

## Pyrethroids Pesticides

### General Information

Pyrethroid pesticides are synthetic analogues of pyrethrins, which are natural chemicals found in chrysanthemum flowers. Pyrethroid pesticides are used to control a wide range of insects on agricultural fields, and in residences, public and commercial buildings, animal facilities, warehouses, and greenhouses. Certain pyrethroid insecticides (such as permethrin, resmethrin, and sumithrin) are also registered for use in mosquito-control programs in the United States. Pyrethroids are generally formulated as a complex mixture of different chemical isomers. National estimates for amounts of pyrethroids applied in the United States range from approximately 175,000 pounds (cyfluthrin, cypermethrin) to 1 million pounds (permethrin) (ATSDR, 2003).

Exposure of the general population to pyrethroid insecticides occurs primarily from the ingestion of food or from residential use. Permethrin is also used in skin lotion and shampoo to treat lice and scabies and has limited systemic absorption through the skin. Pesticide applicators can be exposed to pyrethroid pesticides via dermal and inhalation routes from powders and liquid formulations.

The average daily intake of permethrin (the most frequently used pyrethroid in the United States) for a man weighing 70 kilograms is estimated at about 3.2 micrograms per day. This value is about 1,000 times lower than the acceptable daily intake of permethrin derived by the United Nations' Food and Agriculture Organization and the World Health Organization. The U.S. FDA and USDA, the U.S. EPA, and OSHA have developed criteria on allowable levels of pyrethroids in foods, the environment, and the workplace, respectively.

Pyrethroid insecticides are currently undergoing regulatory review for a re-registration eligibility decision by the U.S. EPA.

Pyrethroids are not well absorbed through the skin. After a person inhales or ingests pyrethroids, the chemicals are rapidly metabolized and eliminated from the body. Elimination half-lives ranging from 5 to 8 hours have been measured for certain pyrethroids after human exposure (Kuhn et al., 1999). Researchers in other countries have frequently detected specific and nonspecific pyrethroid metabolites in urine samples obtained from adults and children in the general population (Heudorf and Angerer, 2001*d*).

Compared with other classes of insecticides (including organochlorines, organophosphates, and carbamates), pyrethroids have less toxicity in animals and people. Most adverse effects are related to the action of pyrethroids on the nervous system, where these chemicals open sodium channels when a nerve cell is excited (Soderlund et al., 2002). This effect can result in abnormal skin sensations (paresthesias) after dermal exposure, a transient symptom which is most commonly reported among pesticide applicators after direct contact with certain types of pyrethroid insecticides. Cases of systemic poisoning are rare and usually result from accidental or intentional ingestion of pyrethroid insecticides. Signs and symptoms of acute pyrethroid poisoning include tremor, salivation, choreoathetosis, and seizures (Ray et al., 2000).

Information about external exposure (i.e., environmental levels) and health effects of specific pyrethroids insecticides is available from ATSDR's Toxicological Profiles at <http://www.atsdr.cdc.gov/toxprofiles> and from the U.S. EPA's IRIS Web site at <http://www.epa.gov/iris>.

**Table 299. Pyrethroid pesticides and their metabolites**

<b>Pyrethroid (CAS number)</b>	<b>Urine metabolite (CAS number)</b>
Cyfluthrin (68359-37-5)	4-Fluoro-3-phenoxybenzoic acid (77279-89-1)
<i>cis</i> -Permethrin (61949-76-6) Cyfluthrin (68359-37-5) and <i>cis</i> -Cypermethrin (52315-07-8)	<i>cis</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (55701-05-8)
<i>trans</i> -Permethrin (61949-77-7) Cyfluthrin (68359-37-5) and <i>trans</i> -Cypermethrin (65732-07-2)	<i>trans</i> -3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (55701-03-6)
Deltamethrin (52918-63-5)	<i>cis</i> -3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid
Cypermethrin (52315-07-8) Deltamethrin (52918-63-5) Permethrin (52645-53-1)	3-Phenoxybenzoic acid (3739-38-6)

## 4-Fluoro-3-phenoxybenzoic Acid

CAS No. 77279-89-1

*Metabolite of Cyfluthrin, CAS No.68359-37-5*

### General Information

The chemical 4-fluoro-3-phenoxybenzoic acid is a specific metabolite of the pyrethroid insecticide cyfluthrin. Exposure to cyfluthrin may occur from the diet (including from certain fruits, vegetables, and grains), residential applications in homes and gardens, and from other indoor or outdoor locations where this pesticide is used.

Cyfluthrin is rapidly metabolized and eliminated from the body. The mean elimination half-life of cyfluthrin was 16 hours after an indoor application of this pesticide (Williams et al., 2003).

### Interpreting Levels of Urinary 4-Fluoro-3-Phenoxybenzoic Acid Reported in the Tables

Urinary levels of 4-fluoro-3-phenoxybenzoic acid were measured in a subsample of NHANES participants aged 6 years and older. Participants were selected within the specified age range to be a representative sample of the U.S. population. In the NHANES 2001-2002 subsample,

urinary levels of 4-fluoro-3-phenoxybenzoic acid were below the limit of detection. In a previous analysis of 217 urine specimens from a nonrandom sample of individuals in the United States that included cases of suspected residential insecticide exposure, the geometric mean concentration of 4-fluoro-3-phenoxybenzoic acid was 0.95 µg/L (Baker et al., 2004). In an investigation of adults and children in the general population in Germany, researchers detected 4-fluoro-3-phenoxybenzoic acid in 16% of urine samples (Heudorf and Angerer, 2001*d*), with adults and children having similar metabolite levels.

Finding a measurable amount of 4-fluoro-3-phenoxybenzoic acid in urine does not mean that the level of the 4-fluoro-3-phenoxybenzoic acid will result in an adverse health effect. These data will help scientists plan and conduct research about the relation between exposure to cyfluthrin and health effects. These data also provide physicians with a reference range so that they can determine whether or not other people have been exposed to higher levels of cyfluthrin than levels found in the general population.

**Table 300. 4-Fluoro-3-phenoxybenzoic acid**

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	< LOD	< LOD	< LOD	2539
<b>Age group</b>							
6-11 years	01-02	*	< LOD	< LOD	< LOD	< LOD	580
12-19 years	01-02	*	< LOD	< LOD	< LOD	< LOD	831
20-59 years	01-02	*	< LOD	< LOD	< LOD	< LOD	1128
<b>Gender</b>							
Males	01-02	*	< LOD	< LOD	< LOD	< LOD	1193
Females	01-02	*	< LOD	< LOD	< LOD	< LOD	1346
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	< LOD	< LOD	< LOD	680
Non-Hispanic blacks	01-02	*	< LOD	< LOD	< LOD	< LOD	701
Non-Hispanic whites	01-02	*	< LOD	< LOD	< LOD	< LOD	957

< LOD means less than the limit of detection, which may vary for some chemicals by year and by individual sample. See Appendix A for LODs.

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 301. 4-Fluoro-3-phenoxybenzoic acid (creatinine corrected)**

Geometric mean and selected percentiles of urine concentrations (in  $\mu\text{g/g}$  of creatinine) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	< LOD	< LOD	< LOD	2538
<b>Age group</b>							
6-11 years	01-02	*	< LOD	< LOD	< LOD	< LOD	580
12-19 years	01-02	*	< LOD	< LOD	< LOD	< LOD	830
20-59 years	01-02	*	< LOD	< LOD	< LOD	< LOD	1128
<b>Gender</b>							
Males	01-02	*	< LOD	< LOD	< LOD	< LOD	1193
Females	01-02	*	< LOD	< LOD	< LOD	< LOD	1345
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	< LOD	< LOD	< LOD	680
Non-Hispanic blacks	01-02	*	< LOD	< LOD	< LOD	< LOD	700
Non-Hispanic whites	01-02	*	< LOD	< LOD	< LOD	< LOD	957

< LOD means less than the limit of detection, which may vary for some chemicals by year and by individual sample. See Appendix A for LODs.

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

***cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane Carboxylic Acid**

CAS No. 55701-05-8

*Metabolite of cis-Permethrin, CAS No.61949-76-6; Cyfluthrin, CAS No.68359-37-5; and cis-Cypermethrin, CAS No. 52315-07-8*

**General Information**

*Cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid is a metabolite of *cis*-permethrin and other pyrethroid insecticides. *Cis*-permethrin is an isomer that is commonly present in insecticide formulations containing permethrin as an active ingredient. Permethrin is the most commonly used pyrethroid on agricultural crops in the United States, and it is the most commonly detectable pyrethroid in foods. Permethrin is also used in residences to control home and garden pests and in public health programs to control mosquitos. The *cis*-isomer of permethrin has more potent insecticidal activity than *trans*-permethrin. The metabolic transformation of *cis*-permethrin to *cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid can also occur in the environment (George, 1985). Thus, in addition to reflecting exposure to *cis*-permethrin and other pyrethroids, the detection of *cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in the urine may also reflect exposure to the metabolite if it was present in the person's food or environment.

The chemical *cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid is also a metabolite of other pyrethroids, including cypermethrin and cyfluthrin (Kuhn et al., 1999). Thus, the detection of *cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in the urine may reflect multiple sources of environmental exposure to different pyrethroid insecticides.

**Interpreting Levels of Urinary *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane Carboxylic Acid Reported in the Tables**

Urinary levels of *cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid were measured in a subsample of NHANES participants aged 6 years and older. Participants were selected within the specified age range to be a representative sample of the U.S. population. The 95<sup>th</sup> percentile values in the 2001-2002 subsample are similar to the corresponding 95<sup>th</sup> percentile values reported in a study of children and adults in Germany (Schettgen, et al., 2002a). Other investigators in Germany detected *cis*-3-(2,2-

**Table 302. *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid**

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	.160 (.120-.200)	.490 (.380-.670)	.890 (.740-1.10)	2539
<b>Age group</b>							
6-11 years	01-02	*	< LOD	.110 (<LOD-.170)	.360 (.280-.590)	.730 (.490-.870)	580
12-19 years	01-02	*	< LOD	.150 (<LOD-.210)	.430 (.300-.630)	.720 (.630-.920)	831
20-59 years	01-02	*	< LOD	.160 (.120-.220)	.510 (.390-.720)	.960 (.790-1.28)	1128
<b>Gender</b>							
Males	01-02	*	< LOD	.140 (.100-.200)	.470 (.370-.610)	.880 (.650-1.35)	1193
Females	01-02	*	< LOD	.180 (.120-.240)	.500 (.360-.740)	.880 (.790-1.08)	1346
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	.130 (.100-.180)	.290 (.250-.380)	.510 (.380-.580)	680
Non-Hispanic blacks	01-02	*	< LOD	.270 (.220-.350)	.640 (.570-.700)	.840 (.710-1.24)	701
Non-Hispanic whites	01-02	*	< LOD	.130 (<LOD-.200)	.500 (.330-.790)	.890 (.670-1.28)	957

< LOD means less than the limit of detection, which may vary for some chemicals by year and by individual sample. See Appendix A for LODs.

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in 30% of urine samples obtained from adults and children in the general population (Heudorf and Angerer, 2001*d*). In that study, urinary metabolite levels in adults and children were similar. Higher levels of *cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (up to 12.8 µg/L) have been measured in urine samples obtained from pyrethroid insecticide applicators (Leng et al., 2003).

Finding a measurable amount of *cis*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in urine does not mean that the level will result in an adverse health effect. These data will help scientists plan and conduct research about the relation between exposure to pyrethroid insecticides and health effects. These data also provide physicians with a reference range so that they can determine whether or not other people have been exposed to higher levels of pyrethroids than levels found in the general population.

**Table 303. *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (creatinine corrected)**

Geometric mean and selected percentiles of urine concentrations (in µg/g of creatinine) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	.219 (.198-.248)	.436 (.373-.521)	.778 (.629-1.03)	2538
Age group							
6-11 years	01-02	*	< LOD	.250 (.184-.318)	.596 (.430-.703)	.745 (.636-.886)	580
12-19 years	01-02	*	< LOD	.154 (.123-.200)	.303 (.250-.382)	.500 (.367-.778)	830
20-59 years	01-02	*	< LOD	.227 (.210-.255)	.444 (.386-.556)	.891 (.640-1.08)	1128
<b>Gender</b>							
Males	01-02	*	< LOD	.171 (.149-.189)	.350 (.302-.412)	.675 (.449-1.03)	1193
Females	01-02	*	< LOD	.263 (.226-.304)	.500 (.432-.564)	.920 (.745-1.11)	1345
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	.165 (.148-.189)	.297 (.263-.350)	.535 (.373-.636)	680
Non-Hispanic blacks	01-02	*	< LOD	.179 (.143-.219)	.385 (.292-.545)	.837 (.545-1.11)	700
Non-Hispanic whites	01-02	*	< LOD	.242 (.206-.269)	.444 (.389-.563)	.837 (.583-1.14)	957

< LOD means less than the limit of detection, which may vary for some chemicals by year and by individual sample. See Appendix A for LODs.

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

***trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane Carboxylic Acid**

CAS No. 55701-03-6

*Metabolite of trans-Permethrin, CAS No. 61949-77-7; Cyfluthrin, CAS No.68359-37-5; and trans-Cypermethrin, CAS No. 65732-07-2***General Information**

The chemical *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid is a metabolite of *trans*-permethrin and other pyrethroid insecticides. *trans*-Permethrin is an isomer that is commonly present in insecticide formulations containing permethrin as an active ingredient. Permethrin is the most commonly used pyrethroid on agricultural crops in the United States, and it is the most commonly detectable pyrethroid in foods. Permethrin is also used in residences to control home and garden pests and in public health programs to control mosquitos. The *trans*- isomer of permethrin has less potent insecticidal activity than *cis*-permethrin. The metabolic transformation of *trans*-permethrin to *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid can also occur in the environment (George, 1985). Thus, in addition to reflecting exposure to *trans*-permethrin, the detection of *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in the urine may also reflect exposure to the metabolite if it were present in the person's food or environment.

*Trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid is also a metabolite of other pyrethroids, including cypermethrin and cyfluthrin (Kuhn et al., 1999). Thus, the detection of detection of *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in the urine may reflect multiple sources of environmental exposure to different pyrethroid insecticides.

**Interpreting Levels of Urinary *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane Carboxylic Acid Reported in the Tables**

Urinary levels of *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid were measured in a subsample of NHANES participants aged 6 years and older. Participants were selected within the specified age range to be a representative sample of the U.S. population. The 95<sup>th</sup> percentile values in the 2001-2002 subsample are similar to the corresponding 95<sup>th</sup> percentile values reported in a study of children and

**Table 304. *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid**

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	.410 (<LOD-.550)	1.20 (.910-1.77)	2.50 (1.68-3.70)	2525
<b>Age group</b>							
6-11 years	01-02	*	< LOD	.470 (<LOD-.680)	1.39 (1.03-1.68)	2.50 (1.55-3.49)	576
12-19 years	01-02	*	< LOD	.490 (<LOD-.670)	1.17 (.780-1.58)	1.94 (1.49-3.77)	826
20-59 years	01-02	*	< LOD	< LOD	1.16 (.850-1.85)	2.56 (1.64-4.66)	1123
<b>Gender</b>							
Males	01-02	*	< LOD	.400 (<LOD-.490)	1.09 (.810-1.63)	2.37 (1.55-4.48)	1184
Females	01-02	*	< LOD	.430 (<LOD-.640)	1.26 (.920-1.95)	2.56 (1.76-3.58)	1341
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	.410 (<LOD-.500)	.900 (.680-1.16)	1.59 (1.11-2.01)	680
Non-Hispanic blacks	01-02	*	< LOD	.570 (.460-.730)	1.26 (1.03-1.68)	1.94 (1.68-2.95)	690
Non-Hispanic whites	01-02	*	< LOD	.400 (<LOD-.610)	1.19 (.840-1.90)	2.60 (1.60-4.66)	954

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\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

adults in Germany (Schettgen et al., 2002a). Other investigators in Germany detected *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in 65% of urine samples obtained from adults and children in the general population (Heudorf and Angerer, 2001d) with adults and children having similar levels of urinary metabolite. Higher levels (up to 13.4 µg/L) of *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid have been reported in pesticide applicators following the application of pyrethroid insecticides (Leng et al., 2003).

Finding a measurable amount of *trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid in urine does not mean that the level will result in an adverse health effect. These data will help scientists plan and conduct research about the relation between exposure to pyrethroid insecticides and health effects. These data also provide physicians with a reference range so that they can determine whether or not other people have been exposed to higher levels of pyrethroids than levels found in the general population.

**Table 305. *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (creatinine corrected)**

Geometric mean and selected percentiles of urine concentrations (in µg/g of creatinine) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	.718 (.636-.778)	1.45 (1.22-1.88)	2.55 (2.07-2.98)	2524
<b>Age group</b>							
6-11 years	01-02	*	< LOD	.903 (.697-1.13)	2.16 (1.40-2.61)	2.80 (2.34-3.44)	576
12-19 years	01-02	*	< LOD	.528 (.431-.651)	.966 (.778-1.12)	1.56 (1.07-2.60)	825
20-59 years	01-02	*	< LOD	< LOD	1.47 (1.20-1.98)	2.47 (2.07-3.11)	1123
<b>Gender</b>							
Males	01-02	*	< LOD	.519 (.475-.571)	1.04 (.875-1.32)	2.20 (1.45-2.57)	1184
Females	01-02	*	< LOD	.875 (.789-1.00)	1.68 (1.47-2.15)	2.81 (2.30-3.19)	1340
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	.569 (.509-.622)	1.08 (.933-1.22)	1.87 (1.27-2.15)	680
Non-Hispanic blacks	01-02	*	< LOD	.475 (.413-.537)	1.12 (.800-1.37)	1.98 (1.20-2.68)	689
Non-Hispanic whites	01-02	*	< LOD	.772 (.700-.848)	1.48 (1.27-2.07)	2.48 (2.15-3.02)	954

< LOD means less than the limit of detection, which may vary for some chemicals by year and by individual sample. See Appendix A for LODs.

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

***cis*-3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane Carboxylic Acid**

CAS No. 63597-73-9

*Metabolite of Deltamethrin, CAS No. 52918-63-5***General Information**

*Cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid is a specific metabolite of the pyrethroid insecticide deltamethrin. Exposure to deltamethrin may occur from the diet and its application in indoor or outdoor locations, including homes and gardens.

The metabolic transformation of deltamethrin to *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid can also occur in the environment (International Programme on Chemical Safety, 1990). Thus, in addition to reflecting exposure to deltamethrin, the detection of *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid in the urine may also reflect exposure to the metabolite if it was present in a person's food or environment. Deltamethrin is not considered a persistent pesticide in the body.

**Interpreting Levels of Urinary *cis*-3-(2,2-Dibromovinyl)-2,2-Dimethylcyclopropane Carboxylic Acid Reported in the Tables**

Urinary levels of *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid were measured in

a subsample of NHANES participants aged 6 years and older. Participants were selected within the specified age range to be a representative sample of the U.S. population. In the NHANES 2001-2002 subsample, urinary levels of *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid were below the limit of detection. In a previous analysis of 217 urine specimens from a nonrandom sample of individuals in the United States that included cases of possible exposure to residential insecticides, the geometric mean concentration of *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid was 0.39 µg/L (Baker et al., 2004). Results of a study of German children and adults showed that the mean urinary concentration of *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid was 0.08 µg/gram creatinine (Heudorf and Angerer, 2001*d*). In another German study, *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid was detected in 19% of urine samples obtained from adults and children in the general population (Heudorf and Angerer, 2001*d*) with adults and children having similar levels of urinary metabolite.

**Table 306. *cis*-3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid**

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	< LOD	< LOD	< LOD	2539
<b>Age group</b>							
6-11 years	01-02	*	< LOD	< LOD	< LOD	< LOD	580
12-19 years	01-02	*	< LOD	< LOD	< LOD	< LOD	831
20-59 years	01-02	*	< LOD	< LOD	< LOD	< LOD	1128
<b>Gender</b>							
Males	01-02	*	< LOD	< LOD	< LOD	< LOD	1193
Females	01-02	*	< LOD	< LOD	< LOD	< LOD	1346
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	< LOD	< LOD	< LOD	680
Non-Hispanic blacks	01-02	*	< LOD	< LOD	< LOD	< LOD	701
Non-Hispanic whites	01-02	*	< LOD	< LOD	< LOD	< LOD	957

< LOD means less than the limit of detection, which may vary for some chemicals by year and by individual sample. See Appendix A for LODs.

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.



Finding a measurable amount of *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid in urine does not mean that the level will result in an adverse health effect. These data will help scientists plan and conduct research about the relation between exposure to deltamethrin and health effects. These data also provide physicians with a reference range so that they can determine whether or not other people have been exposed to higher levels of deltamethrin than levels found in the general population.

**Table 307. *cis*-3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid (creatinine corrected)**

Geometric mean and selected percentiles of urine concentrations (in µg/g of creatinine) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	*	< LOD	< LOD	< LOD	< LOD	2538
<b>Age group</b>							
6-11 years	01-02	*	< LOD	< LOD	< LOD	< LOD	580
12-19 years	01-02	*	< LOD	< LOD	< LOD	< LOD	830
20-59 years	01-02	*	< LOD	< LOD	< LOD	< LOD	1128
<b>Gender</b>							
Males	01-02	*	< LOD	< LOD	< LOD	< LOD	1193
Females	01-02	*	< LOD	< LOD	< LOD	< LOD	1345
<b>Race/ethnicity</b>							
Mexican Americans	01-02	*	< LOD	< LOD	< LOD	< LOD	680
Non-Hispanic blacks	01-02	*	< LOD	< LOD	< LOD	< LOD	700
Non-Hispanic whites	01-02	*	< LOD	< LOD	< LOD	< LOD	957

< LOD means less than the limit of detection, which may vary for some chemicals by year and by individual sample. See Appendix A for LODs.

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

## 3-Phenoxybenzoic Acid

CAS No. 3739-38-6

*Metabolite of Cypermethrin, CAS No. 52315-07-8, Deltamethrin, CAS No. 52918-63-5; and Permethrin, CAS No. 52645-53-1*

### General Information

The chemical 3-phenoxybenzoic acid is a metabolite of cypermethrin, deltamethrin, permethrin, and possibly other pyrethroid insecticides. Thus, the detection of this metabolite in the urine may reflect multiples sources of environmental exposure to different pyrethroid insecticides. The metabolic transformation of certain pyrethroids to 3-phenoxybenzoic acid occurs in the body as well as in the environment. Thus, in addition to reflecting exposure to certain pyrethroids, so detecting 3-phenoxybenzoic acid in the urine may also reflect exposure to the metabolite if it was present in a person's food or environment.

### Interpreting Levels of Urinary 3-Phenoxybenzoic Acid Reported in the Tables

Urinary levels of 3-phenoxybenzoic acid were measured in a subsample of NHANES participants aged 6 years and older. Participants were selected within the specified age range to be a representative sample of the U.S. population.

In the NHANES 2001-2002 subsample, the median concentration 3-phenoxybenzoic acid in urine was similar to measurements reported in a study of German adults aged 17-61 years (Schettgen et al., 2002b). In a previous analysis of 217 urine specimens from a nonrandom sample of individuals in the United States that included cases of possible exposure to residential insecticides, geometric mean levels of 3-phenoxybenzoic acid were approximately six-fold higher than levels in the NHANES 2001-2002 subsample (Baker et al., 2004).

A previous study of adults and children in the United States reported the detection of 3-phenoxybenzoic acid in 12% of urine samples at concentrations of up to 30 µg/g creatinine (Baker et al., 2000). In a study by Leng et al. (2003), 3-phenoxybenzoic acid was detected in 25% of urine samples obtained from adult pest-control operators applying pyrethroid insecticides, and metabolite concentrations were observed to increase during the first 48 hours after an application. In that study, 3-phenoxybenzoic acid levels in urine ranged 0.1-11.5 µg/L.

**Table 308. 3-Phenoxybenzoic acid**

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	<b>.321</b> (.276-.374)	<b>.280</b> (.220-.340)	<b>.690</b> (.560-.810)	<b>1.69</b> (1.41-2.33)	<b>3.32</b> (2.52-5.25)	2539
<b>Age group</b>							
6-11 years	01-02	<b>.325</b> (.260-.406)	<b>.300</b> (.200-.410)	<b>.750</b> (.560-1.03)	<b>1.81</b> (1.34-2.69)	<b>3.28</b> (2.25-4.12)	580
12-19 years	01-02	<b>.353</b> (.288-.434)	<b>.290</b> (.250-.390)	<b>.800</b> (.560-1.13)	<b>1.85</b> (1.48-2.35)	<b>3.45</b> (2.14-6.69)	831
20-59 years	01-02	<b>.314</b> (.271-.364)	<b>.270</b> (.210-.340)	<b>.670</b> (.530-.780)	<b>1.64</b> (1.27-2.34)	<b>3.25</b> (2.51-6.16)	1128
<b>Gender</b>							
Males	01-02	<b>.328</b> (.277-.387)	<b>.290</b> (.230-.370)	<b>.680</b> (.560-.750)	<b>1.55</b> (1.26-2.16)	<b>3.23</b> (2.56-5.78)	1193
Females	01-02	<b>.315</b> (.266-.373)	<b>.250</b> (.210-.320)	<b>.730</b> (.530-.920)	<b>1.76</b> (1.47-2.35)	<b>3.28</b> (2.34-6.16)	1346
<b>Race/ethnicity</b>							
Mexican Americans	01-02	<b>.297</b> (.238-.369)	<b>.250</b> (.190-.340)	<b>.650</b> (.480-.810)	<b>1.30</b> (.830-2.26)	<b>2.71</b> (1.51-3.44)	680
Non-Hispanic blacks	01-02	<b>.507</b> (.428-.601)	<b>.510</b> (.430-.630)	<b>.950</b> (.840-1.12)	<b>2.00</b> (1.65-2.28)	<b>3.25</b> (2.52-4.62)	701
Non-Hispanic whites	01-02	<b>.298</b> (.246-.362)	<b>.230</b> (.180-.320)	<b>.590</b> (.470-.800)	<b>1.72</b> (1.27-2.46)	<b>3.38</b> (2.25-7.64)	957

### Comparing Adjusted Geometric Means

Geometric mean levels of urinary 3-phenoxybenzoic acid for the demographic groups were compared after adjusting for the covariates of race/ethnicity, age, gender, and urinary creatinine. For NHANES 2001-2002, children aged 6-11 years had slightly higher adjusted geometric mean levels of urinary 3-phenoxybenzoic acid than the group aged 12-19 years. Females had slightly higher levels than males. In addition, non-Hispanic blacks had slightly higher levels than Mexican Americans or non-Hispanic whites. It is unknown whether these differences associated with age, gender, or race/ethnicity represent differences in exposure, pharmacokinetics, or the relationship of dose per body weight.

Finding a measurable amount of 3-phenoxybenzoic acid in urine does not mean that the level will result in an adverse health effect. These data will help scientists plan and conduct research about the relation between exposure to pyrethroid insecticides and health effects. These data also provide physicians with a reference range so that they can determine whether or not other people have been exposed to higher levels of pyrethroids than levels found in the general population.

**Table 309. 3-Phenoxybenzoic acid (creatinine corrected)**

Geometric mean and selected percentiles of urine concentrations (in  $\mu\text{g/g}$  of creatinine) for the U.S. population aged 6-59 years, National Health and Nutrition Examination Survey, 2001-2002.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)				Sample size
			50th	75th	90th	95th	
<b>Total, age 6 and older</b>	01-02	<b>.316</b> (.274-.365)	<b>.283</b> (.243-.333)	<b>.582</b> (.490-.721)	<b>1.46</b> (1.13-1.91)	<b>3.10</b> (2.21-4.88)	2538
<b>Age group</b>							
6-11 years	01-02	<b>.423</b> (.335-.534)	<b>.382</b> (.296-.500)	<b>.859</b> (.594-1.35)	<b>2.20</b> (1.61-2.95)	<b>3.32</b> (2.64-5.40)	580
12-19 years	01-02	<b>.274</b> (.229-.328)	<b>.236</b> (.189-.313)	<b>.539</b> (.424-.730)	<b>1.10</b> (.864-1.63)	<b>2.35</b> (1.36-6.19)	830
20-59 years	01-02	<b>.311</b> (.271-.357)	<b>.282</b> (.245-.328)	<b>.550</b> (.444-.673)	<b>1.44</b> (1.02-1.91)	<b>3.10</b> (1.91-4.92)	1128
<b>Gender</b>							
Males	01-02	<b>.264</b> (.226-.309)	<b>.238</b> (.200-.280)	<b>.490</b> (.413-.571)	<b>1.17</b> (.955-1.60)	<b>2.75</b> (1.60-4.00)	1193
Females	01-02	<b>.378</b> (.321-.446)	<b>.333</b> (.283-.391)	<b>.716</b> (.534-.932)	<b>1.66</b> (1.25-2.37)	<b>3.34</b> (2.25-5.19)	1345
<b>Race/ethnicity</b>							
Mexican Americans	01-02	<b>.275</b> (.230-.329)	<b>.241</b> (.206-.316)	<b>.512</b> (.404-.650)	<b>1.03</b> (.750-1.67)	<b>1.83</b> (1.15-2.74)	680
Non-Hispanic blacks	01-02	<b>.362</b> (.300-.437)	<b>.350</b> (.283-.415)	<b>.636</b> (.526-.757)	<b>1.36</b> (1.17-1.83)	<b>2.82</b> (1.63-3.80)	700
Non-Hispanic whites	01-02	<b>.312</b> (.261-.372)	<b>.279</b> (.233-.333)	<b>.554</b> (.438-.811)	<b>1.52</b> (1.09-2.35)	<b>3.43</b> (1.88-5.48)	957

