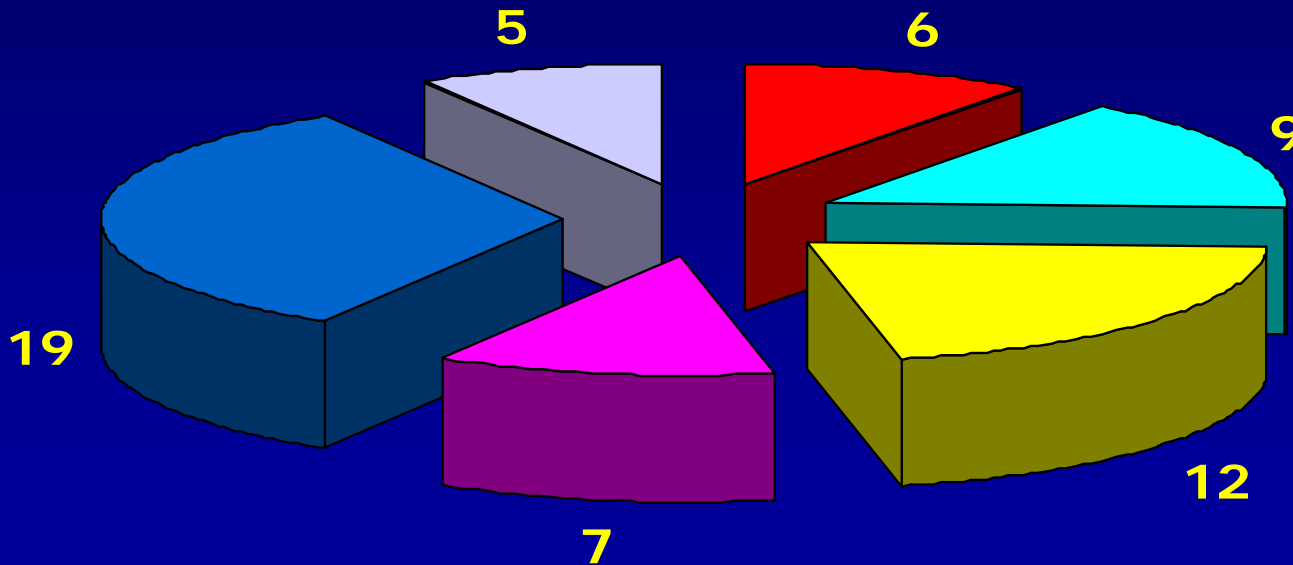
ERGO is situated at the Northern part of Germany, Europe

Some Words about ERGO

- More than 20 years experience in dioxin analysis
- Capacity: 3000 dioxin analyses per year
- 3 (4) HRGC/HRMS instruments
- Authorized by WHO and European Union for Food and Feeding stuff analysis for dioxin
- Accreditation in accordance with EN/ISO 17025
- Customers in more than 30 countries worldwide



The ERGO Team



- Chemists
- Engineers
- Laboratory technicians
- Technicians
- Support
- Administration

*Thant's New: **eurofins** and ERGO*

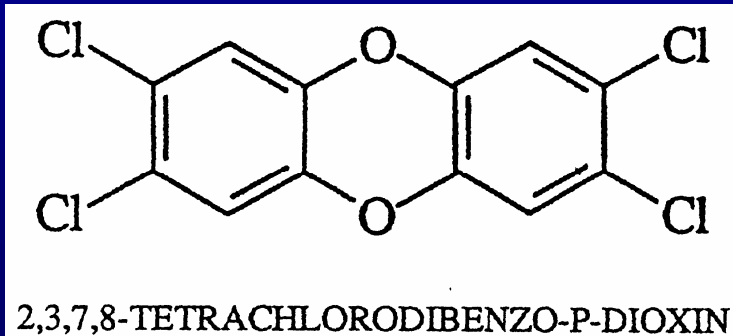
- ERGO belongs to the eurofins Group a globally working group in the bioanalytical market with about 2.500 employees in 40 laboratories in EU and US and Asia
- 5.000 different analytical methods
- Investments in R&D and state-of-the-art equipment
- Expertise in technical & regulatory matters

Components of Question

- Polychlorinated dioxins and furans
PCDDs and PCDFs



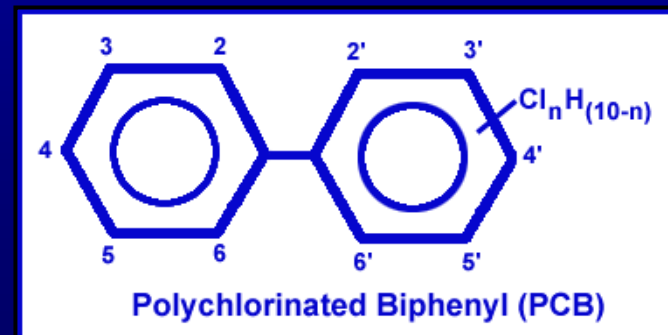
- **Relevant for Humans:**
- 17 congeners with 2,3,7,8-chlorine substitution



- Polychlorinated biphenyls
PCBs



- **Relevant for Humans:**
- 12 dioxin-like congeners, 4 non-ortho, 8 mono-ortho



Outline

- Sources
- Tissue selection
- Relevance of food
- Tolerably daily intake
- Body burden
- Time trends
- Factors of influence
- Special consumptions
- Occupational exposure
- Vietnam
 - general
 - early investigations
 - recent investigations
 - hot spots

Chemical & Industrial Sources for Dioxins

- Waste incineration**
- Thermal industrial processes**
- Metal production**
- Chlorine industry**
- Bleaching of pulp**
- Traffic**
- Domestic furnaces**

**Humans may become
contaminated with PCDD/Fs and
dioxin-like PCBs by:**

- **Environmental exposure**
- **Occupational exposure**
- **Accidental exposure**

Exposure Pathways

Emission

Environment

Food



Incineration
Industry

Chlorine
Industry

Thermal Metal
Process

Car
Exhaust



Rain/deposition

Dump Site/Sludge

Plants, gras

Soil / Water

Beef, cow
milk/-products

Pork/
-products

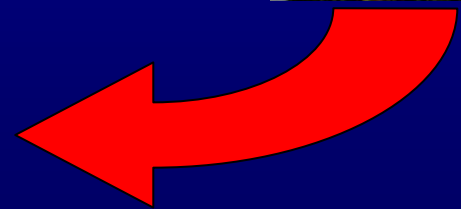
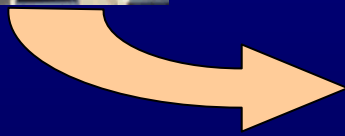
Chicken/
-products

Fish/
-products

Vegetables



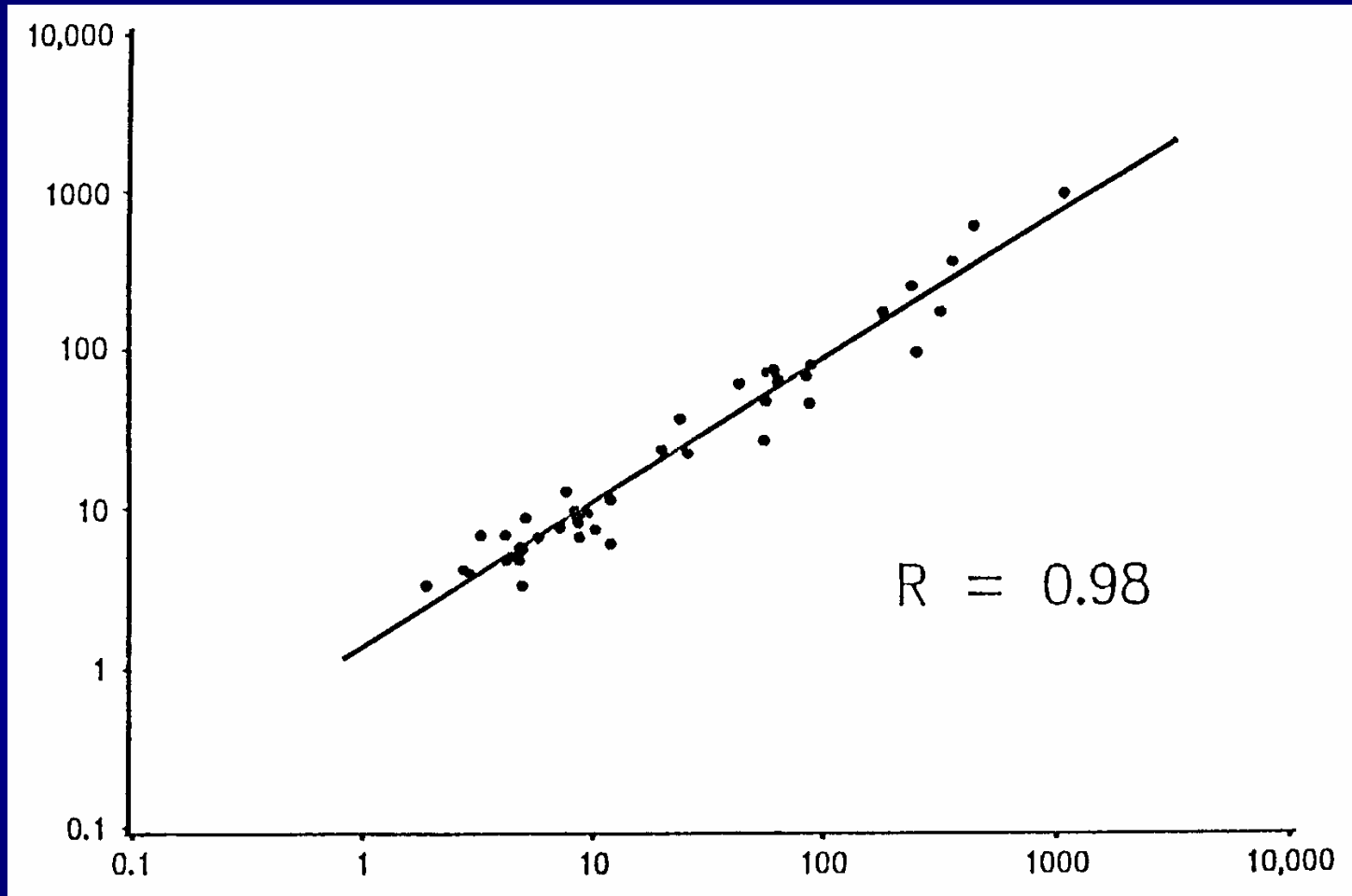
Humans



Importance of Food

- Consumption of food contributes normally with **>95 %** to the daily total PCDD/PCDF and PCB uptake
- Food rich in fat, especially originating from animals, is most important
- Food originating from plants usually shows a lower content of PCDDs/PCDFs

Adipose and Serum 2,3,7,8-TCDD Levels



Adipose
2,3,7,8-
TCDD
pg/g -
lipid
weight
basis

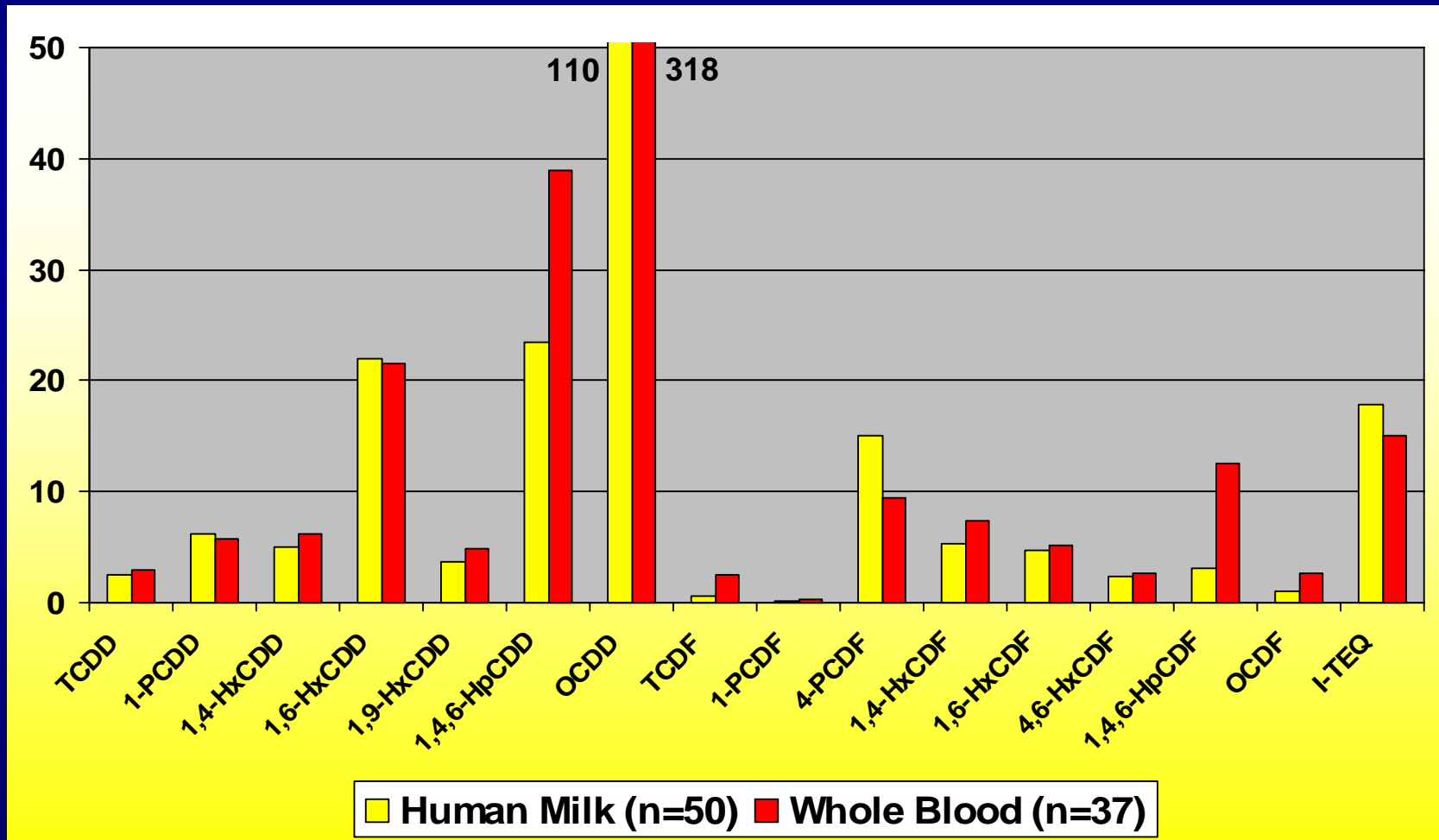
Serum 2,3,7,8-TCDD
pg/g - lipid weight basis

Patterson et al, 1988

PCDDs/PCDFs in Humans

Comparison of Blood and Milk, 1994

Values in pg/g, lipid based



Tolerable Intake for Dioxins and Dioxin-like PCBs

WHO, 1998

1 – 4 pg TEQ/kg b.w./day

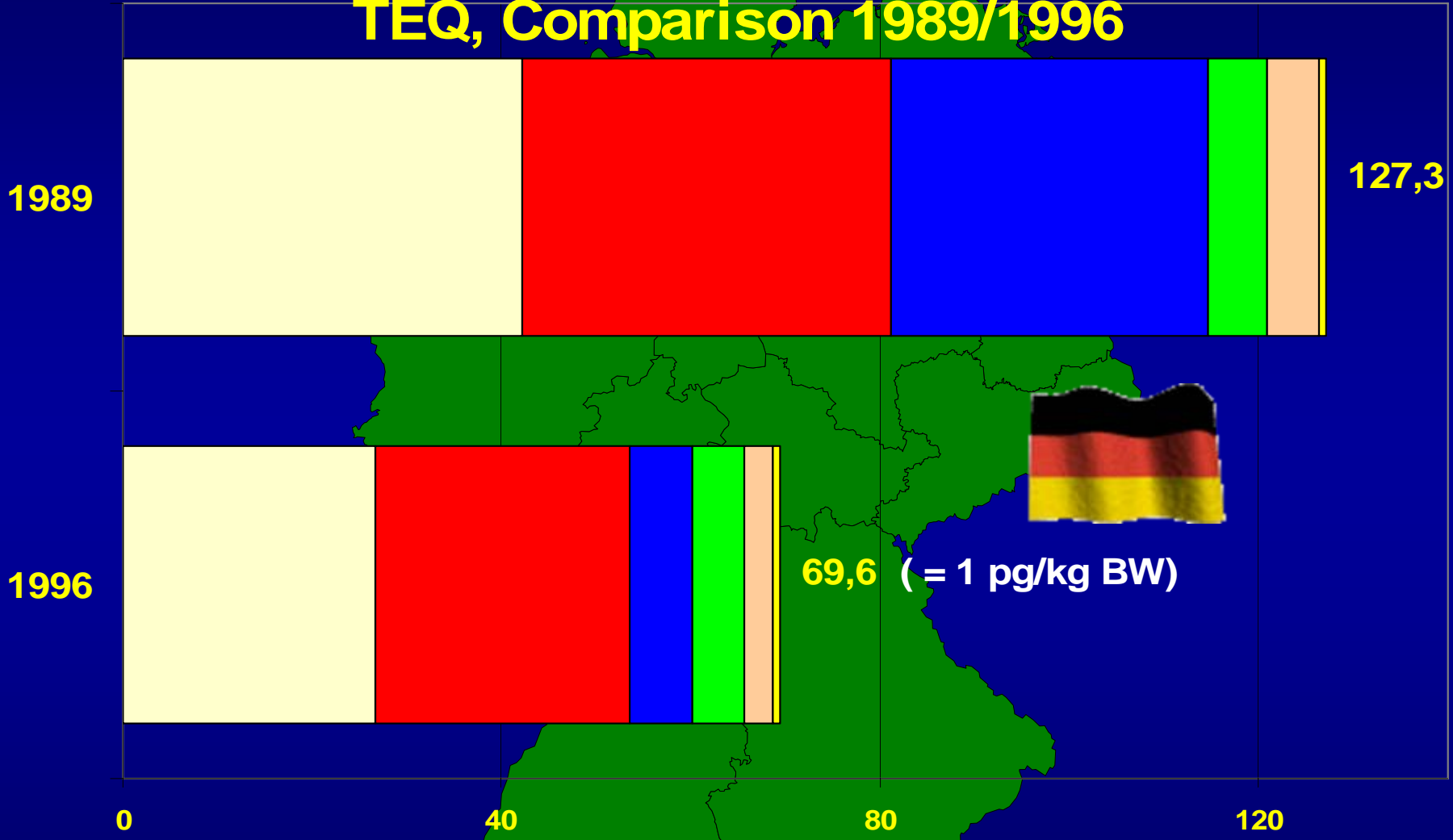
SCF, 2001

14 pg TEQ/kg b.w./week

JECFA, 2001

70 pg TEQ/kg b.w./month

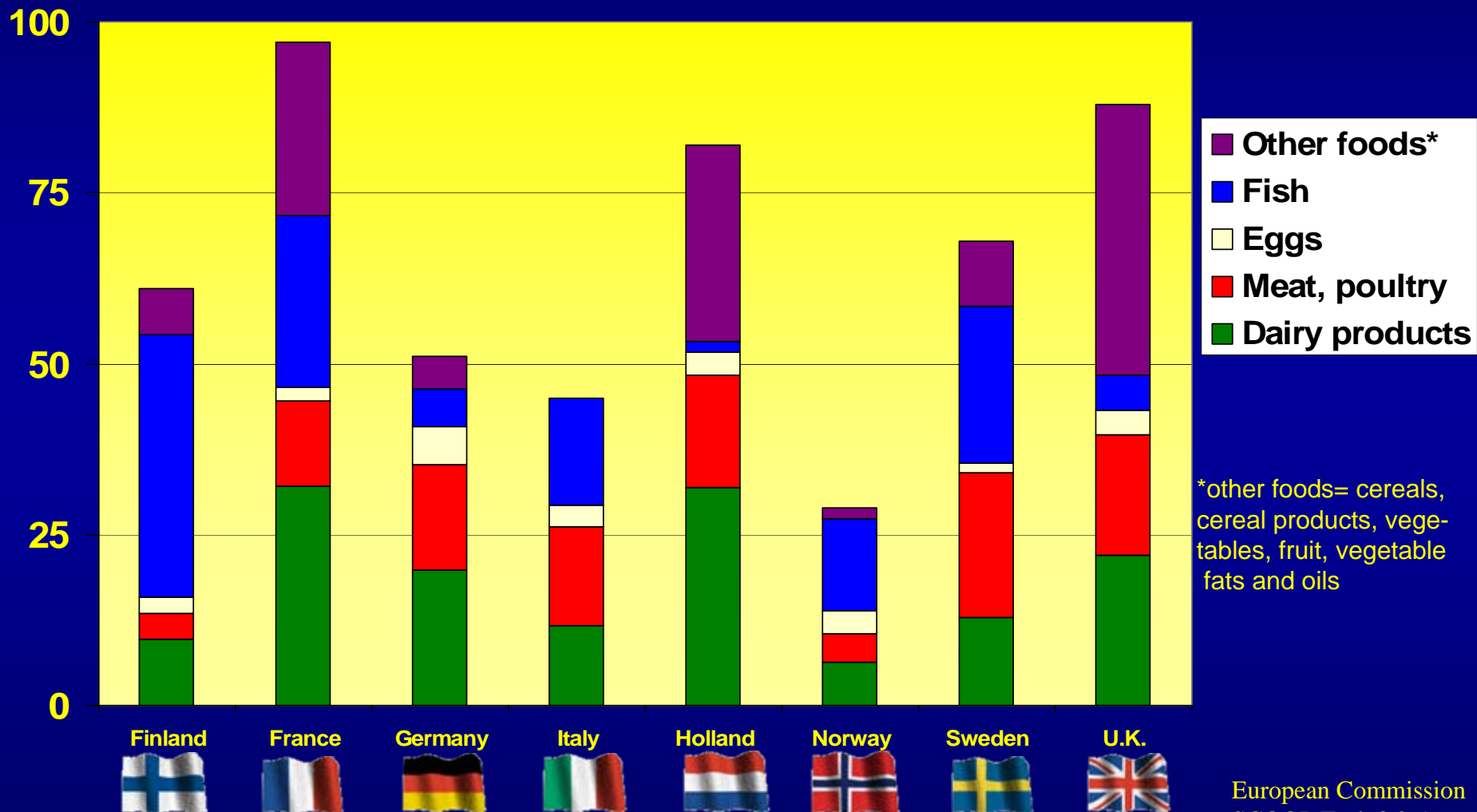
Average daily PCDD/F intake via food in pg TEQ, Comparison 1989/1996



Reduction of Dioxin Emissions by different Ordinances in Germany

- Ban of PCBs and PCP, 1989
- Limiting value for combustion plants, 1990:
0,1 ng I-TEQ/m³
- Ban of scavengers, 1992
- Limiting values for sewage sludge, 1992 :
100 ng I-TEQ/kg
- Maximum workplace concentration, 1993 :
50 pg I-TEQ/m³
- Prohibition on certain chemicals, 1994

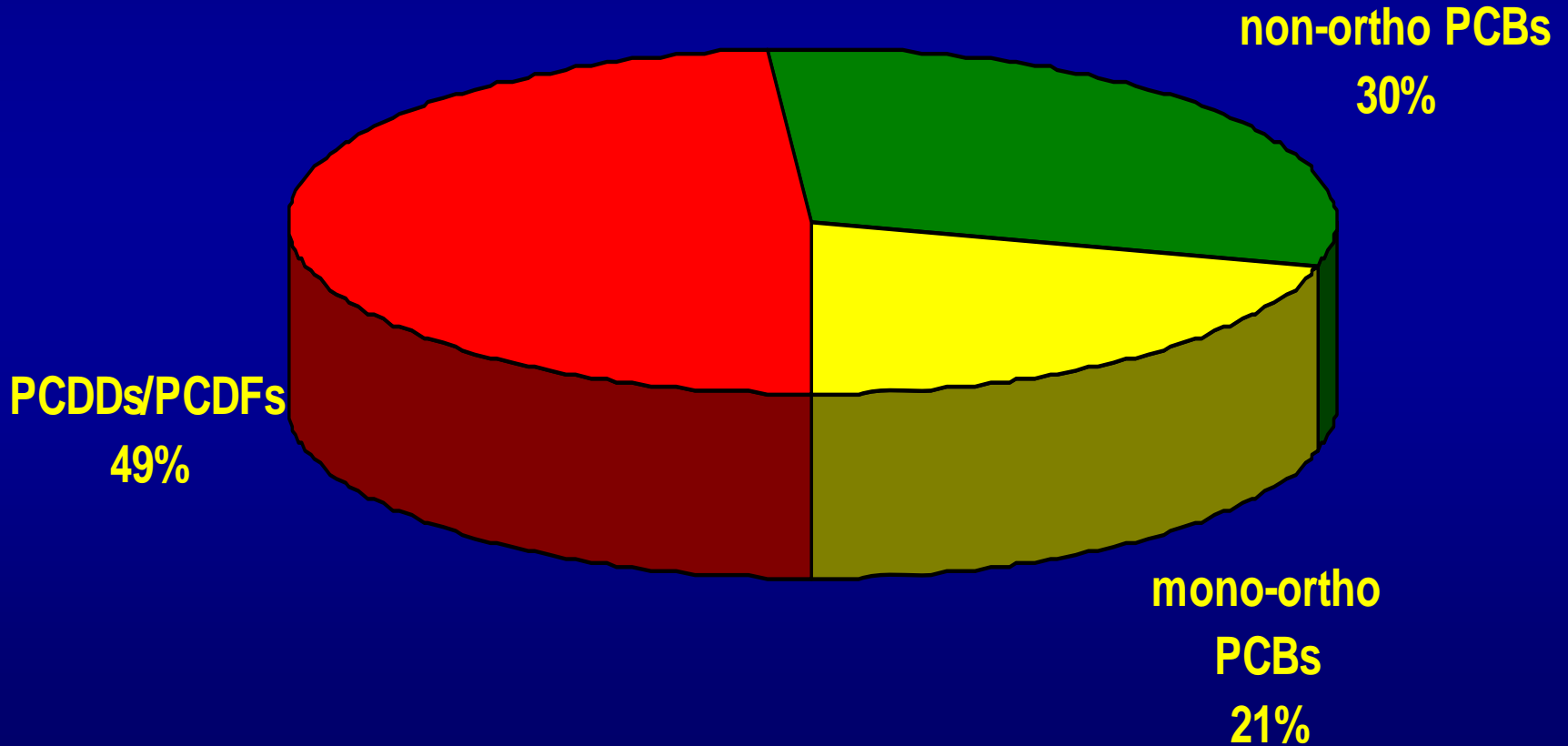
Dietary Intake of PCDD/Fs (I-TEQ, pg/d) from Major Food Groups, Adults or Total Population



*other foods= cereals, cereal products, vegetables, fruit, vegetable fats and oils

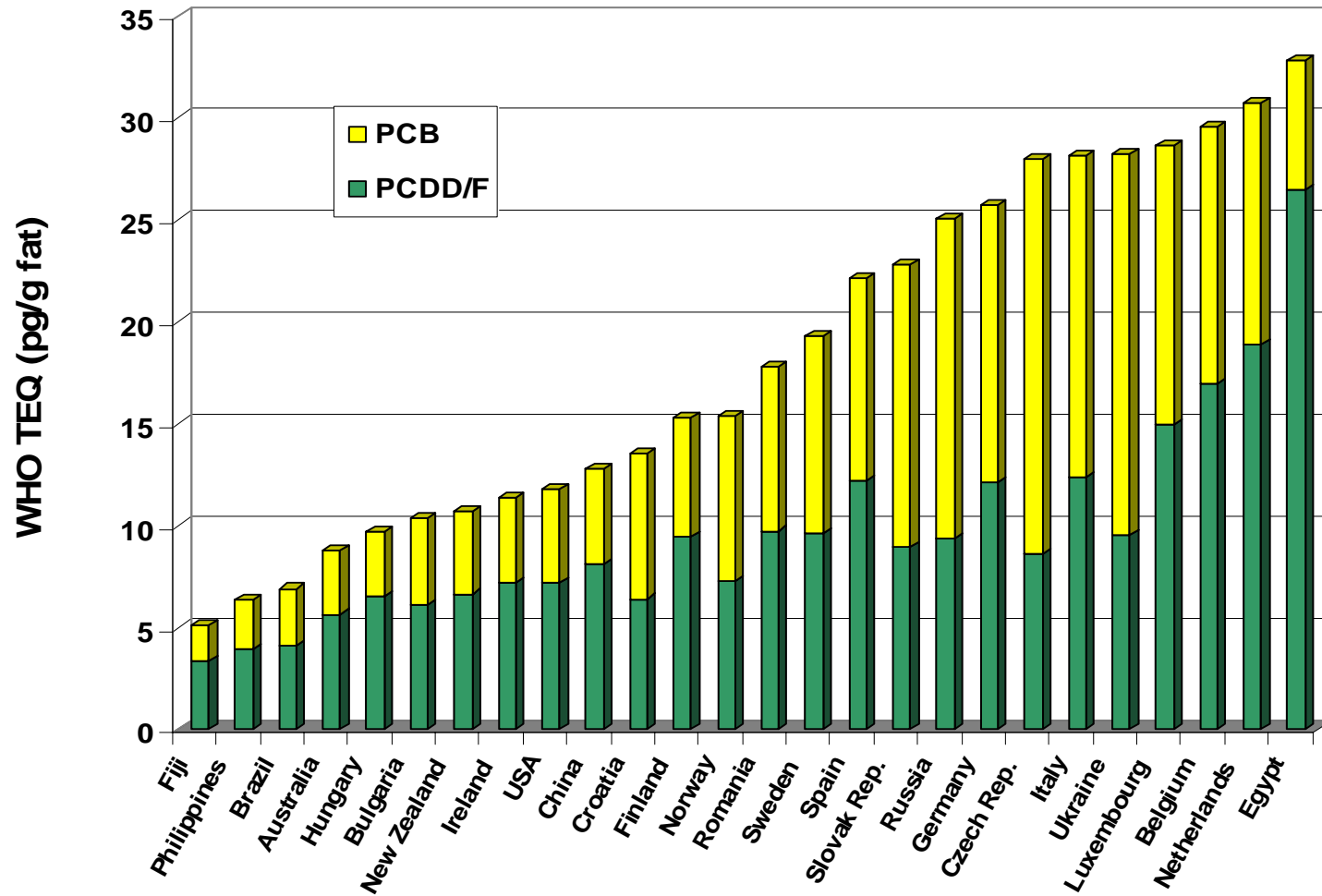
Contribution of PCDDs/PCDFs and Dioxin-like PCBs to Total WHO-TEQ

(Fürst and Pöpke, 2002)



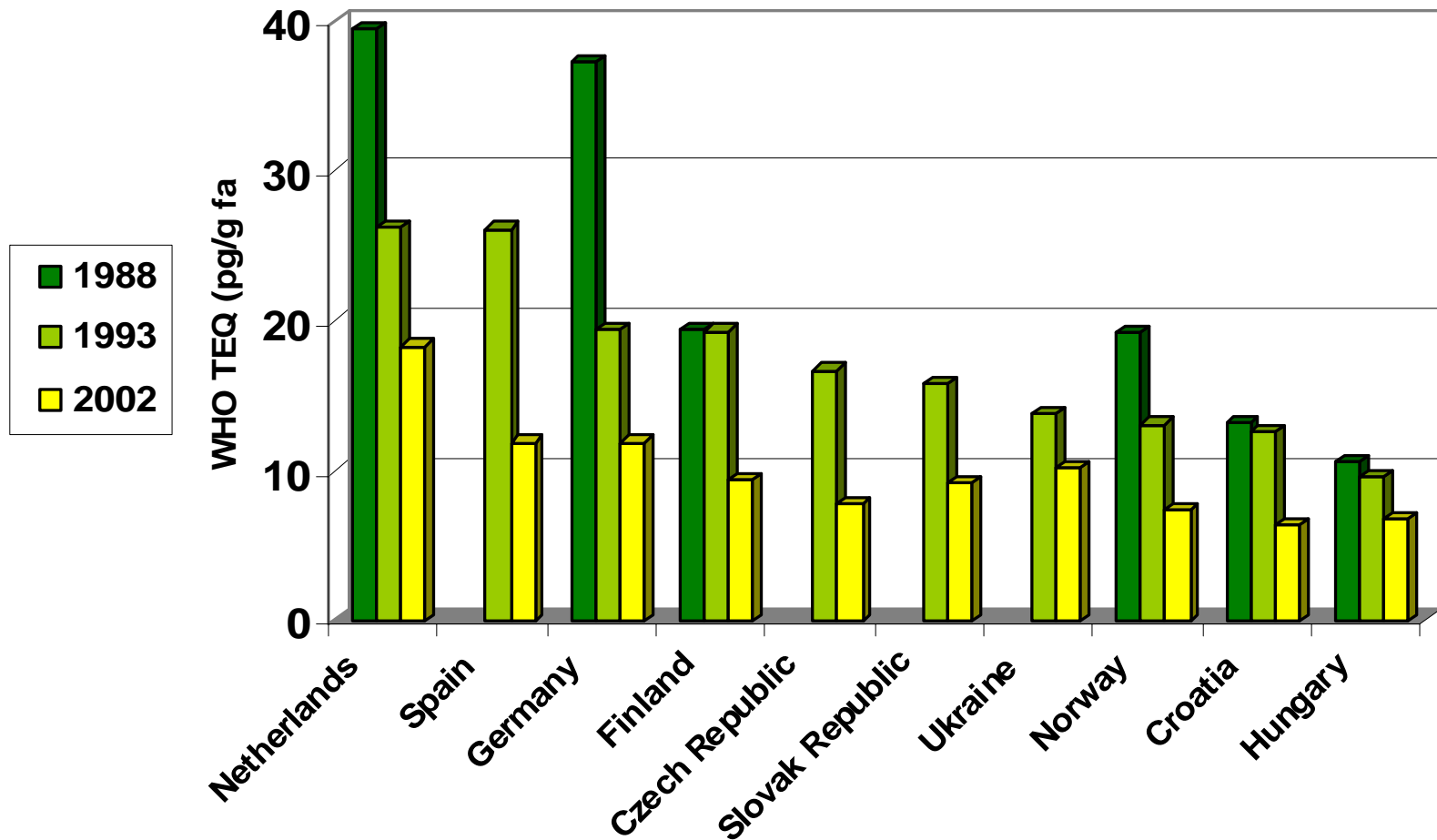
RESULTS OF THE WHO-COORDINATED EXPOSURE STUDY ON THE LEVELS OF PCBs, PCDDs AND PCDFs IN HUMAN MILK

Rainer Malisch and Rolaf van Leeuwen, Dioxin 2003



Temporal Trend of PCDD/Fs in Human Milk

Rolaf van Leeuwen and Rainer Malisch, Dioxin 2002



Biological Half-Lives of PCDD/Fs and PCBs in Humans

Problem : Most PCDD/Fs and PCBs have long half-lives, e.g.

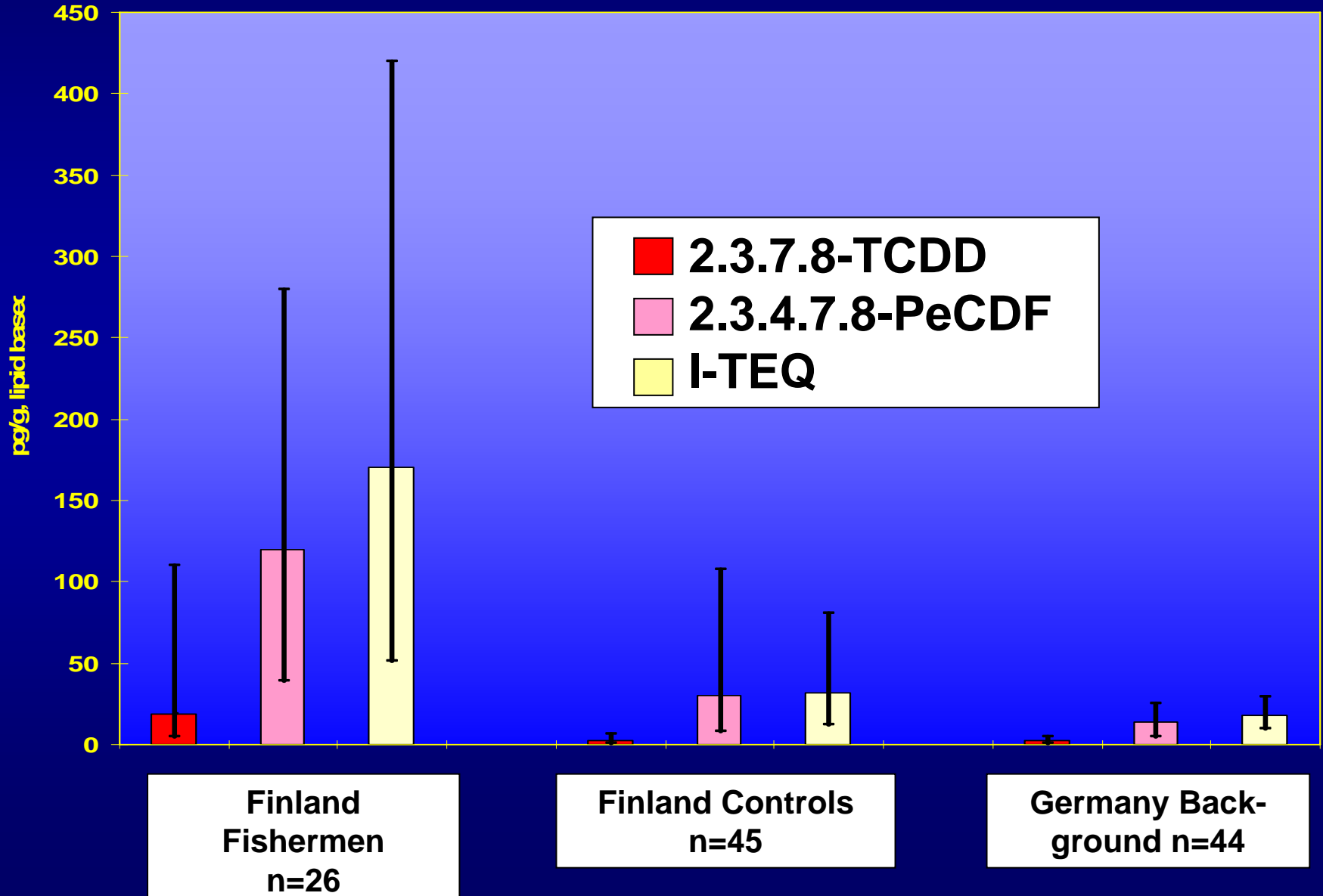
2.3.7.8.-TCDD : 7 years

Consequence : Permanent intake of PCDD/Fs via food leads to high concentration in humans **(accumulation)**

Factors of Influence on Human Body Burden for PCDDs/PCDFs

- **Consumption habits**
- **Severe weight loss**
- **Age dependency**
- **Women: nursing / non nursing**
- **Infants: nursed / not nursed**

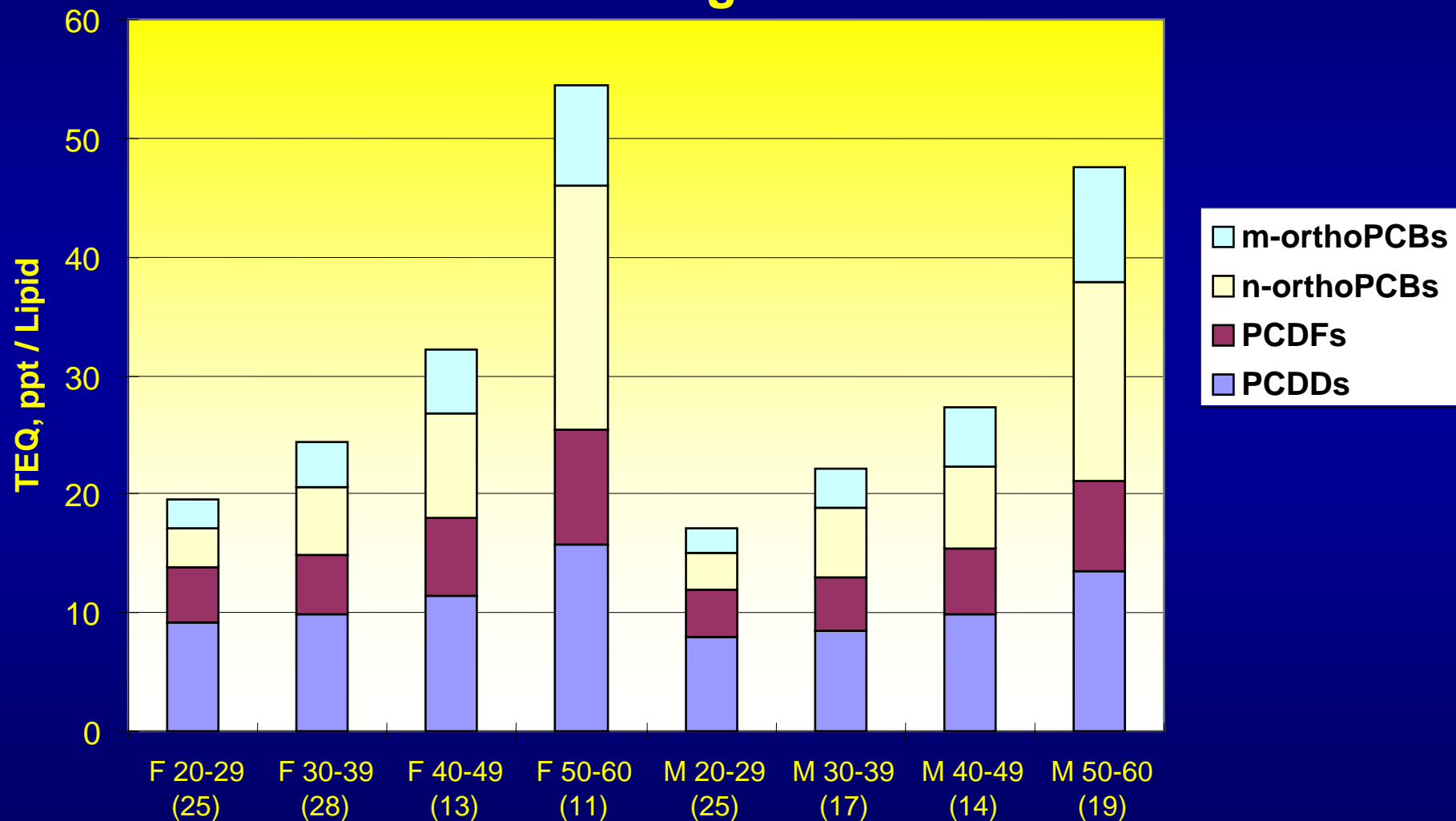
PCDDs/Fs in Selected Population, Influence of Fish Consumption, Kivivanta et al., 2000



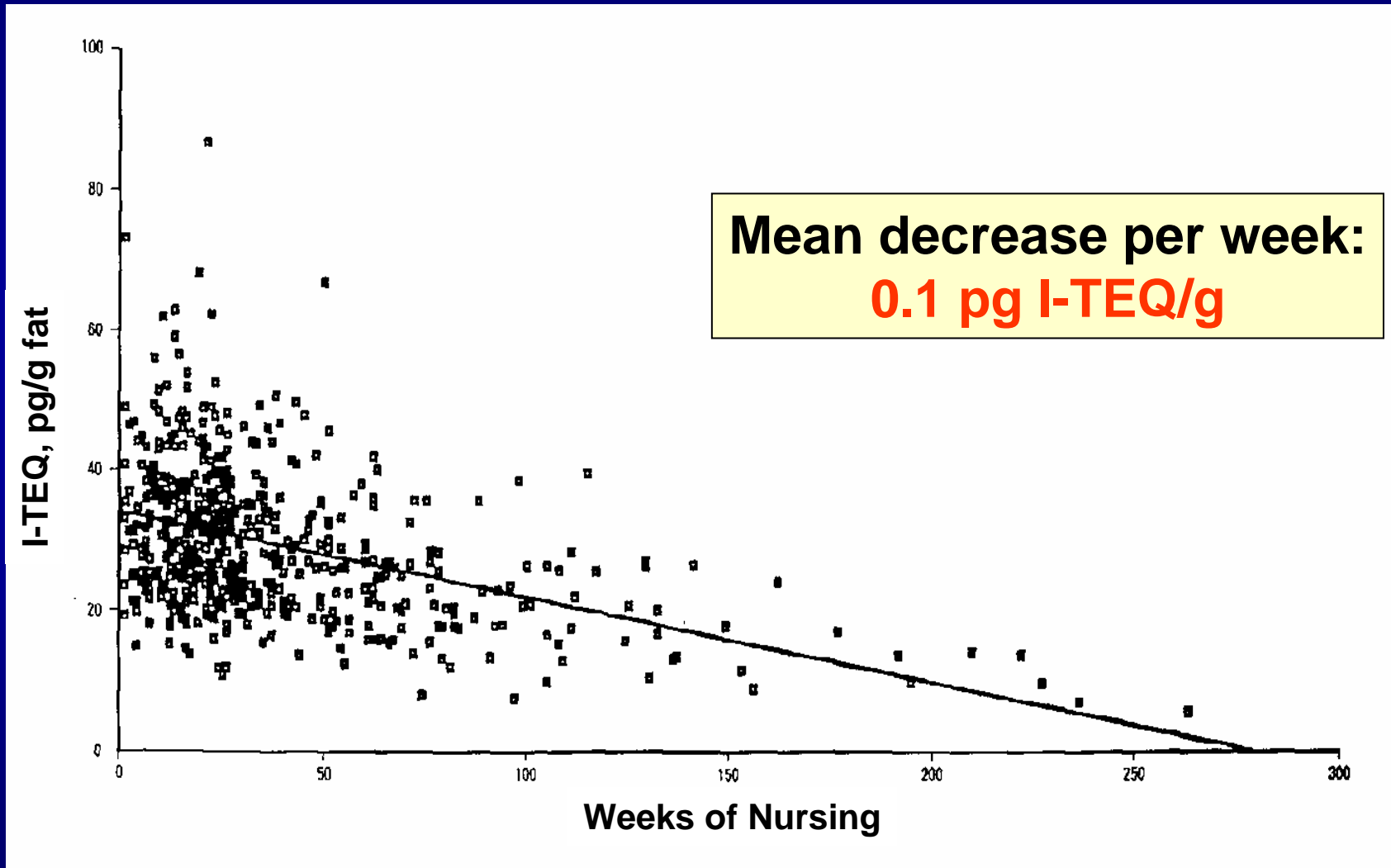
Increase of PCDD/PCDF Concentration (TEQ) in Human Blood due to Weight Loss in pg/g, lipid based



TEQ Concentrations from PCDDs, PCDFs, n-orthoPCBs, m-orthoPCBs in the Blood of Fukuoka residents (n=152), different Age and Sex



Influence of Nursing Time for Human Milk PCDD/PCDF Burden



Source : Fürst, CLUA Münster, 1991

Daily Intake of PCDDs/Fs of Nursed Infants in Germany, 1998

Basis: 5 kg BW

800 ml/day

3 % lipids

Human milk :

13,6 pg/g TEQ

Total Intake

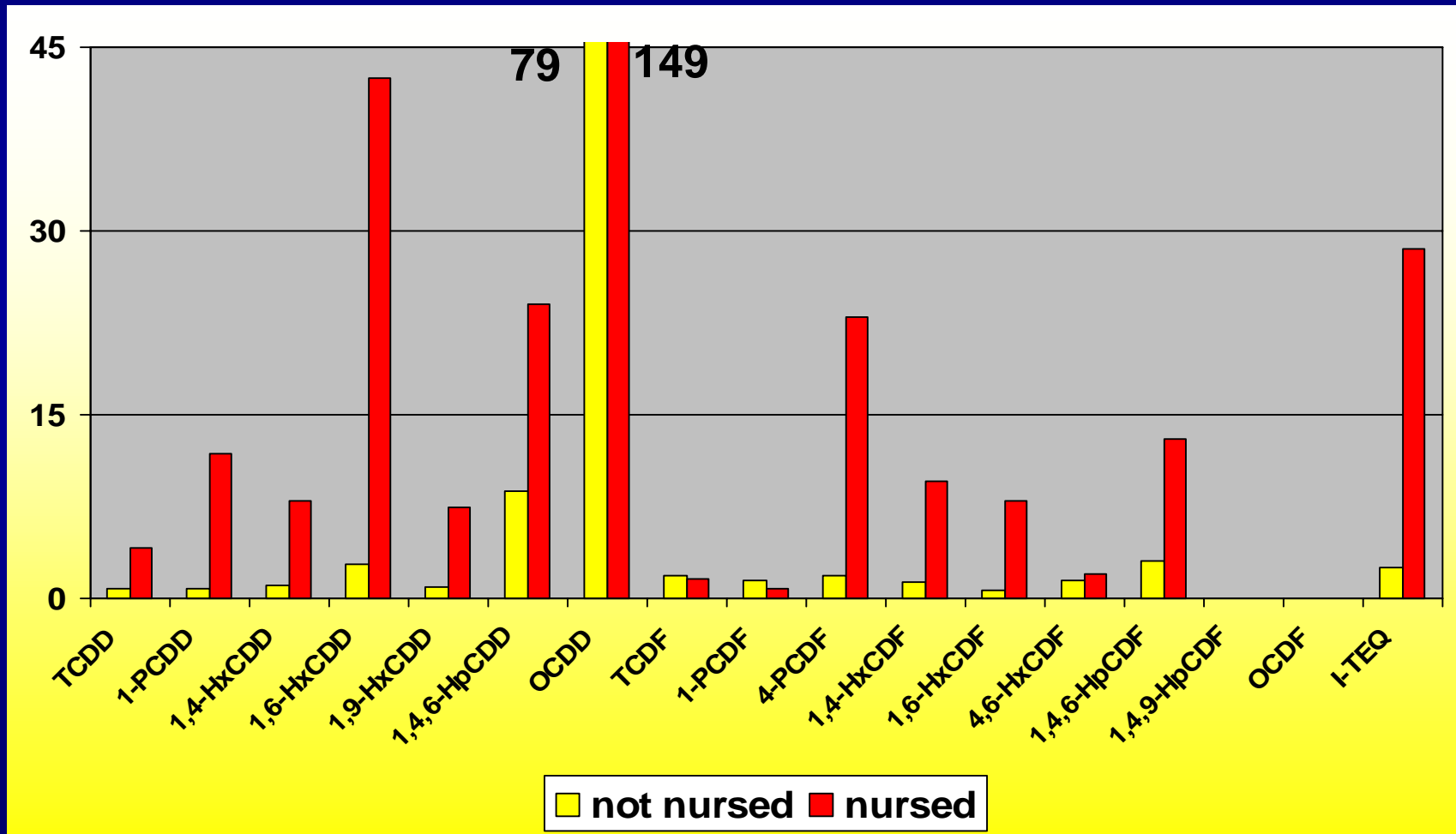
- in pg/day: 324
- in pg/kg BW/day: 65



PCDDs/PCDFs in Human Blood

Comparison of nursed and not nursed infant

Values in pg/g, lipid based



Early Investigations in Vietnam



Vietnam, Background

- **Agent Orange**, a mixture of
 2,4,5-T (2,4,5-trichloro-phenoxy-acetic acid)
 2,4-D (2,4-dichloro-phenoxy-acetic acid)

was sprayed as defoliant on about

- **10 % of southern Vietnam** during the Vietnam war between **1962-1971**

2,4,5-T was contaminated with
2,3,7,8- TCDD in the low ppm-range.

Background, contd.

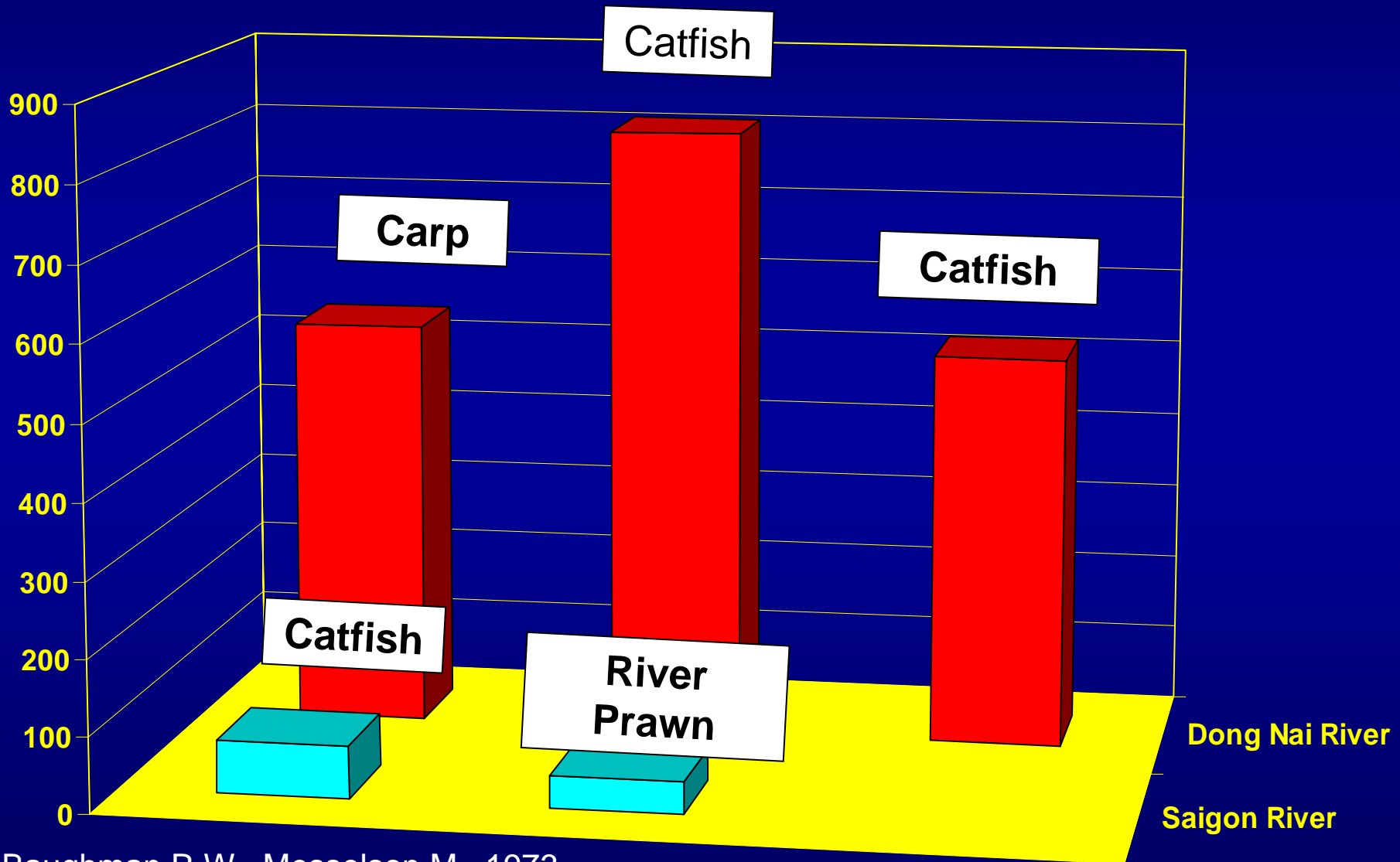
Previous studies have documented **intake of TCDD** in among **US war veterans** and in **Vietnamese**

Kahn et al., 1988,
Schechter et al., 1990, 1992, 1995
Michalek et al., 1996.

Samples collected between 1970 and 1973 documented elevated levels for TCDD in **milk samples** from southern Vietnamese woman as well as in **fish and shrimp samples** from areas in this region.

Baughman et al., 1973

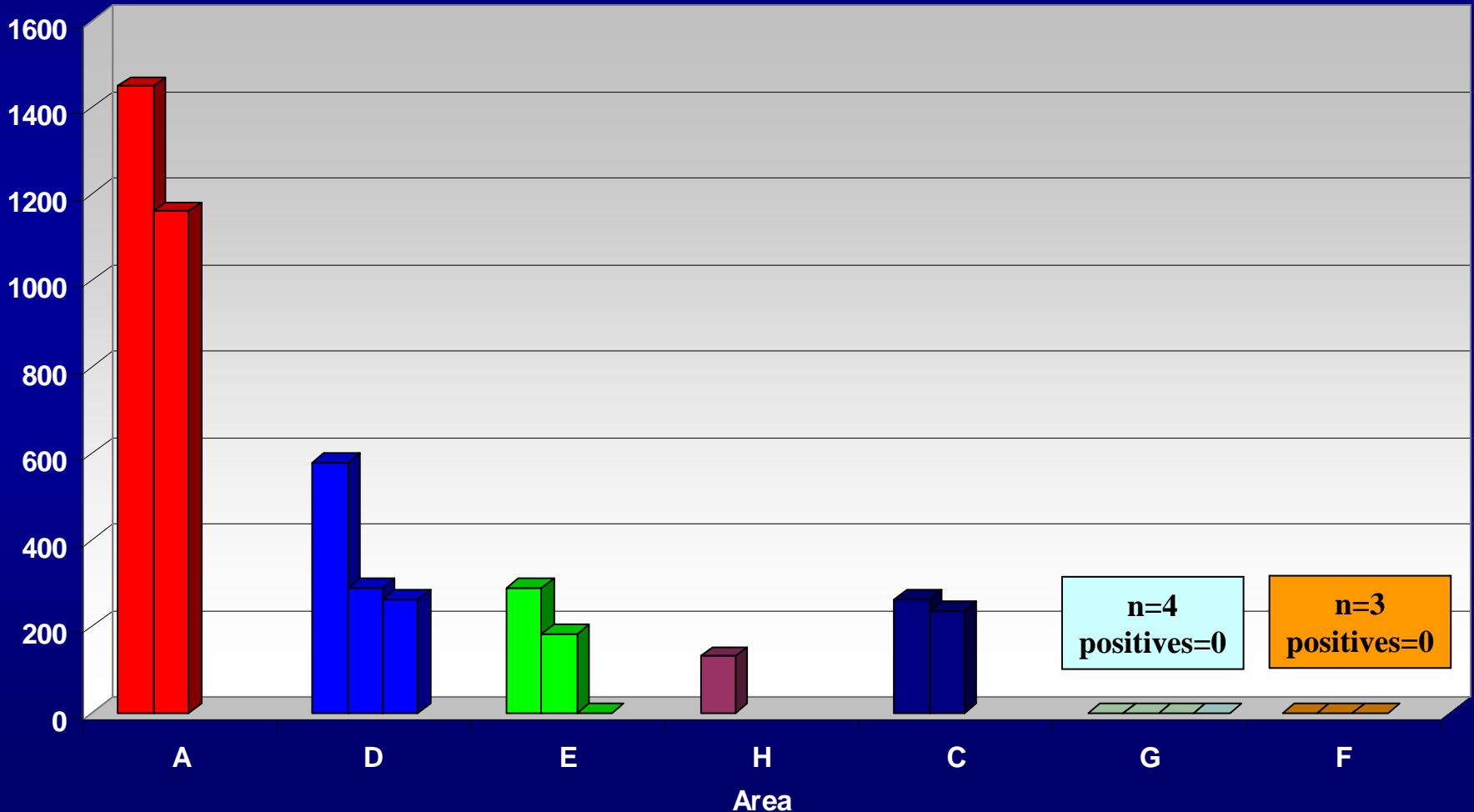
2,3,7,8-TCDD Levels in Fish and Shrimp Samples from Southern Vietnam, collected 1970, pg/g, wet weight



Baughman R.W., Messelson M., 1973

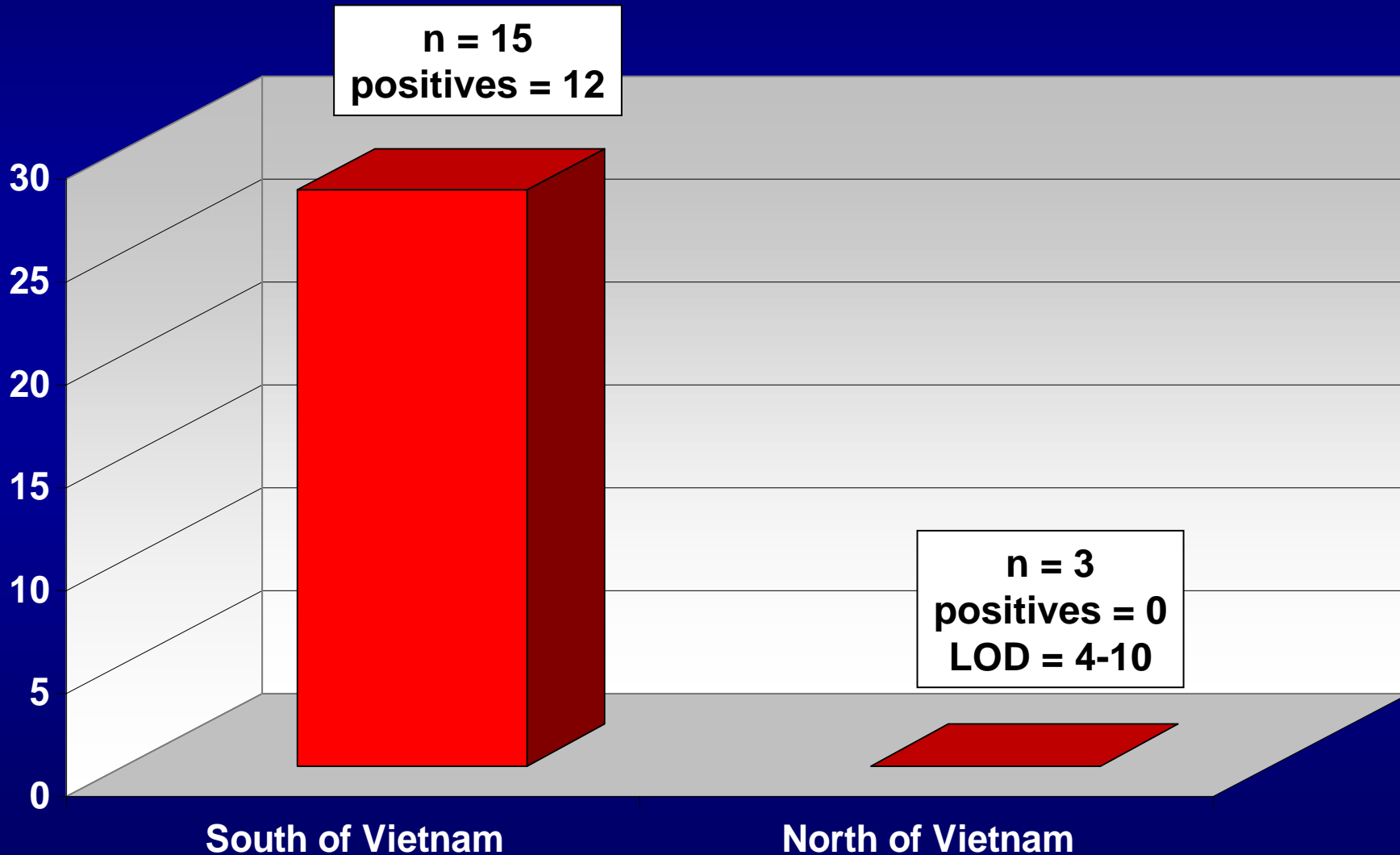
2,3,7,8-TCDD in 18 Human Milk Samples from South Vietnam

Values in pg/g, lipid based, Baughman et al, 1974



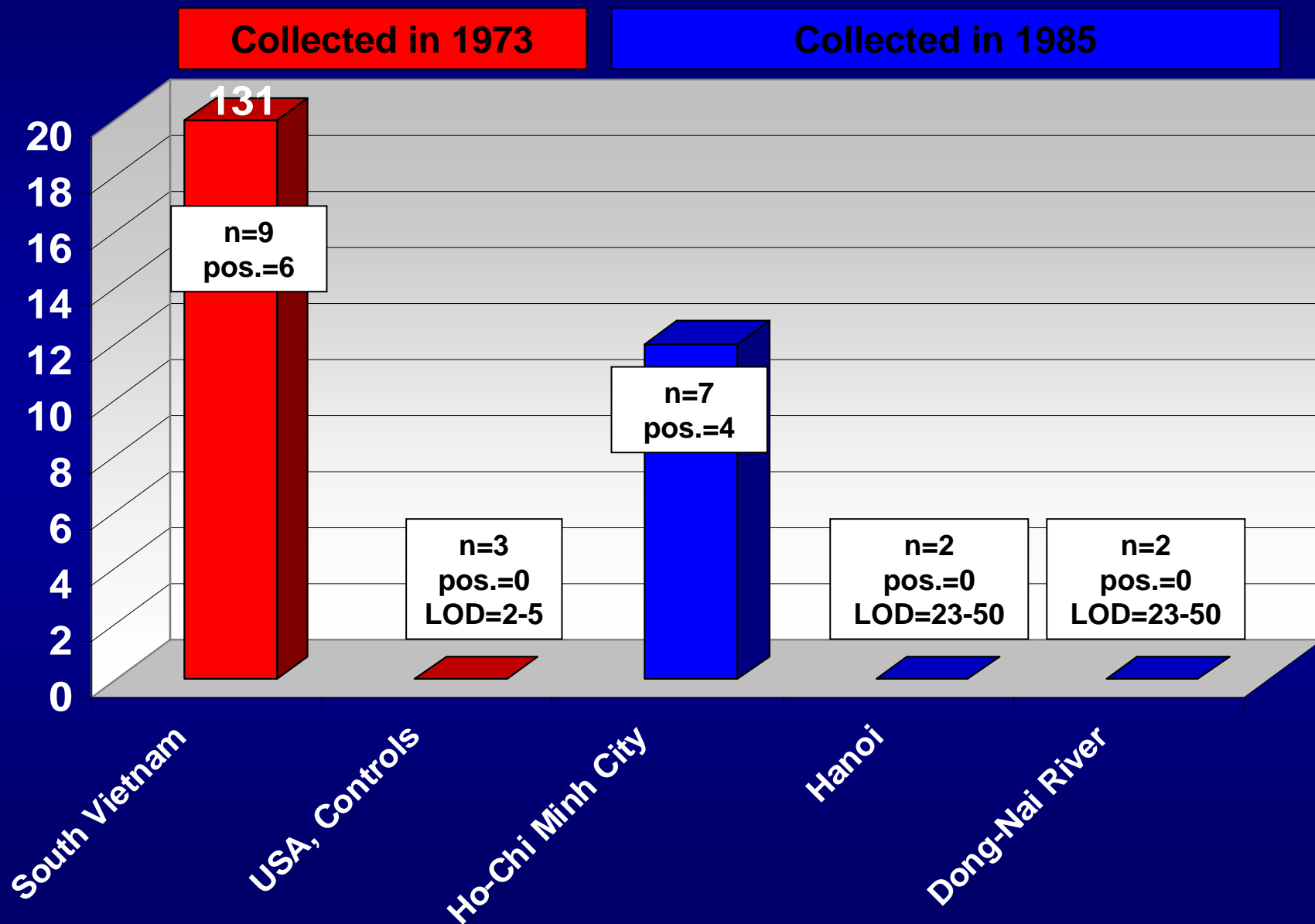
Further Investigations: 2,3,7,8-TCDD in Adipose Tissue

Schechter, Ryan, Constable, 1986, Values in pg/g lipid based



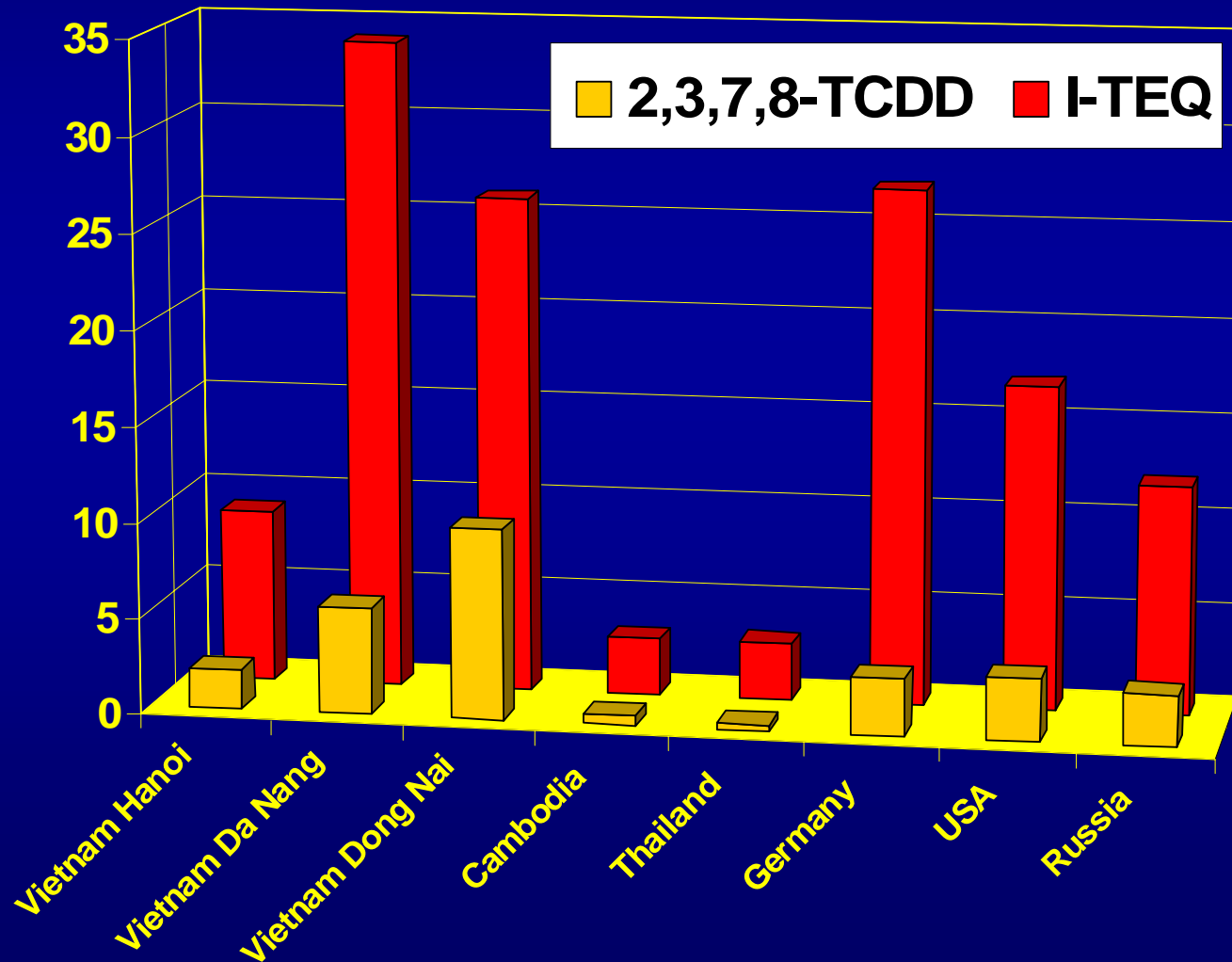
Further Investigations: 2,3,7,8-TCDD in Human Milk

Schechter, Ryan, Constable, 1987, Values in pg/g lipid based



Further Investigations: PCDDs/Fs in Human Milk from Vietnam and other Countries

Schechter, Fürst et al. 1991, Values in pg/g, lipid based



2,3,7,8-TCDD in Human milk

Original data from Baughman et al., 1973

Concentration

measured originally

- Samples collected : 1970
- Values, pg/g lipid:
 - (a) 1832
 - (b) 333
 - (c) 100

Concentration

estimated in 2005

- Half life for TCDD: 7 years
- Time between Coll./Estimate: 35 years
- No of elimination cycles: ~ 5
- Resulting values, pg/g lipid:
 - (a) ~ 60
 - (b) ~ 10
 - (c) ~ 3

Examples for HOT SPOTS (Local Reservoirs) in Vietnam



Recent Investigations for Human Exposure in Vietnam

Origin **No of samples (n)**

- Hanoi (comparison) 6 (inclusively pool of n = 100)
- Biên Hoa 43
- Binh My 12
- Tra Noc 12
- An Tay Commune, Ben Cat District, Binh Duong Province 20
- Phu My Hung Commune, Cu Chi District, Ho Chi Minh City 20
- Truong Dong Commune, Hoa Thanh District, Tay Ninh Province 20
- Can Gio 20
- Phu My (*Dien Khan – Nha Trang*) 20
- Phu Cat 20

b) Area of Biên Hòa (area of former air base)



Samples from Area of Former Air Base Biên Hòa

Time of collection: 1999 – 2002

Type, number and origin of samples:

Soil:	3	Biên Hòa
Sediment:	11	10 Biên Hòa, 1 Hanoi
Human Blood:	49	43 Biên Hòa, 6 Hanoi
Food:	16	Biên Hòa, Biên Hưng

Publications:

Soil -, sediment -, blood samples:	Schechter A., et al., JOEM, 2001
Blood samples:	JOEM, 2002
Food samples:	JOEM, 2003

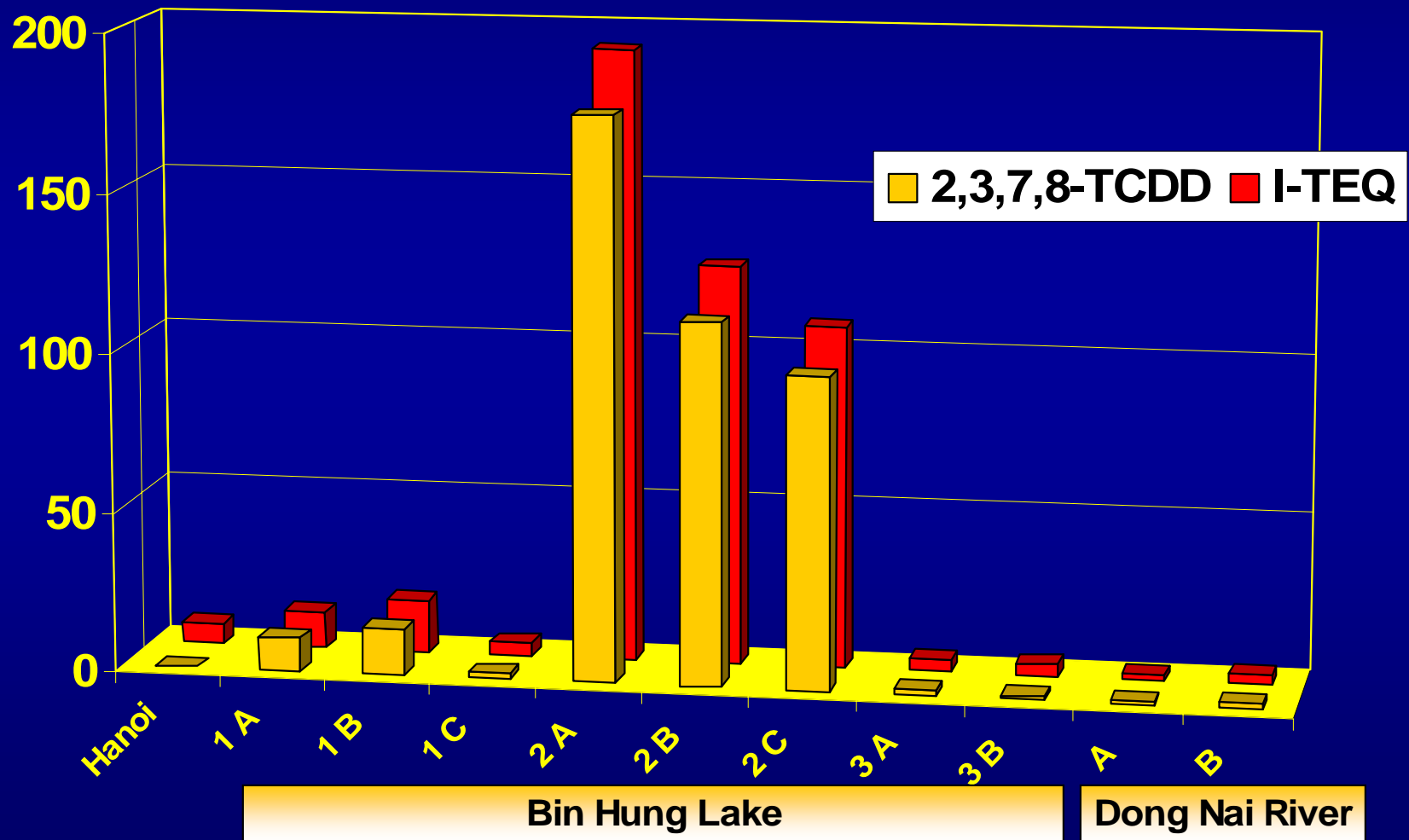
Levels of 2,3,7,8-TCDD and TEQ in Soil Samples collected from Bin Hoa Air Base, a Former Agent Orange Storage Facility

Concentration in ng/kg d.m. (Schechter et al. 2001)

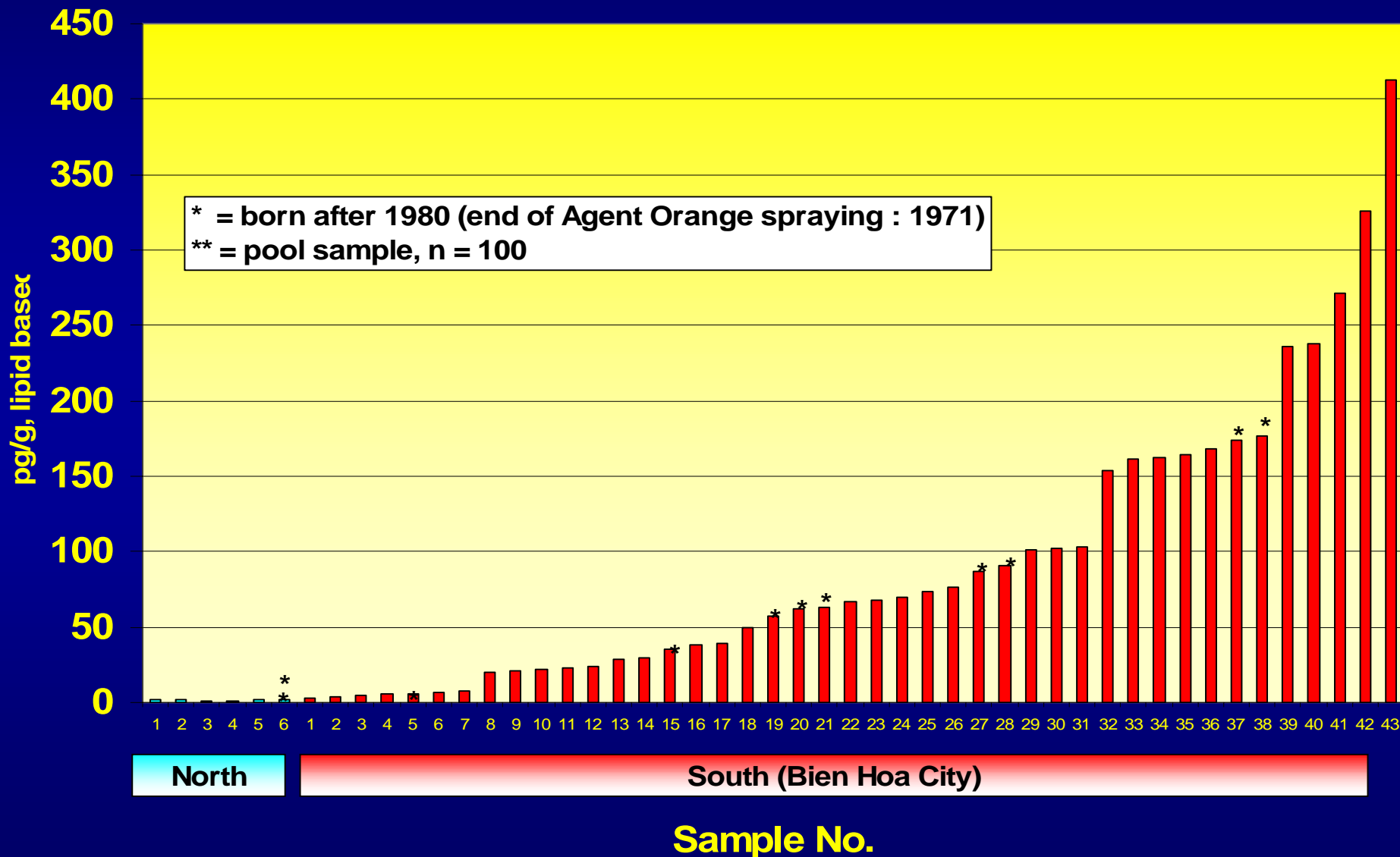
	Sample 1	Sample 2	Sample 3
2,3,7,8-TCDD	1,164,699	603,968	N.D.
Total PCDDs	1,645,017	714,740	39.4
Total PCDFs	146,721	38,852	N.D.
TEQ (PCDDs/PCDFs)	1,180,737	610,874	0.04

PCDDs/PCDFs in Sediment, Vietnam

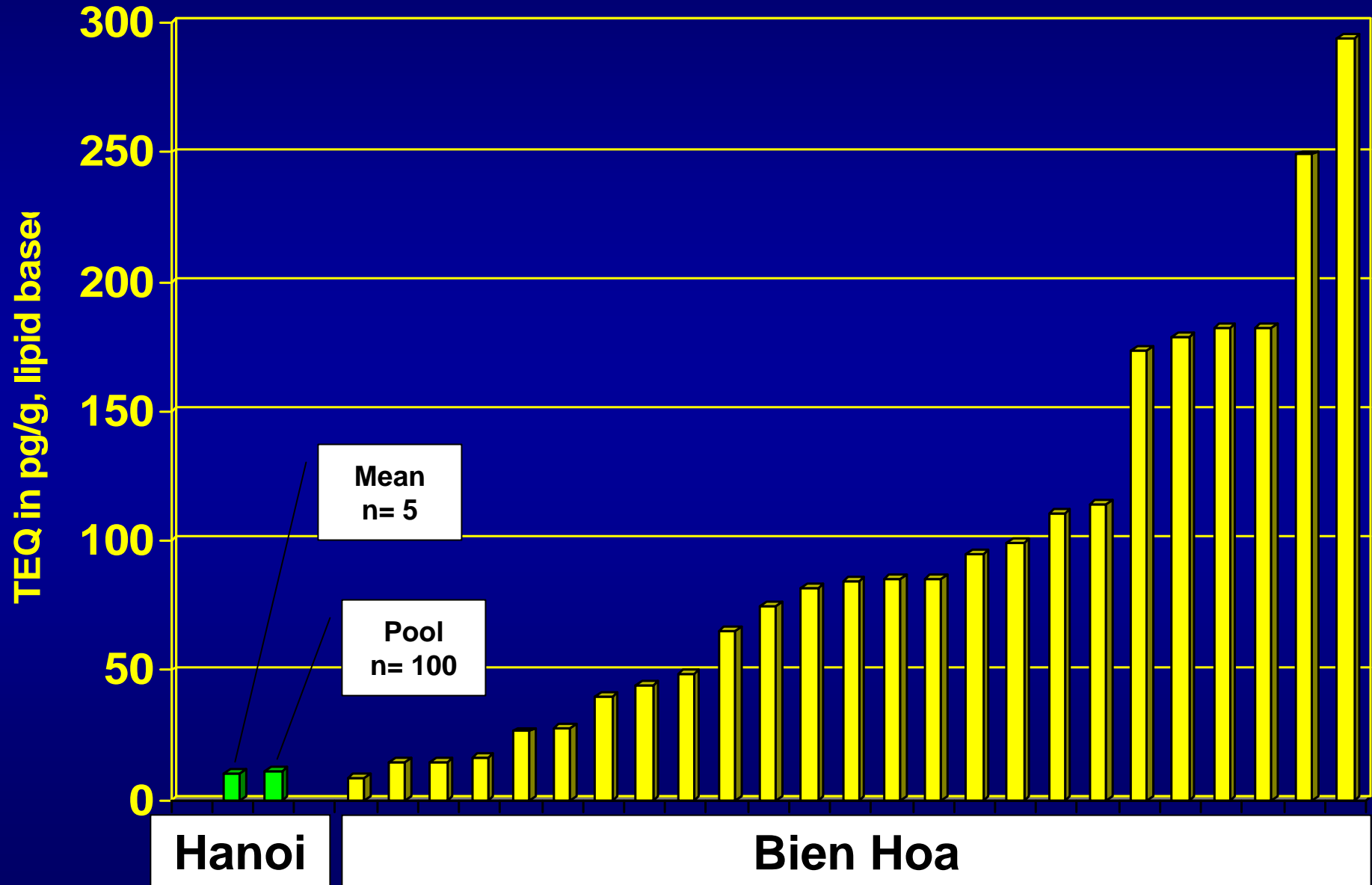
Values in ng/kg, dry matter



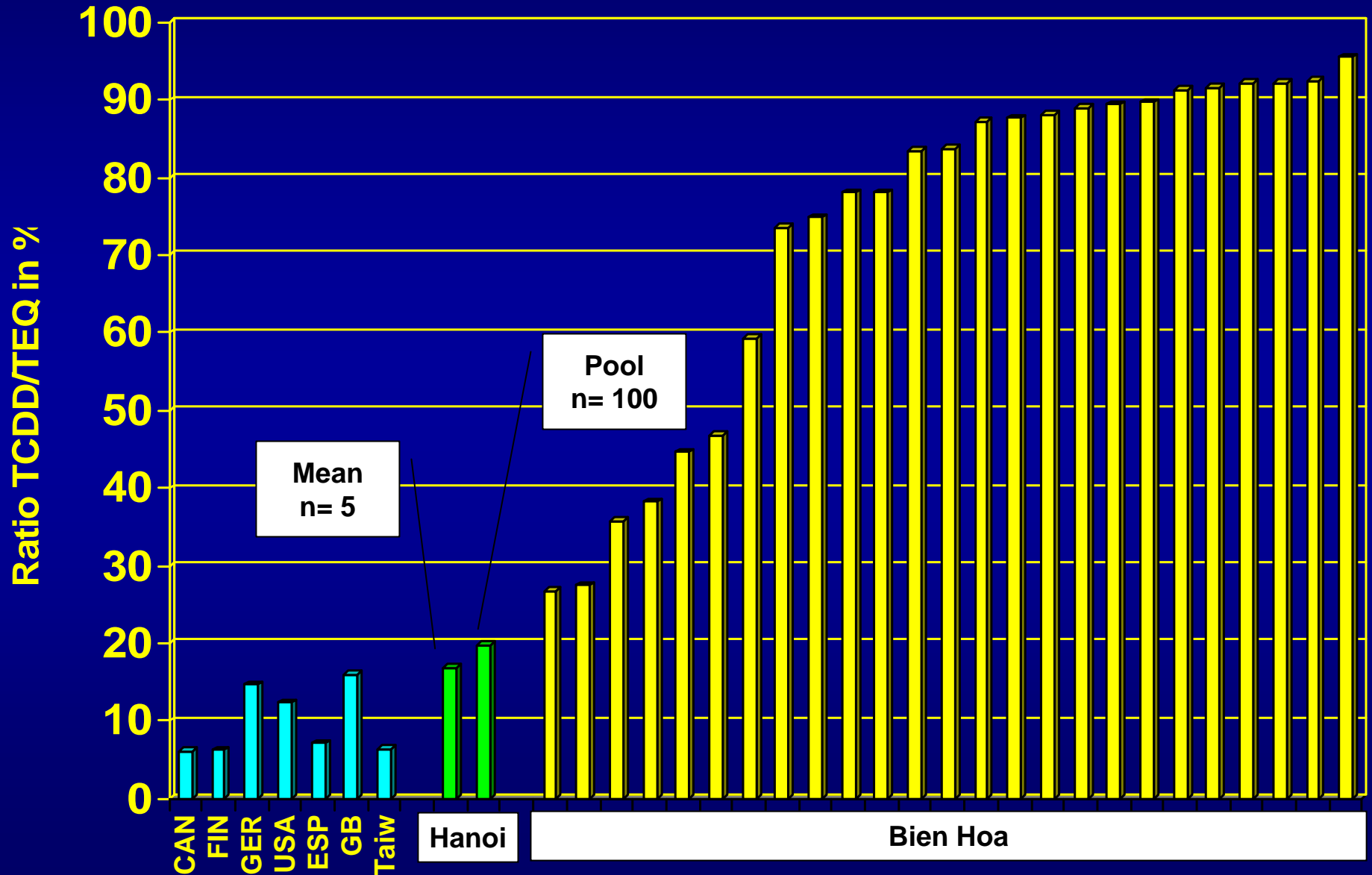
2,3,7,8-TCDD levels in Human Blood, Vietnam



TEQ in Human Blood from Agent Orange Sprayed Areas - Bien Hoa -

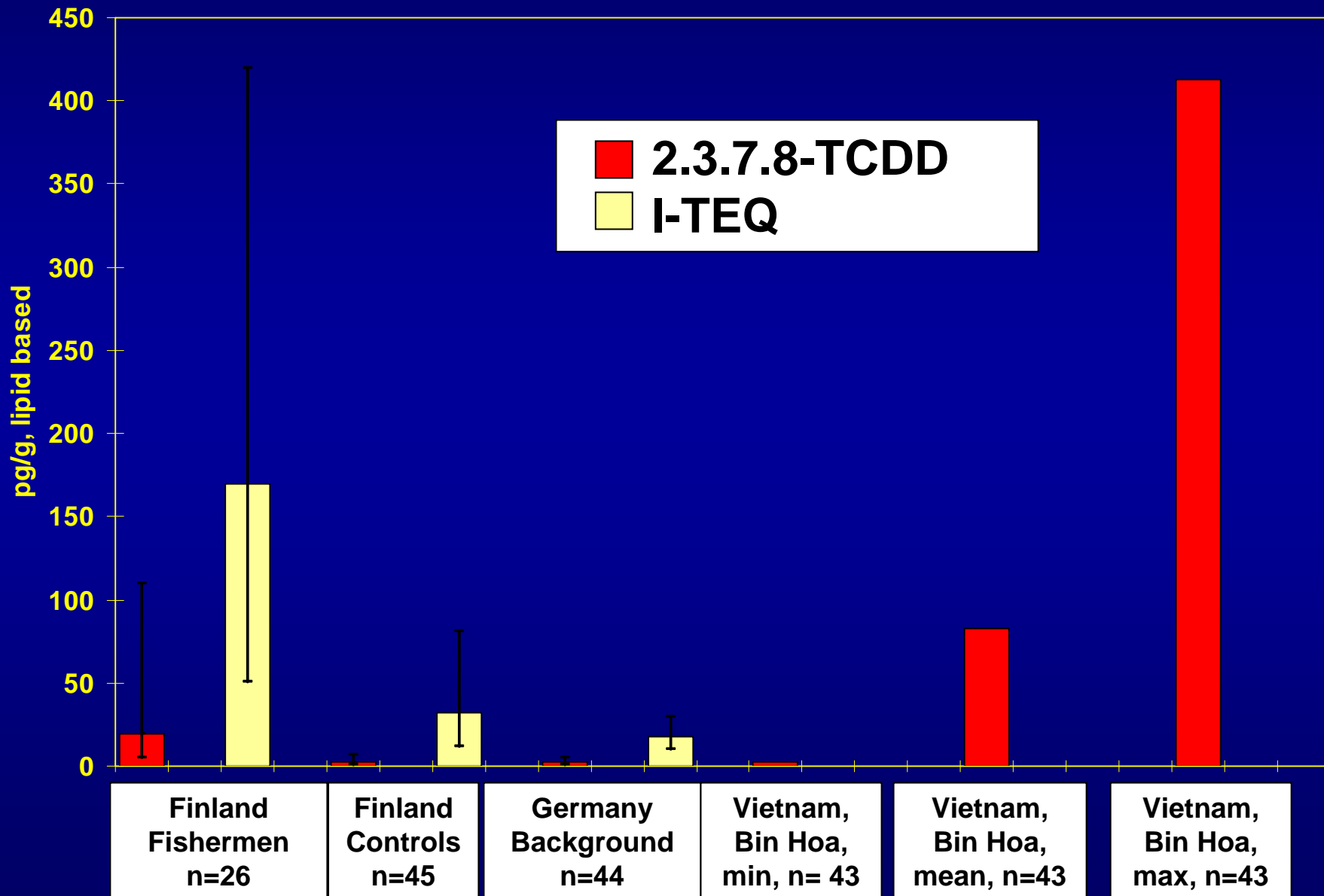


Ratio 2.3.7.8-TCDD/TEQ - Bien Hoa -



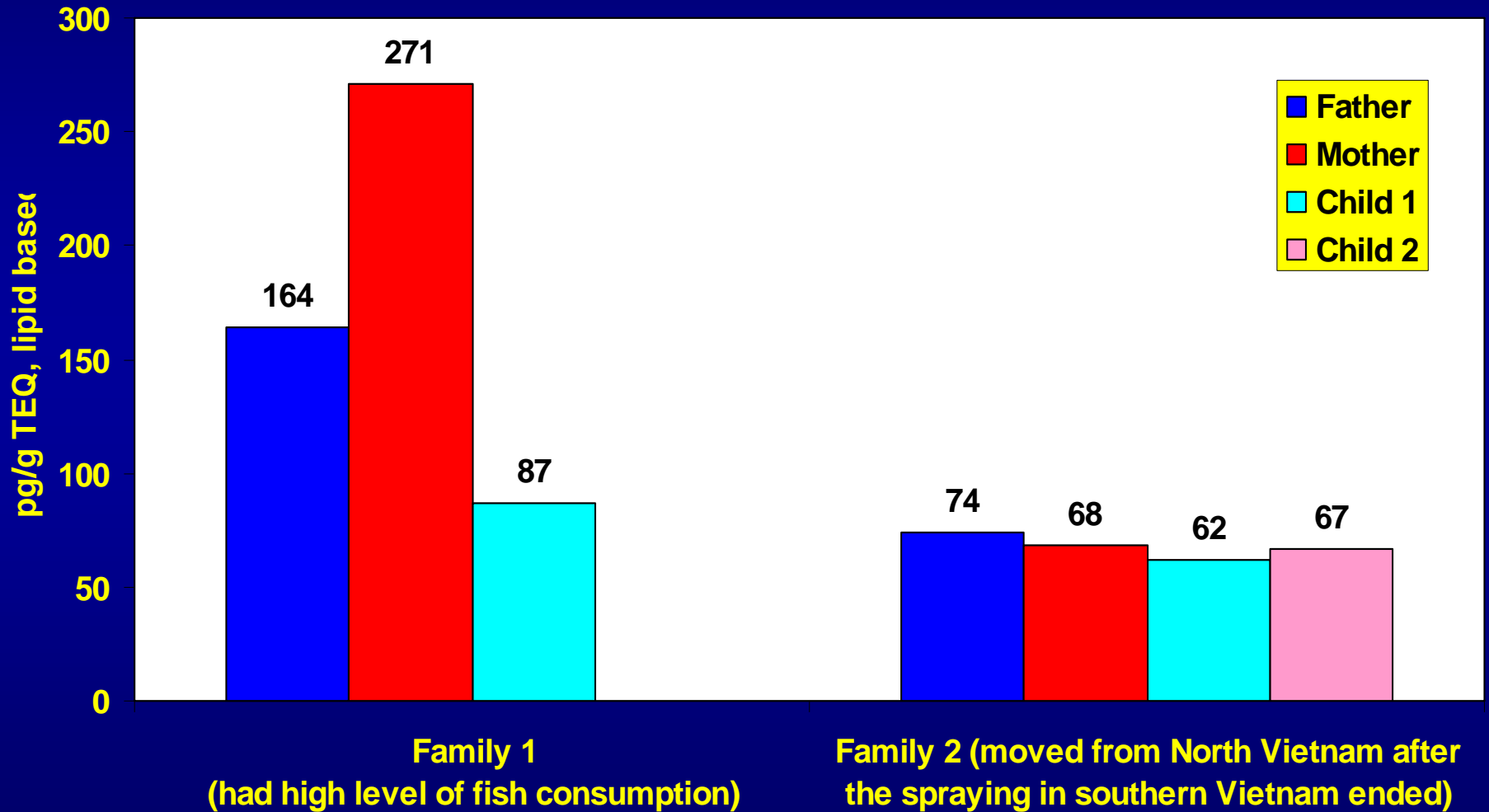
PCDD/Fs in selected Population,

Finland: Kivivanta et al., 2000 -- Vietnam: Schechter et al., 2002



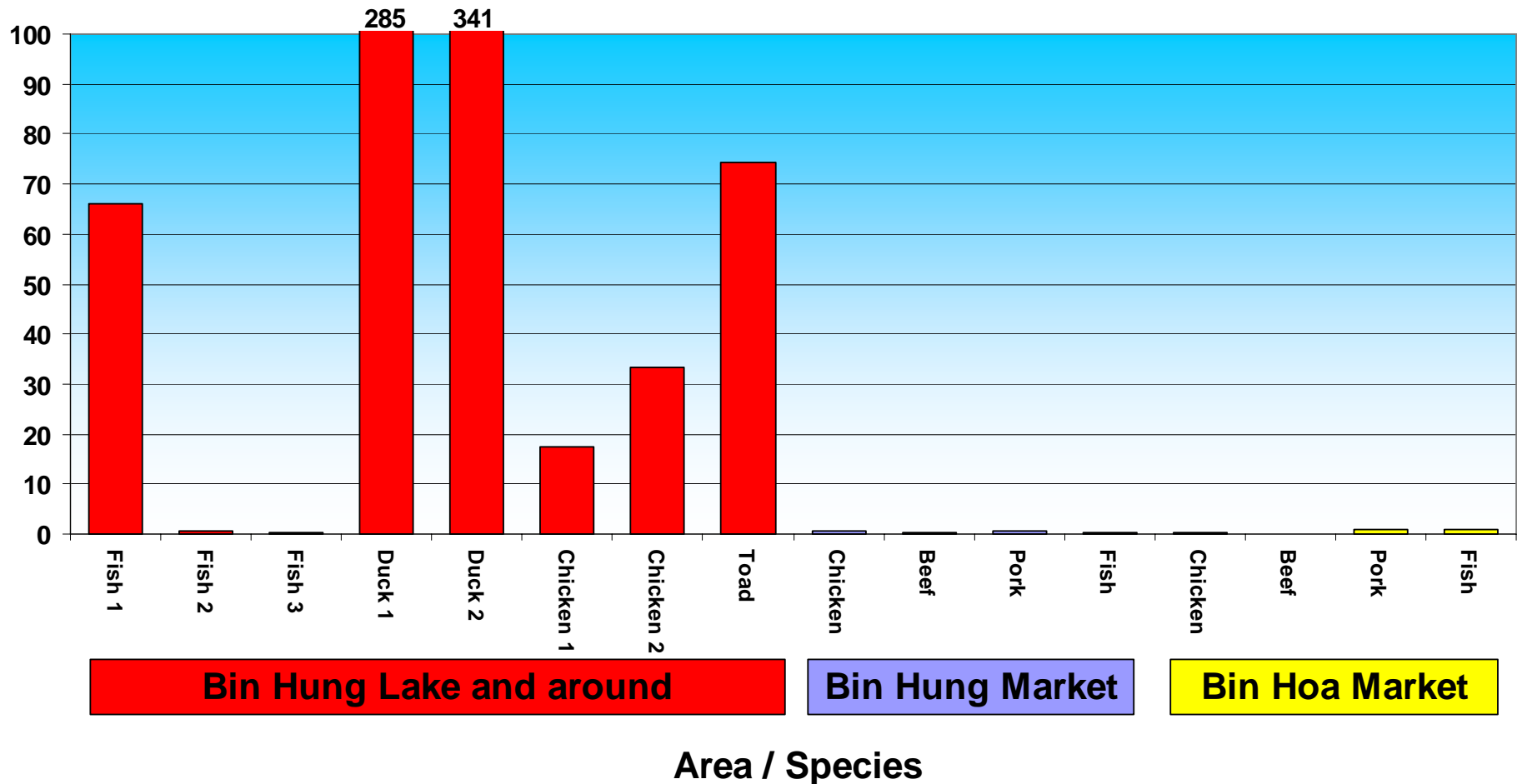
TCDD Blood Levels in Vietnam, Bin Hoa, 1999

Values in pg/g, lipid based



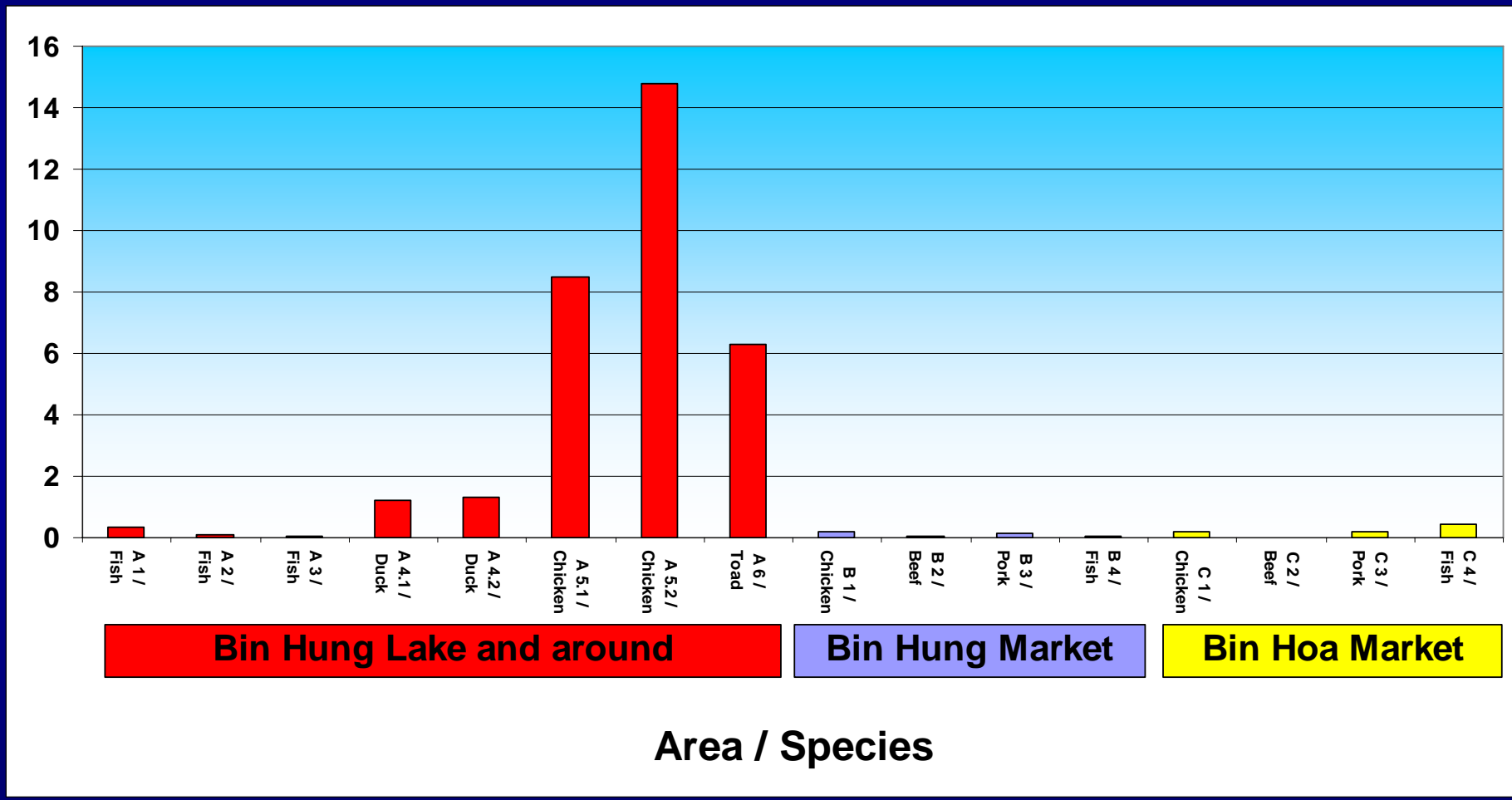
PCDDs/Fs in Selected Vietnamese Food

TEQs values in pg/g, wet weight based
(Schechter et al., 2003)



WHO-PCBs in Vietnamese Food (WHO-TEQs)

Values in pg/g, wet weight based, Schecter et al., 2003

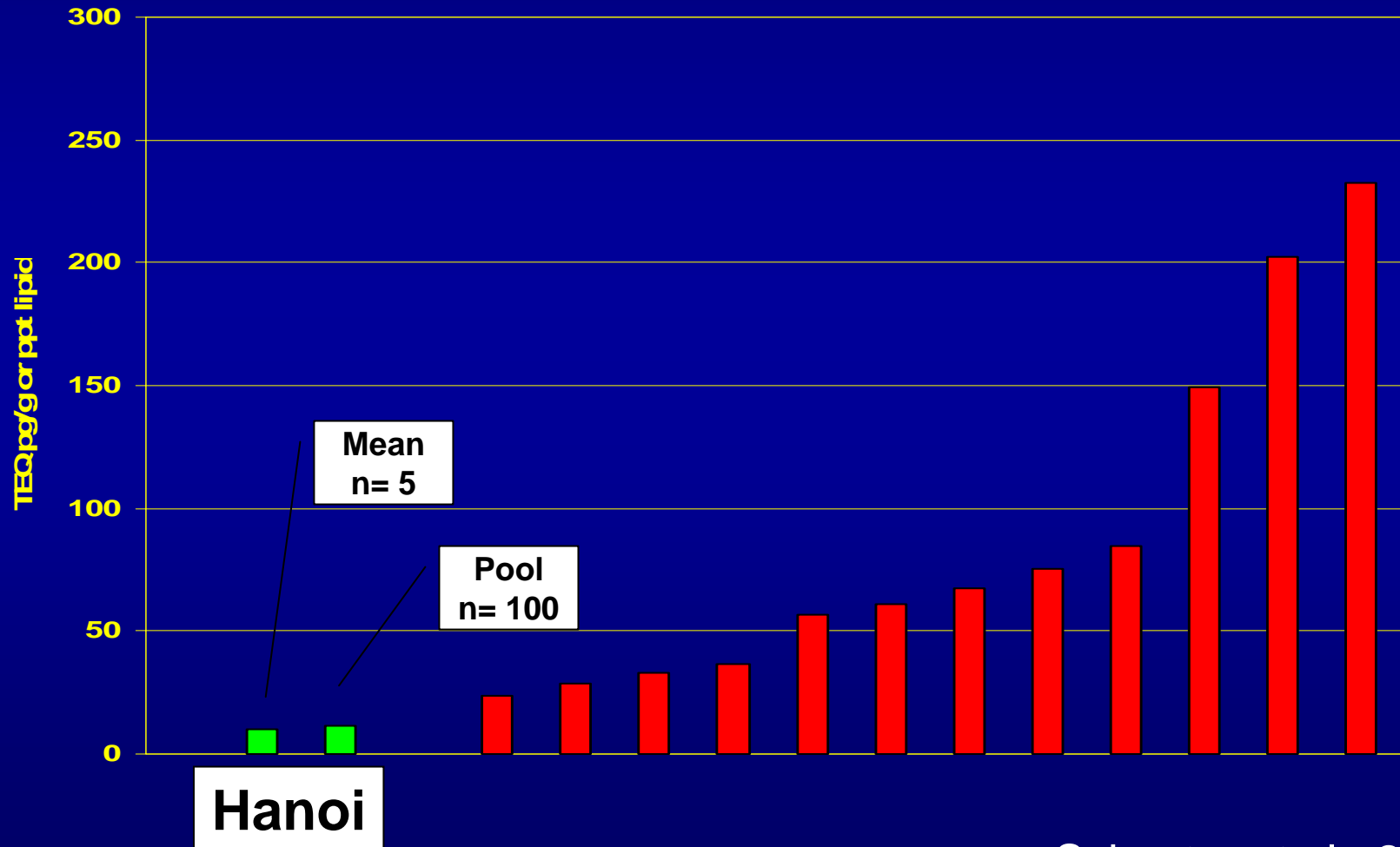


Area of Tra Noc

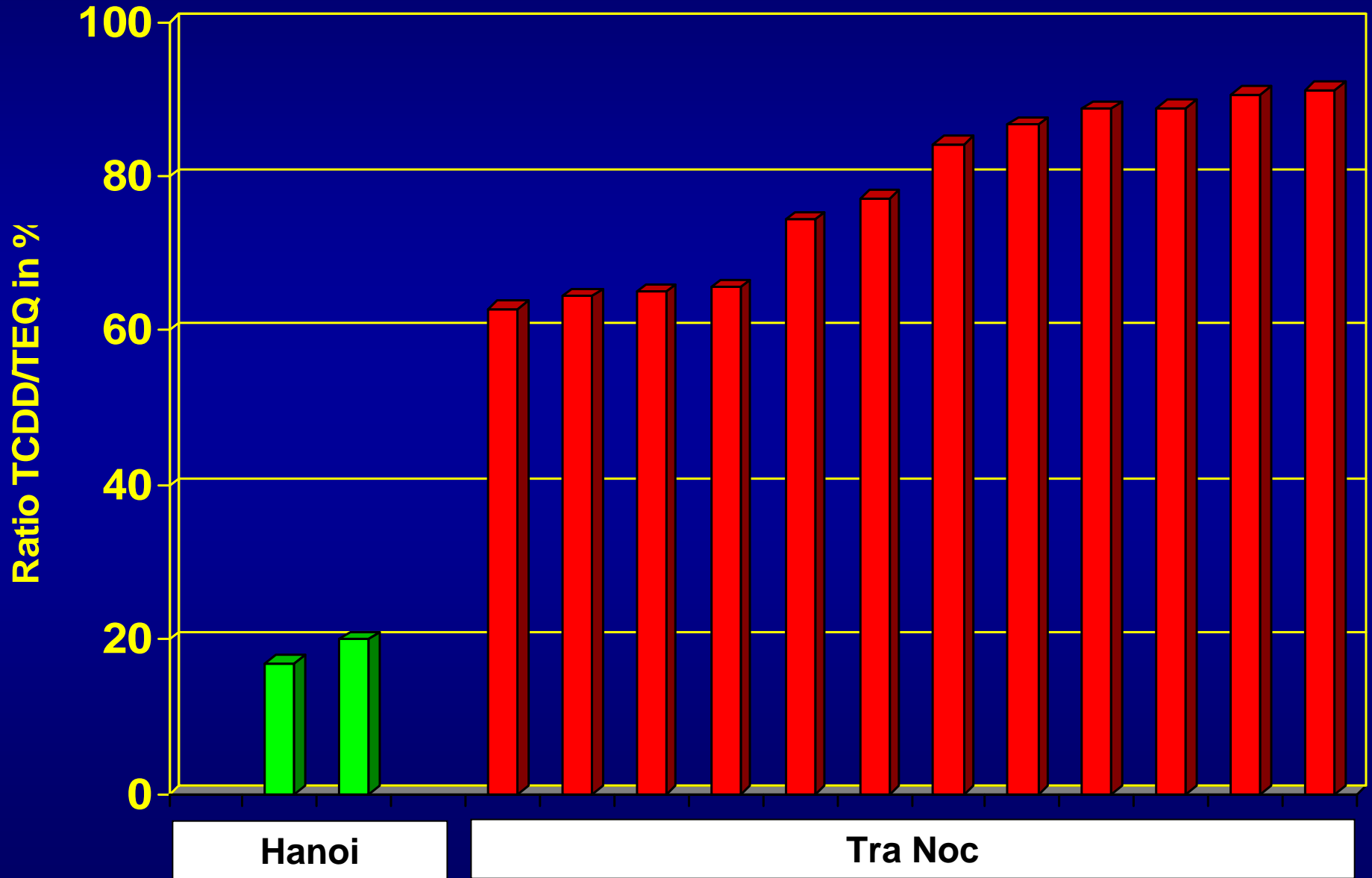


Tra Noc

TEQ (PCDD/PCDF) in Human Blood from Agent Orange Sprayed Areas - Tra Noc -

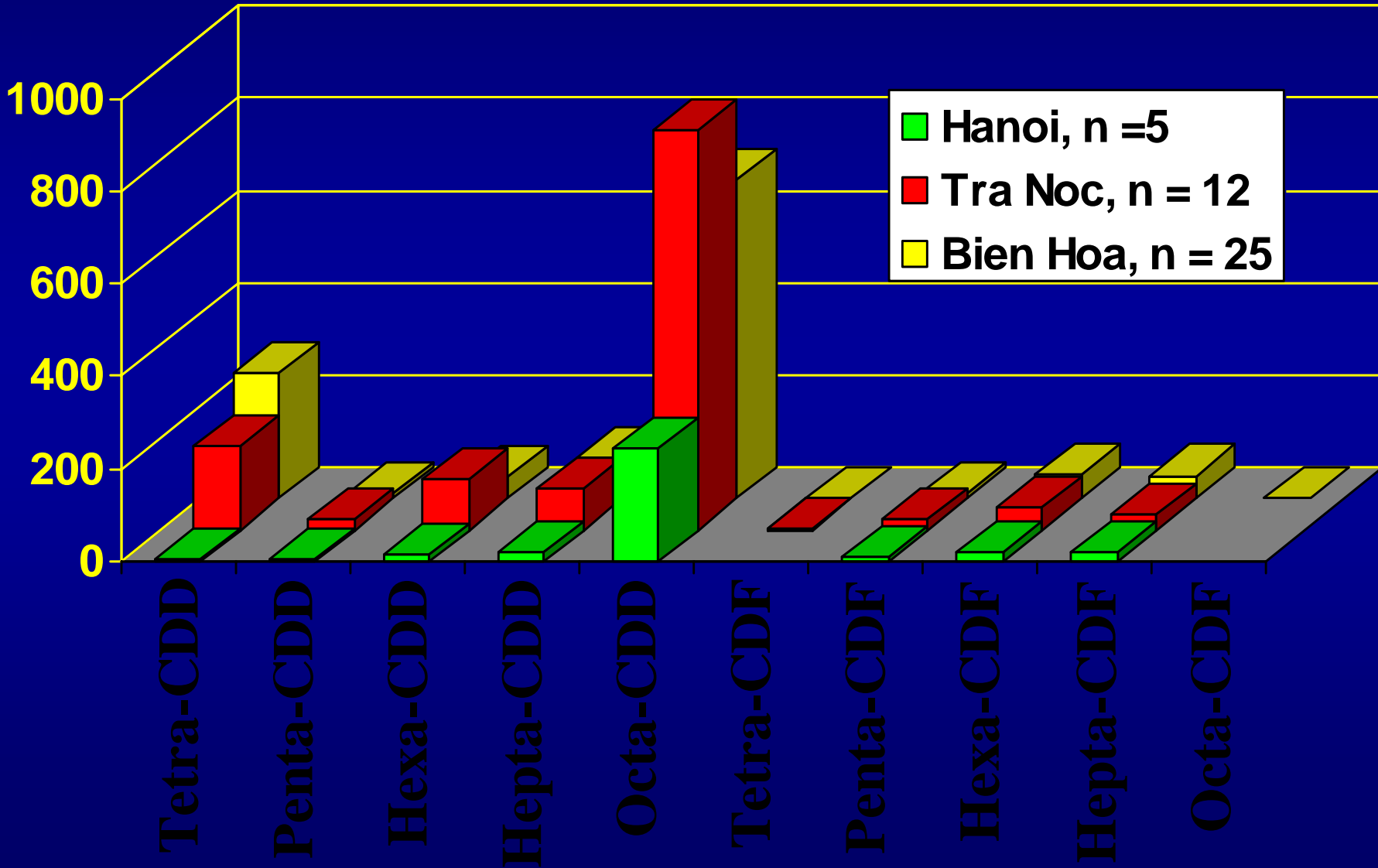


Ratio 2,3,7,8-TCDD :TEQ - Tra Noc -



PCDD/F Pattern in Human Blood

Vietnam, Hot Spots (in ng/g, lipid based)



c) Area of Binh My

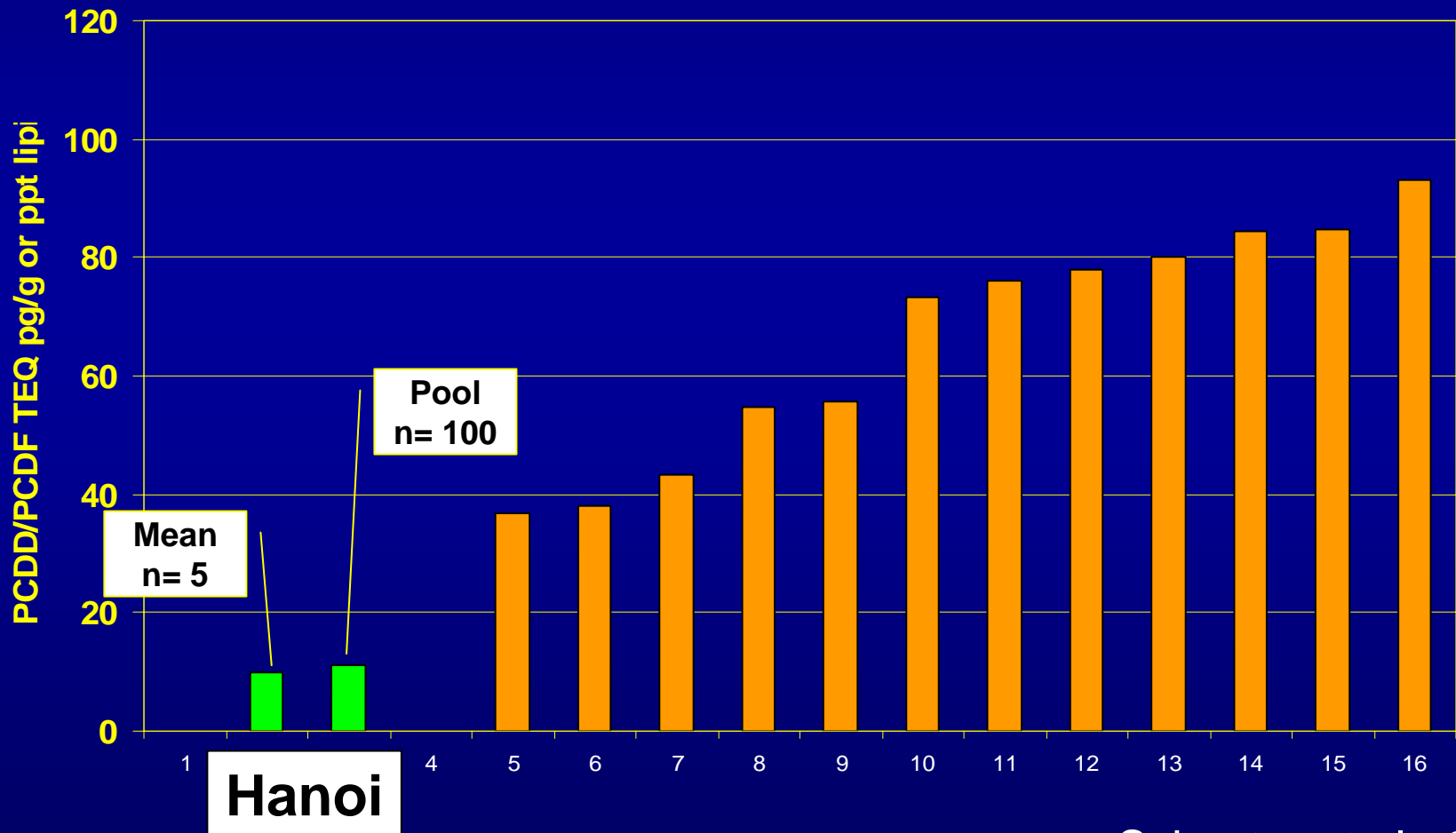


Binh My

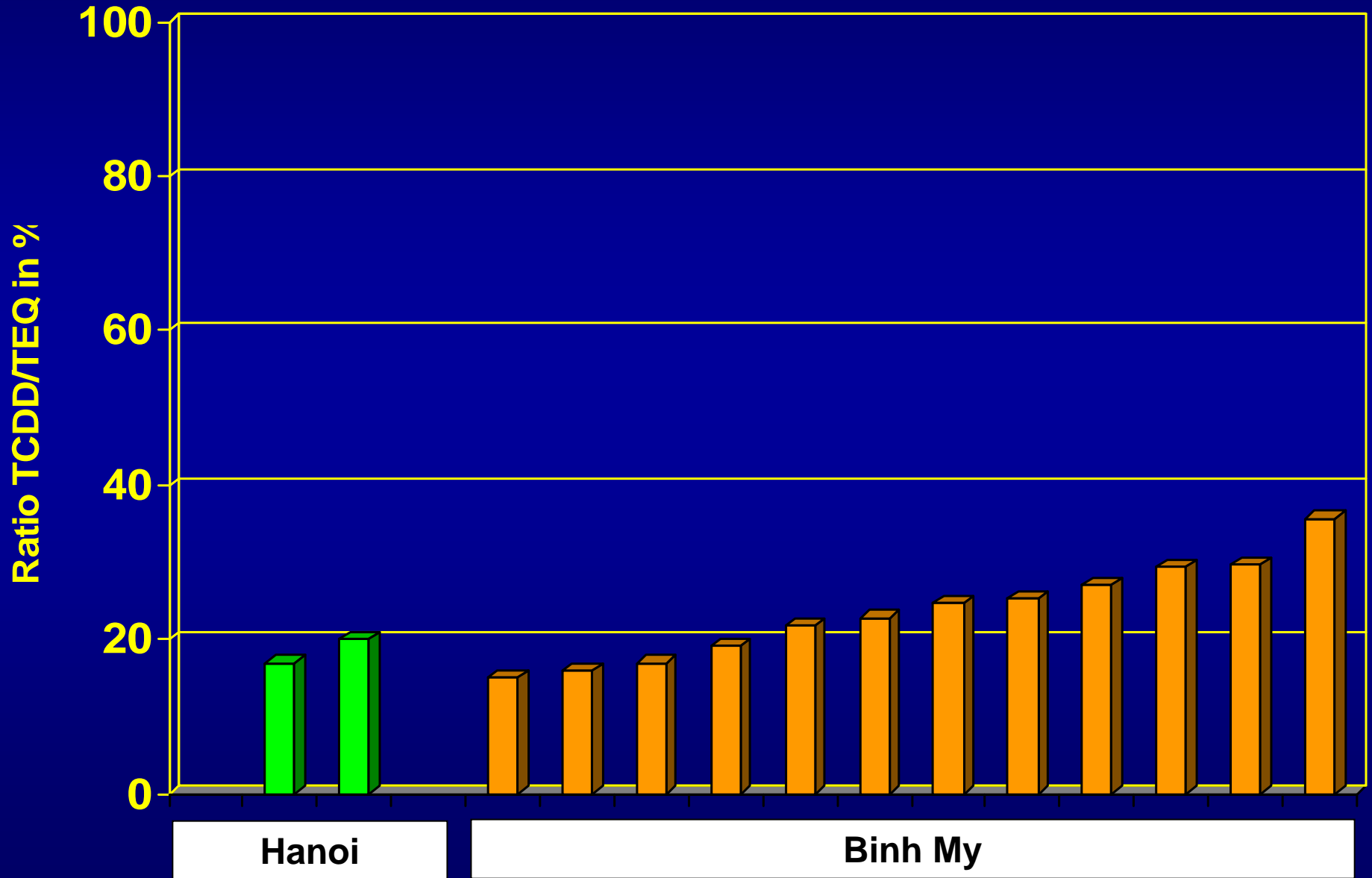


PCDD/F Pattern in Human Blood Vietnam

Hot Spots, Binh My, values in ng/g, lipid based

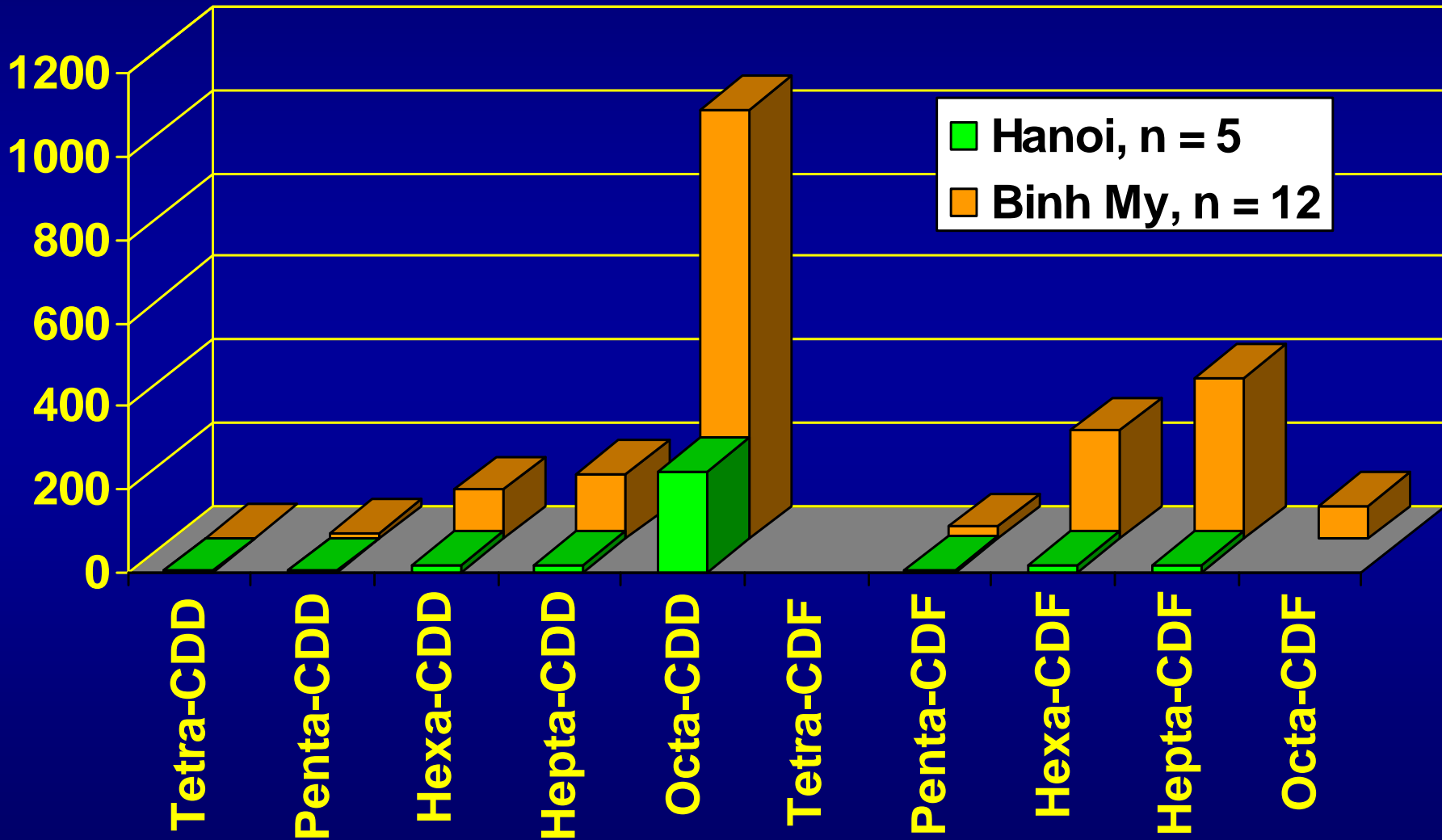


Ratio 2,3,7,8-TCDD : TEQ - Binh My -



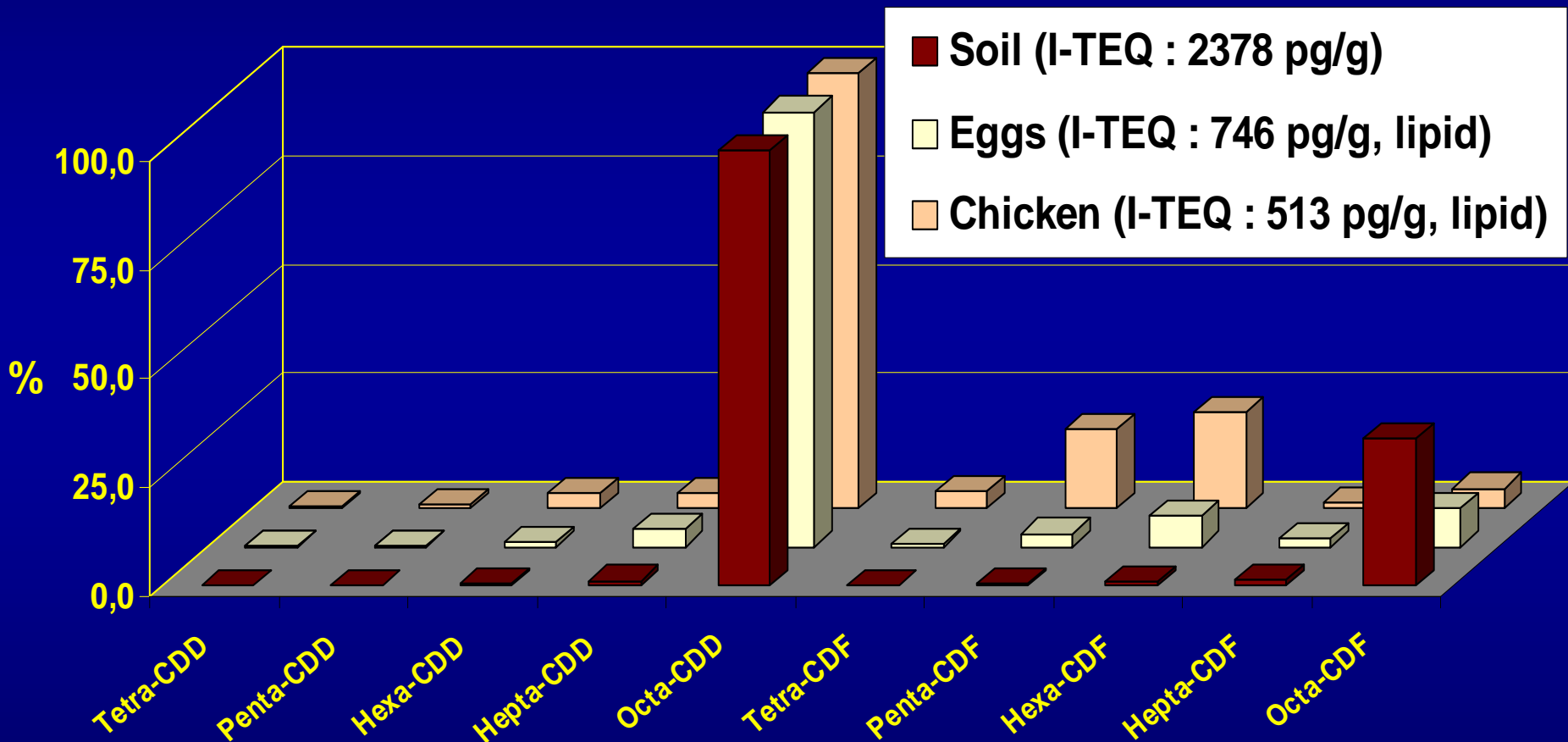
PCDD/F Pattern in Human Blood

Vietnam, Hot Spots (in ng/g, lipid based)



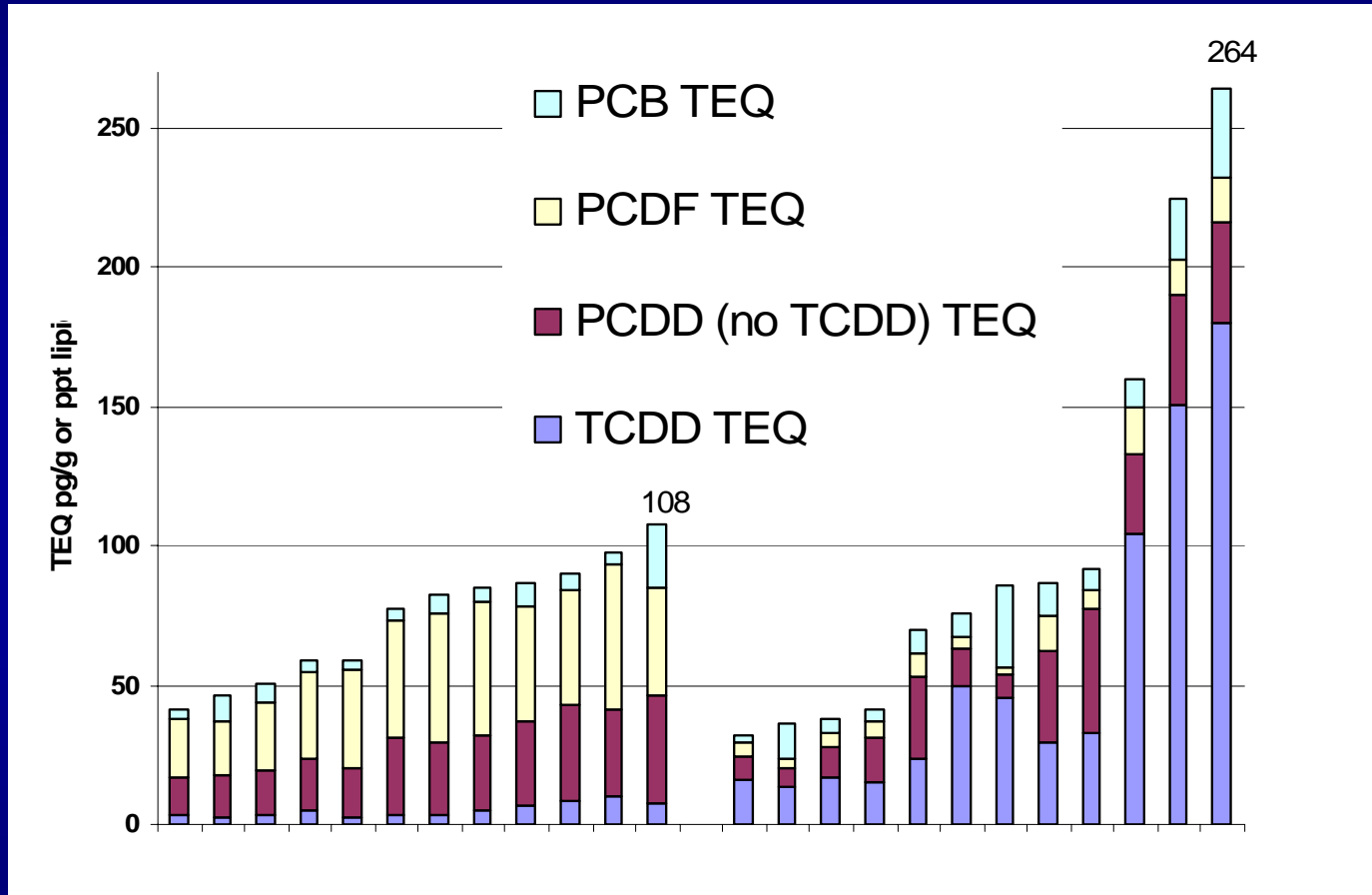
PCDDs/PCDFs in Exposure Material

Totals of ONLY 2.3.7.8-substituted Congeners



PCDD/F Pattern in Human Blood Vietnam

2 new Hot Spots, values in ng/g, lipid based



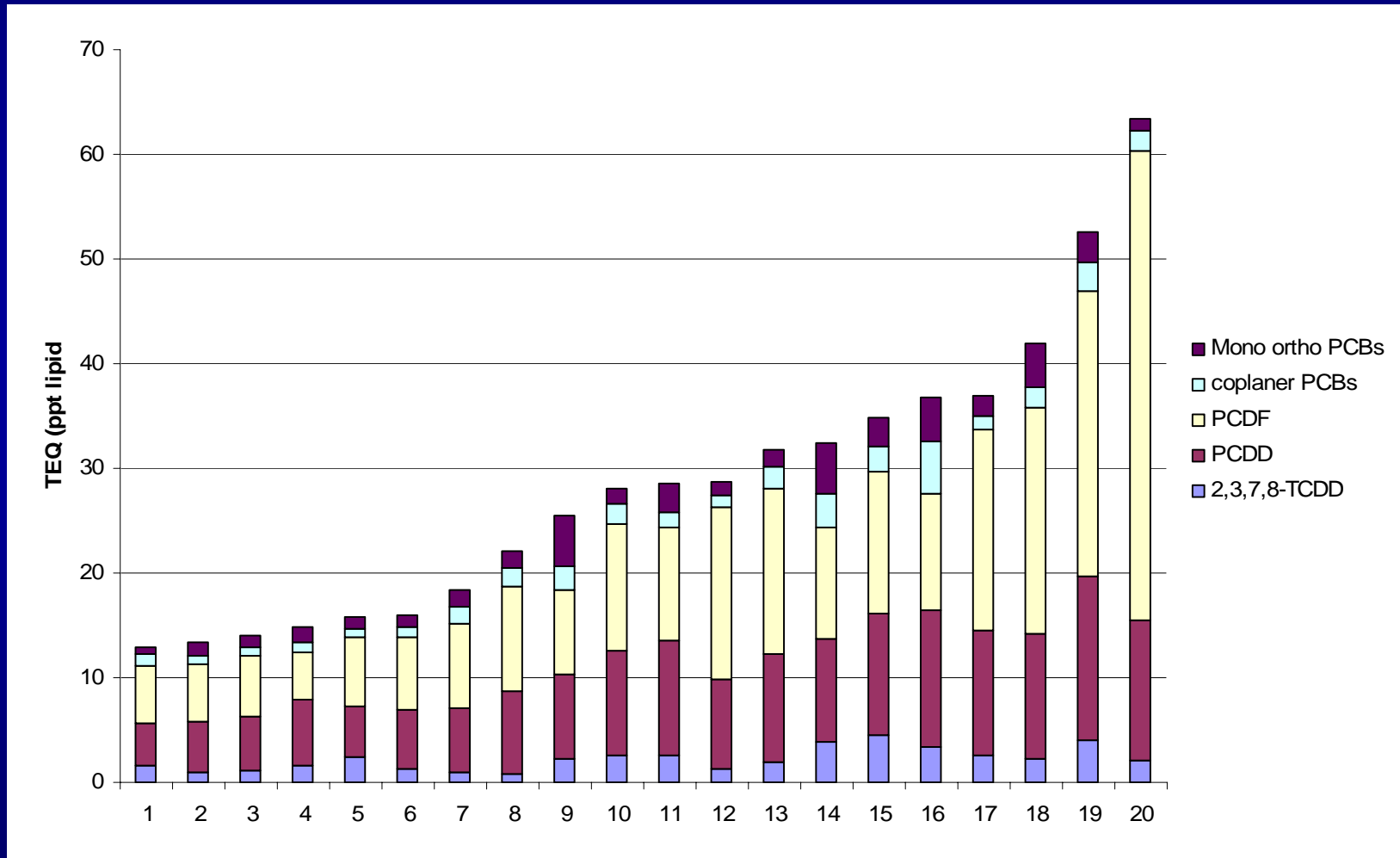
Recent Investigations for Human Exposure in Vietnam

- An Tay Commune, Ben Cat District, Binh Duong Province
- Phu My Hung Commune, Cu Chi District, Ho Chi Minh City
- Truong Dong Commune, Hoa Thanh District, Tay Ninh Province
- For each of the 3 areas 20 blood samples were collected
- Data were published at Dioxin 2005 in Toronto, August 05

New findings: TEQ in Human Blood

An Tay Commune, Ben Cat District, Binh Duong Province

Values in TEQ, pg/g lipid, Schecter et al., 2004

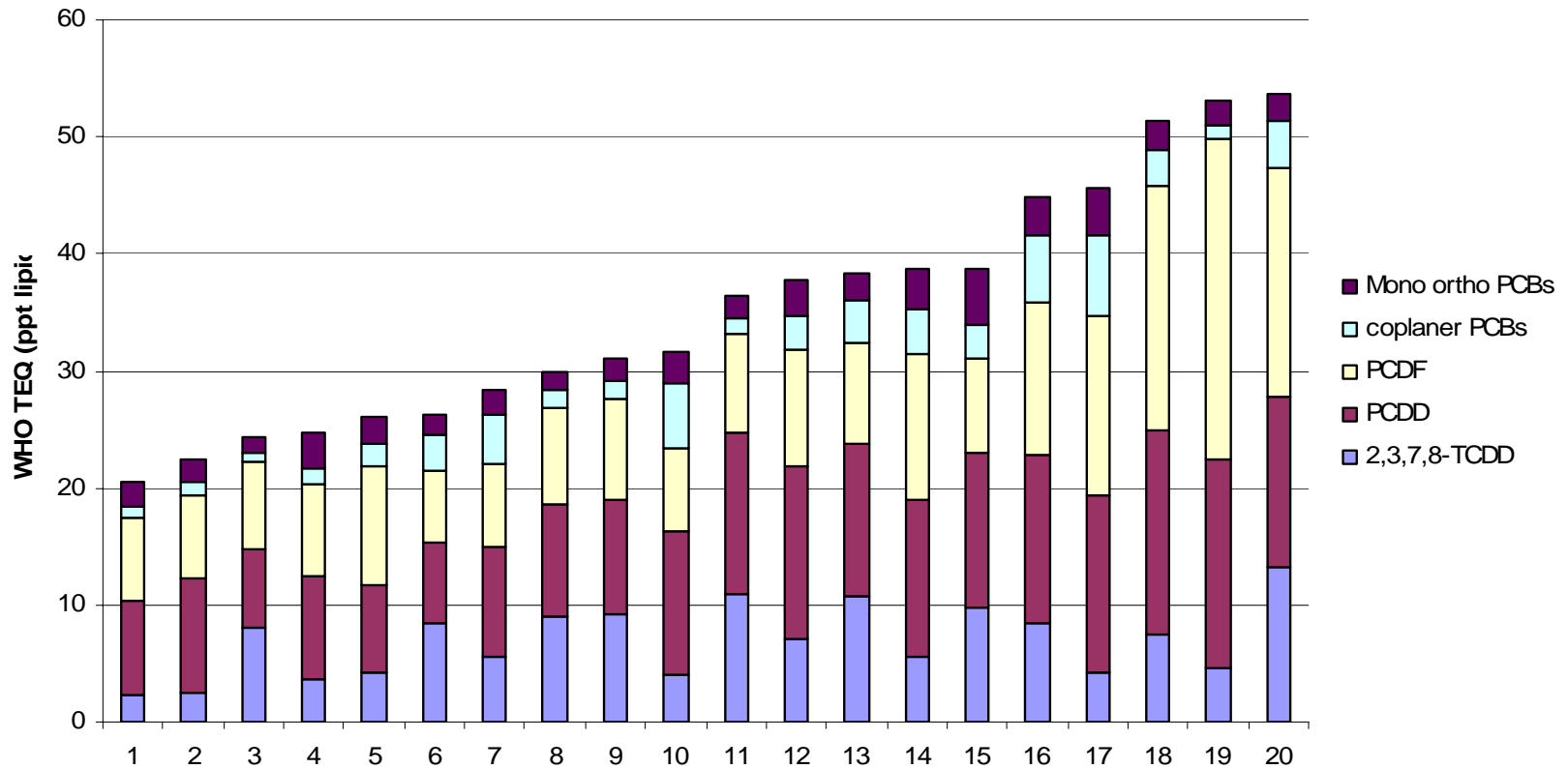


TEQ range: 12.9 – 63.3 pg/g. TCDD range: 1 – 4.6 pg/g

New findings: TEQ in Human blood

Phu My Hung Commune, Cu Chi District, HCM City.

TEQ, pg/g lipid, Schecter et al., 2004

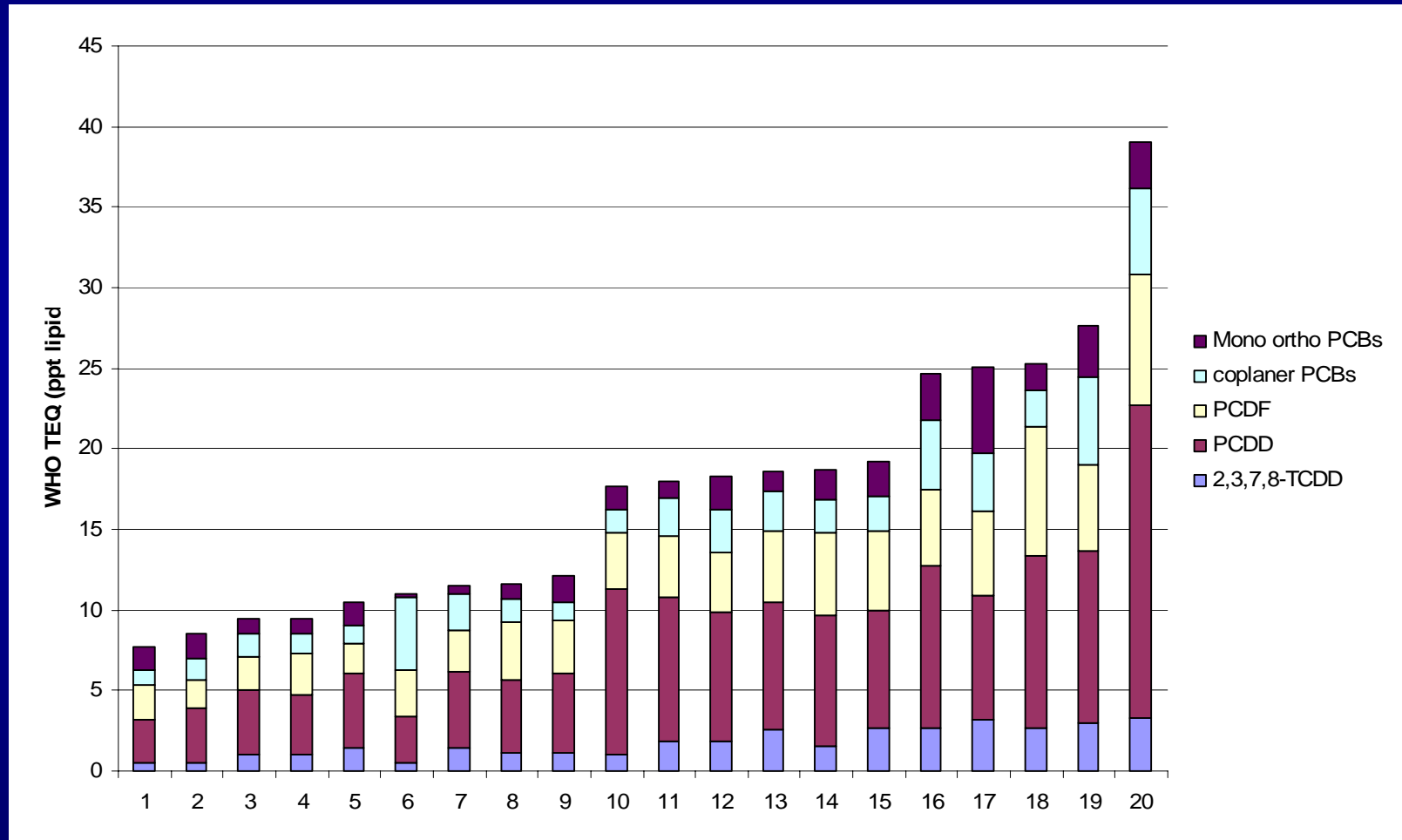


TEQ range: 20.5 – 53.6 pg/g. TCDD range: 2.3 – 13.2 pg/g

New findings: TEQ in Human blood

Truong Dong Commune, Hoa Thanh District, Tay Ninh Province

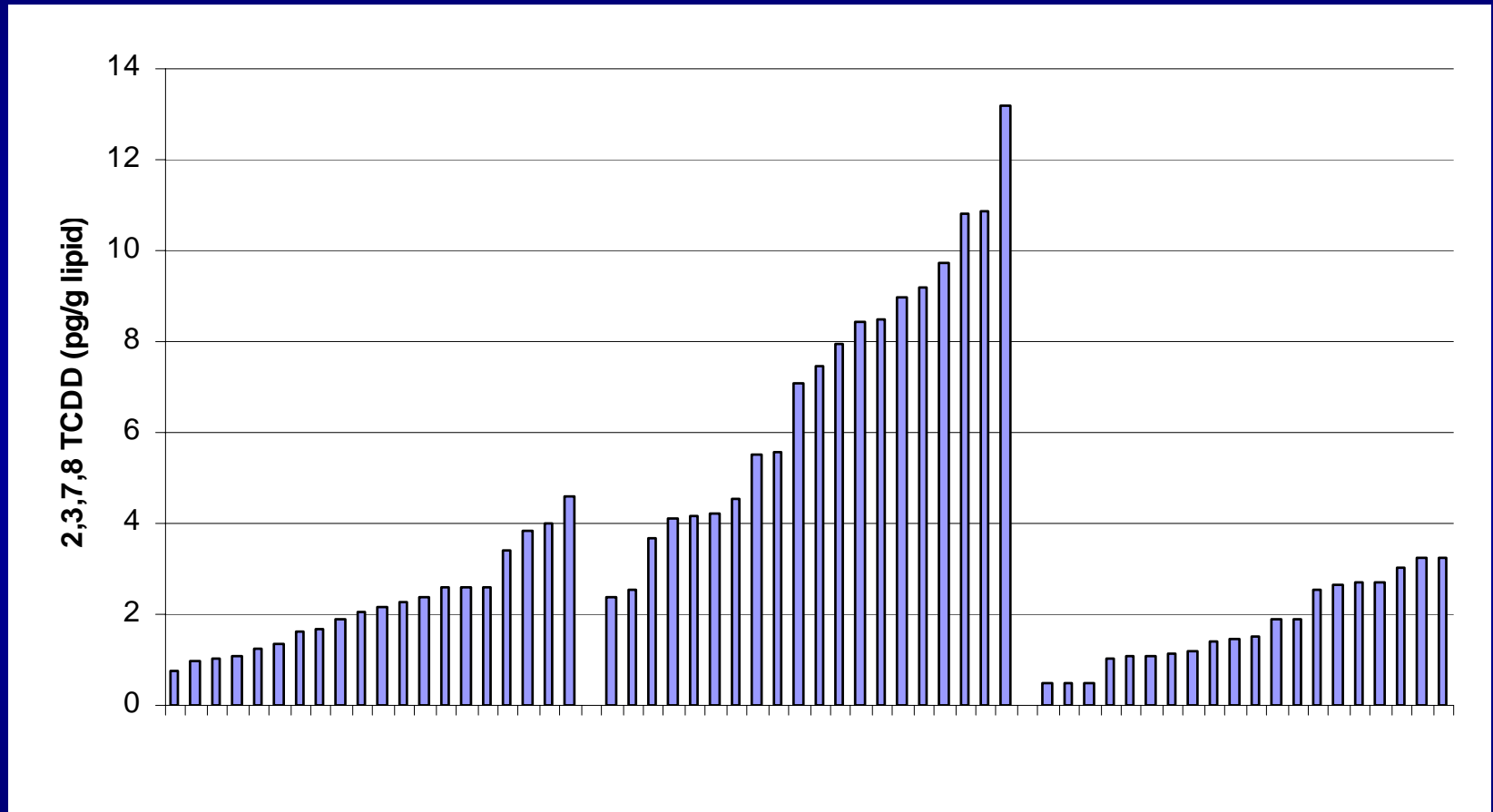
TEQ, pg/g lipid, Schechter et al., 2004



TEQ range: 7.7 – 39 pg/g. TCDD range: 0.5 – 3.3 pg/g

New Findings: TCDD in Human blood

Concentration in pg/g lipid, Schechter et al., 2004



An Tay

1 – 4.6 pg/g

Phu My

2.3 - 13.2 pg/g

Truong Dong

0.5 - 3.3 pg/g

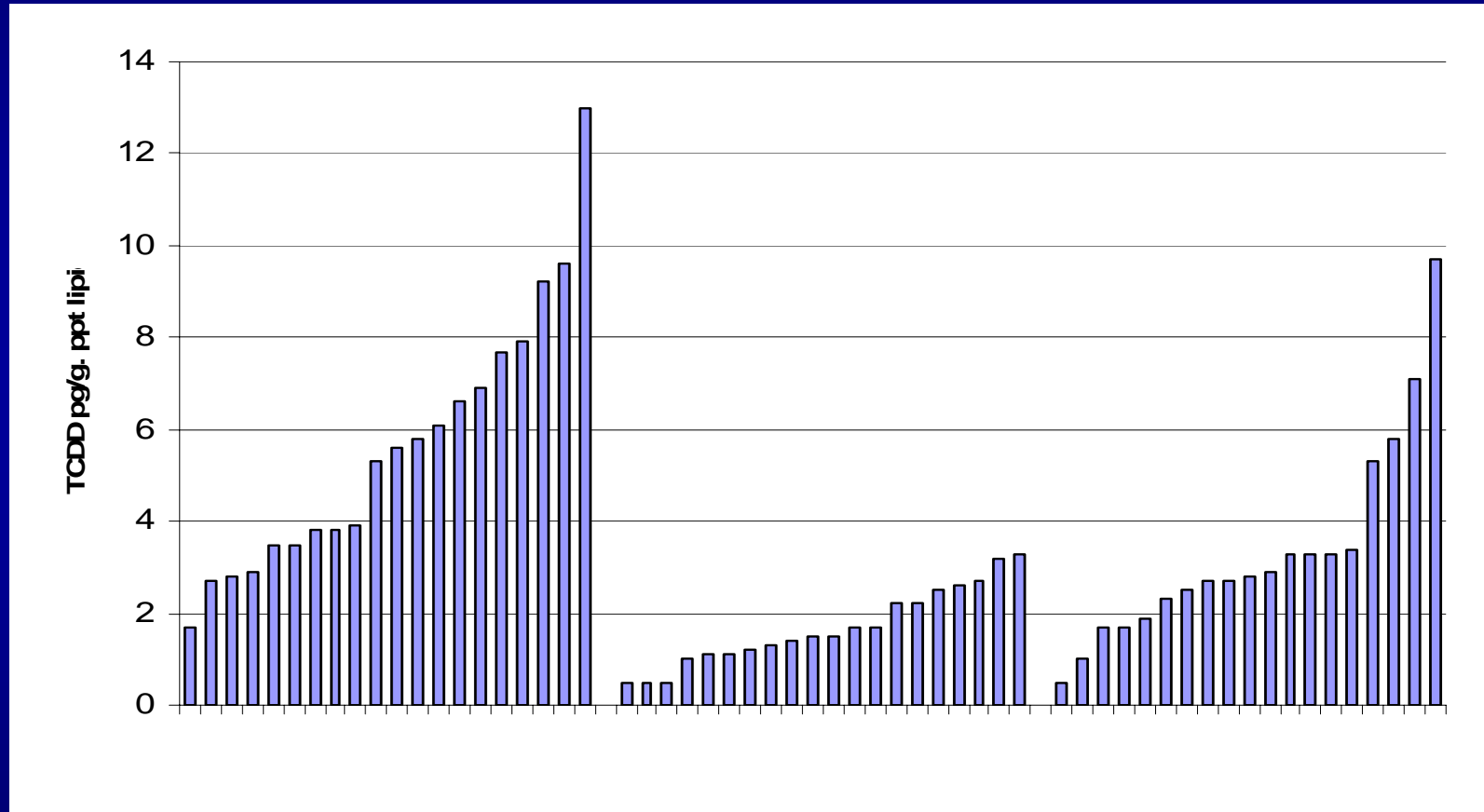
Recent Investigations for Human Exposure in Vietnam

- Can Gio
- *Phu My (Dien Khan – Nha Trang)*
- Phu Cat

- For each of the 3 areas 20 blood samples were collected
- Only TCDD was analyzed
- Data were published at Dioxin 2005 in Toronto, August 05

New Findings: TCDD in Human Blood

Concentration in pg/g lipid, Schechter et al., 2005



Can Gio

Range: 1.7 - 13

Median: 5.45

Dien Khan-Nha Trang

Range: nd(1) - 3.3

Median: 1.5

Phu Cat

Range: nd(1) - 9.7

Median: 2.8

Conclusions - 1

- **The daily consumption of low-level contaminated food leads to the accumulation of PCDD/Fs and dioxin like PCBs in human lipids.**
- **The dominant source of dioxins and dioxin like PCBs for humans is food.**
- **The daily dioxin intake of breast fed infants is – for the nursing period – 50 –fold higher than in adults.**

Conclusions - 2

- High consumption of contaminated food may result in a distinct difference in PCDD/F and dioxin like PCB levels compared to normal consumption habits.
- The dioxin concentrations – based on lipids – in human adipose tissue, blood and milk are quite similar.
- Dioxin background levels in humans living in industrialized countries, show a distinct decline over a period of about 15 years

Conclusions - 3

- In Vietnam a number of local reservoirs (hot spots) could be identified
- It can not be excluded that these hot spots still have a permanent influence on the contamination locally produced food resulting finally in a exposure of residents
- Despite declining PCDD/F trend, the exposure of babies during the breast feeding period is still matter of concern and justifies taking measures to reduce dioxin emission into the air. This is highly relevant for nursed infants living in hot spot areas of Vietnam.

Outlook

- For further information on the pathway of human exposure in HOT SPOT areas it is recommended to analyze local food and environmental samples.
- For source identification (other than Agent Orange) further investigations are recommended for the Bin My area.
- For a better estimation of background contamination in Hanoi (controls) a larger number of samples needs to be analyzed.

Thank you for your attention

