CONCENTRATIONS AND MASS TRANSPORT OF PESTICIDES AND ORGANIC CONTAMINANTS IN THE MISSISSIPPI RIVER AND SOME OF ITS TRIBUTARIES, 1987–89 AND 1991–92

by Wilfred E. Pereira, John A. Moody, Frances D. Hostettler, Colleen E. Rostad, and Thomas J. Leiker

U.S. GEOLOGICAL SURVEY

Open-File Report 94–376

Denver, Colorado
1995

U.S. DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS AND ABBREVIATIONS

Multiply	*By*	*To obtain*
cubic meter per second (m^3/s)	35.31	cubic foot per second
meter (m)	3.281	foot
liter (L)	2.642×10^{-1}	gallon
microliter (µL)	2.642×10^{-7}	gallon
micrometer	3.937×10^{-5}	inch
kilometer	6.214×10^{-1}	mile
millimeter (mm)	3.937×10^{-2}	inch
kilogram	2.205	pound
kilogram per day (kg/d)	2.205	pounds per day
square kilometer (km^2)	3.861×10^{-1}	square mile

To convert degree Celsius (°C) to degree Fahrenheit (°F), use the following formula:

$$°F = 9/5\,(°C) + 32.$$

Milligram per liter (mg/L) is a unit expressing the concentration of a chemical constituent in solution as weight (milligrams) of solute per unit volume (liter) of water; 1 mg/L equals 1,000 micrograms per liter (µg/L) or 1,000,000 nanograms per liter (ng/L).

Grams per liter (g/L).

Grams per milliliter (g/mL).

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ABSTRACT

Concentrations and mass transport of pesticides and organic contaminants in the Mississippi River and some of its tributaries are reported for 1987–89 and 1991–92. Water samples collected during 1987–89 from the Lower Mississippi River and some of its tributaries were analyzed for (a) triazine herbicides and their degradation products (atrazine, desethylatrazine, desisopropyl-atrazine, cyanazine, and simazine); (b) chloroacetanilide herbicides and their degradation products (alachlor, 2-chloro-2′,6′-diethylacetanilide, 2-hydroxy-2′,6′-diethylacetanilide, and metolachlor); (c) organic contaminants (2,6-diethylaniline, 1,3,5-trimethyl-2,4,6-triazinetrione, tris-2-chloroethylphosphate, tris-2-chloropropylphosphate isomer A, and tris-2-chloropropylphosphate isomer B). Samples collected during 1991–92 from the entire navigable reach of the Mississippi River and some of its tributaries were analyzed for (a) triazine herbicides and their degradation products (ametryn, atrazine, desethylatrazine, desisopropylatrazine, cyanazine, cyanazineamide, hexazinone, metribuzin, prometon, prometryn, and simazine); (b) chloroacetanilide herbicides and their degradation products (alachlor, 2-chloro-2′,6′-diethylacetanilide, 2-hydroxy-2′,6′-diethylacetanilide, and metolachlor); (c) miscellaneous pesticides and their transformation products (deet, diazinon, fluometuron, molinate, 4-ketomolinate, norflurazon, desmethylnorflurazon, and thiobencarb); (d) miscellaneous organic contaminants (2,6-diethylaniline, caffeine, 1,3,5-trimethyl-2,4,6-triazinetrione, tris-2-chloroethylphosphate, tris-2-chloropropylphosphate isomer A, and tris-2-chloropropylphosphate isomer B). Concentration and precision and recovery data for the analytes of interest are reported in tables. Determined concentrations are presented in tables. The transport of these compounds in kilograms per day was determined and is presented in graphs.

The maximum measured concentration of a triazine herbicides was 4,700 nanograms per liter (ng/L) of atrazine in a water sample collected near the mouth of the Kaskaskia River on July 28, 1991. This concentration equals a mass transport into the Mississippi River of about 3 kilograms per day (kg/d). The maximum mass transport, however, was about 2,900 kg/d for the Mississippi River below Vicksburg, Mississippi, where the average concentration of atrazine was 1,550 ng/L on May 6, 1992.

The maximum measured concentration of a chloroacetanilide herbicide was 900 ng/L of alachlor in a water sample collected from the Mississippi River at Thebes, Illinois, on May 22, 1988, when the water discharge of the Mississippi River was near record low levels—this corresponds to a mass transport of about 280 kg/d. The maximum mass transport for alachlor was 660 kg/d for the Mississippi River at Helena, Arkansas, where the concentration was 450 ng/L on June 17, 1989.

The maximum measured concentration of an organic contaminant in the Mississippi River was an average of 853 ng/L of 2,6-diethylaniline in a water sample collected from the Mississippi River at St. Louis, Missouri, on May 20, 1988; the corresponding mass transport was 250 kg/d. The maximum mass transport was 300 kg/d for the Mississippi River at St. Louis, Missouri, on December 3, 1987.

INTRODUCTION

The Mississippi River and its tributaries drain the largest river basin in the United States, an area of about 3.0×10^6 km^2 (Moody and Meade, 1992). Many agricultural chemicals from the Midwestern States and other industrial chemicals are transported to the Mississippi River in agricultural runoff, ground-water discharge, or atmospheric deposition, thereby affecting the water quality. The widespread use of millions of kilograms of herbicides on farm lands in the Midwestern States (Gianessi and Puffer, 1990) makes the Mississippi River and its tributaries particularly vulnerable to contamination by agricultural chemicals. Pesticide usage on major crops in the 14-State region drained by the Mississippi River, along with selected physicochemical properties and health-advisory levels, is shown in table 1.

Table 1.--Summary of properties, use, and health-advisory levels for principal pesticides used in the Mississippi River Basin

[mg/L, milligram per liter; K_{oc}, soil sorption coefficient normalized to organic carbon; g/mL, gram per milliliter; ng/L, nanogram per liter; µg/L, microgram per liter; --, no data; *, none established]

Pesticide	Water solubility[1] (mg/L)	Soil sorption coefficient, K_{oc}[1]	Soil half life[1] (days)	Annual usage in 14-State area[2]	Major crop use[2]	Maximum contaminant level[3] (ng/L)	Lifetime health-advisory level[4] (µg/L)
Triazine herbicides and their degradation products							
Ametryn	185	300	60	--	Corn	*	0
Atrazine	33	100	60	47	Corn, sorghum	3,000	3
Cyanazine	170	190	14	19	Corn, cotton	*	10
Hexazinone	33,000	54	90	--	Pine forests (non-crop)	*	200
Metribuzin	1,220	60	40	3.3	Soybeans	*	200
Prometon	720	150	500	--	Weeds (non-crop)	*	100
Prometryn	33	400	60	0.6	Cotton	*	*
Simazine	6.2	130	60	0.9	Corn	[5]1,000	4
Chloroacetanilide herbicides and their degradation products							
Alachlor	240	170	15	41	Corn, soybeans, sorghum	2,000	*
Metolachlor	530	200	90	37	Corn, soybeans, sorghum	*	100
Miscellaneous pesticides and their transformation products							
Diazinon	60	1,000	40	--	Crop	*	0.6
Fluometuron	110	100	85	1.9	Cotton	*	90
Molinate	970	190	21	2.2	Rice	*	*
Norflurazon	28	600	90	1.0	Cotton	*	*
Thiobencarb	28	900	21	0.5	Rice	*	*

[1]From Wauchope and others (1991).
[2]Annual use in millions of pounds active ingredient from Gianessi and Puffer (1990).
[3]From U.S. Environmental Protection Agency (1991a).
[4]From U.S. Environmental Protection Agency (1991b).
[5]From U.S. Environmental Protection Agency (1990).

Purpose and Scope

The purpose of this report is to describe laboratory analytical methods for the determination of pesticides and selected organic compounds in the dissolved phase of the water column and to provide a single document containing a listing of all concentrations and graphs of mass transport of pesticides and organic contaminants in the Mississippi River and some of its tributaries.

Study Area

In 1987, the U.S. Geological Survey (USGS) started a multidisciplinary study to investigate the movement, mixing, and storage of toxic chemicals, especially those associated with suspended sediments, in an 1,800-km reach of the Mississippi River between Winfield, Mo. (about 100 km upstream from St. Louis), to Belle Chasse, La. (about 50 km downstream from New Orleans). In 1991, the United States Congress requested that the USGS conduct a water-quality study of the entire navigable reach of the Mississippi River. This study encompasses the navigable reach of the river from St. Anthony Falls, Minn. (at Upper Mississippi River mile 857.7), to Belle Chasse, La. (at Lower Mississippi River mile 73.1), a total distance of about 2,800 km. As part of these studies, several tributaries of the Mississippi River also were sampled to determine inputs and mixing and redistribution of contaminants downstream from major river confluences. Sampling sites on the Mississippi River and some of its tributaries are shown in figures 1 and 2, and are listed in table 2.

Acknowledgments

The authors wish to thank Bob Meade for designing the sampling strategy and helping to collect most of the tributary water samples. Collecting samples from big rivers required the assistance of many people who often volunteered to perform duties above and beyond those that were required as part of their normal work schedule: Ron Antweiler, Ellen Axtmann, Larry Barber, LaDonna Bishop, Terry Brinton, Pat Brown, Greg Brown, Wes Campbell, Gail Chumura, Geoff Ellis, Daphne Frilot, John Garbarino, Don Goolsby, Heidi Hays, Bob Hirsch, Lois Koehnken, Tom Kraemer, Jim Krest, Jerry Leenheer, Gail Mallard, Debby Martin, Brent McKee, Stephanie Monsterleet, Ted Noyes, Dale Peart, Jim Ranville, Terry Rees, Dave Roth, Alan Shiller, Mike Simpson, Bob Stallard, Herb Stevens, Charles Tabor, Howard Taylor, Lisa Torick, Woodrow Wang, Tim Willoughby, and Jeff Writer.

Several standard compounds used in this study were provided by Ciba-Geigy Corporation, Monsanto Company, and Sandoz Corporation. The Research Vessel ACADIANA was rented from the Louisiana Universities Marine Consortium, Cocordrie, La., and was operated by Lee Black, Cheryl Blanchard, Wilton Delaune, Mike Detraz, Derral Dupres, Chuck Guidry, Jonathan Landry, Craig LeBoeuf, Steve Rabalais, and Wayne Simoneaux.

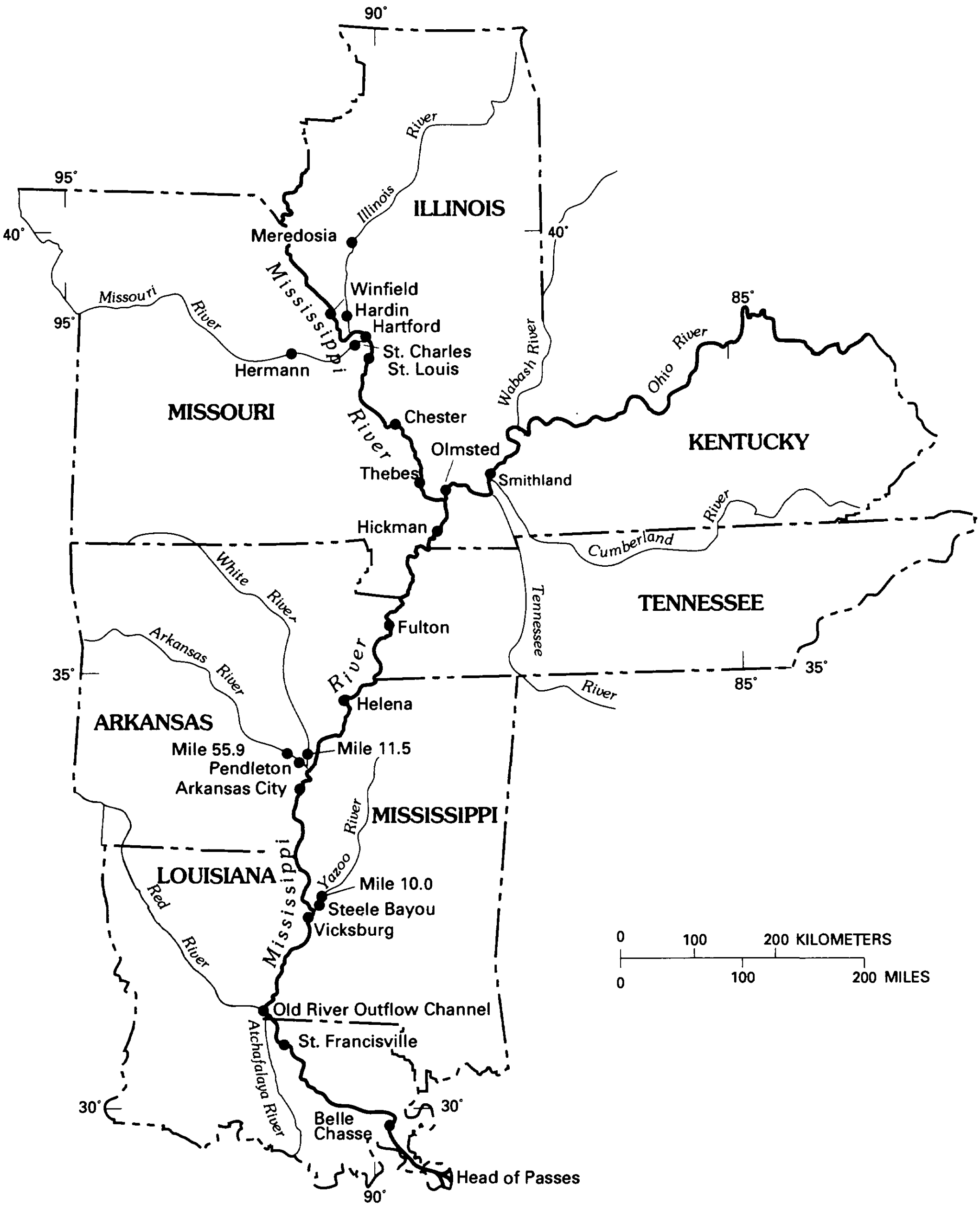


Figure 1.--Location of sampling sites for the 1987–89 cruises on the Mississippi River and some of its tributaries.

Figure 2.--Location of sampling sites for the 1991–92 cruises on the Mississippi River and some of its tributaries. Sampling sites on most tributaries were at about mile 1.0 and are not indicated (see table 2).

Table 2.--Sampling sites on the Mississippi River and some of its tributaries

[X, cross section was sampled; ~, approximate]

Site name	River mile[1]		Cruise							
			July–Aug. 1987	Nov.–Dec. 1987	May–June 1988	March–April 1989	June 1989	July–Aug. 1991	Oct.–Nov. 1991	April–May 1992
Mississippi R. above St. Anthony Falls, Minn.	UM	857.7						X[2]	X	X
Minnesota R. at Mile 3.5, Minn.	MN	3.5						X	X	X
Mississippi R. at Hastings, Minn.	UM	812.2						X	X	X
St. Croix R. at Mile 0.5, Wis.	SC	0.5						X	X	X
Mississippi R. near Pepin, Wis.	UM	764.5						X	X	X
Chippewa R. at Mile 1.7, Wis.	CH	1.7						X	X	X
Mississippi R. at Trempealeau, Wis.	UM	713.8						X	X	X
Mississippi R. below Lock and Dam 9, Wis.	UM	639.7						X	X	X
Wisconsin R. at Mile ~1.0, Wis.	WI	1.0						X	X	X
Mississippi R. at Clinton, Iowa	UM	520.3						X	X	X
Rock R. at Mile ~1.0, Ill.	RK	1.0						X	X	X
Iowa R. at Mile ~1.0, Iowa	IA	1.0						X	X	X
Mississippi R. at Keokuk, Iowa	UM	363.1						X	X	X
Des Moines R. at Mile ~1.0, Iowa	DM	1.0						X	X	X
Mississippi R. near Winfield, Mo.	UM	239.2	X	X	X	X	X	X	X	X
Illinois R. below Meredosia, Ill.	IL	67.2	X	X	X					
Illinois R. at Hardin, Ill.	IL	21.8				X	X	X	X	X
Mississippi R. at Hartford, Ill.	UM	197.7	X							
Missouri R. at Hermann, Mo.	MO	97.9	X		X	X	X			
Missouri R. at St. Charles, Mo.	MO	28.1		X				X	X	X
Mississippi R. at St. Louis, Mo.	UM	179.3	X	X	X	X	X			
Kaskaskia R. at Mile 1.5, Ill.	KA	1.5						X	X	X
Mississippi R. at Chester, Ill.	UM	108.9	X							
Mississippi R. at Thebes, Ill.	UM	43.9		X	X	X	X	X	X	X
Ohio R. below Smithland Lock and Dam, Ill.	OH	919.2	X							
Ohio R. at Olmsted. Ill.	OH	965.0	X	X	X	X	X	X	X	X
Mississippi R. below Hickman, Ky.	LM	916.8	X	X	X	X	X			
Mississippi R. at Fulton, Tenn.	LM	777.3		X	X		X			
Mississippi R. below Fulton, Tenn.	LM	773.5				X				
Mississippi R. at Helena, Ark.	LM	663.9	X	X	X	X	X			
White R. at Mile 11.5, Ark.	WH	11.5	X	X	X	X	X			
White R. at Mile 1.2, Ark.	WH	1.2						X	X	X
Arkansas R. at Mile 55.9, Ark.	AR	55.9	X							
Arkansas R. at Pendleton, Ark.	AR	22.4				X	X			
Arkansas R. at Mile 0.0, Ark.	AR	0.0						X	X	X

Table 2.--Sampling sites on the Mississippi River and some of its tributaries--Continued

Site name	River mile[1]	Cruise							
		July–Aug. 1987	Nov.–Dec. 1987	May–June 1988	March–April 1989	June 1989	July–Aug. 1991	Oct.–Nov. 1991	April–May 1992
Mississippi R. above Arkansas City, Ark.	LM 566.0	X	X	X	X	X			
Steele Bayou at Mile ~0.5, Miss.	SB 0.5		X						
Yazoo R. at Mile 10.0, Miss.	YZ 10.0		X	X					
Yazoo R. below Steele Bayou, Miss.	YZ 9.0				X	X			X
Yazoo R. at Mile ~3.0, Miss.	YZ ~3.0						X	X	
Mississippi R. below Vicksburg, Miss.	LM 433.4	X	X	X	X	X	X	X	X
Old R. Outflow Channel near Knox Landing, La.	OR 5.5	X	X	X	X	X			
Mississippi R. near St. Francisville, La.	LM 266.4	X	X	X	X	X	X	X	X
Mississippi R. below Belle Chasse, La.	LM 73.1	X	X	X	X	X	X	X	X

[1]UM, Upper Mississippi River miles measured upriver from confluence with Ohio River.
LM, Lower Mississippi River miles measured upriver from Head of Passes, La.
MN, Minnesota River miles measured upriver from confluence with the Upper Mississippi River (844.0).
SC, St. Croix River miles measured upriver from confluence with the Upper Mississippi River (UM 811.3).
CH, Chippewa River miles measured upriver from confluence with the Upper Mississippi River (UM 763.3).
WI, Wisconsin River miles measured upriver from confluence with the Upper Mississippi River (UM 630.6).
RK, Rock River miles measured upriver from confluence with the Upper Mississippi River (UM 479.0).
IA, Iowa River miles measured upriver from confluence with the Upper Mississippi River (UM 434.0).
DM, Des Moines River miles measured upriver from confluence with the Upper Mississippi River (UM 361.4).
IL, Illinois River miles measured upriver from confluence with Upper Mississippi River (UM mile 218.0).
MO, Missouri River miles measured upriver from confluence with Upper Mississippi River (UM miles 195.3).
KA, Kaskaskia River miles measured upriver from confluence with the Upper Mississippi River (UM 117.3).
OH, Ohio River miles measured downriver from Pittsburgh, Pa., Ohio-Mississippi confluence is at Ohio River mile 981.5 and Lower Mississippi River mile 953.8.
WH, White River miles measured upriver from confluence with Lower Mississippi River (LM mile 598.8).
AR, Arkansas River miles measured upriver from confluence with Lower Mississippi River (LM miles 581.5).
SB, Steele Bayou River miles measured upriver from confluence with the Yazoo River (~YZ 9.5).
YZ, Yazoo River miles measured upriver from confluence with Lower Mississippi River (LM mile 437.2).
OR, Old River Outflow Channel miles measured downriver from the Old River Control Structure (LM mile 314.5).
[2]Sample was collected at river mile 858.3.

METHODS

Sample Collection

Depth-integrated water samples were collected using Teflon materials and Teflon-coated equipment during the cruises of July–August 1987, November–December 1987, May–June 1988, March–April 1989, and June 1989 at sampling sites on the Mississippi River and some of its tributaries. Similar samples also were collected at 16 sampling sites from the entire navigable reach of the Mississippi River and some navigable tributaries during the sampling cruises of July–August 1991, October–November 1991, and April–May 1992. Surface dip samples at one location near midstream were collected in 1-L Teflon bottles near the mouth of 10 smaller tributaries (St. Croix, Chippewa, Wisconsin, Rock, Iowa, Des Moines, Kaskaskia, White, Arkansas, and Yazoo Rivers). For the five cruises between 1987 and 1989, a Lagrangian sampling scheme was used that followed and collected samples from approximately the same mass of water as it moved freely downstream from St. Louis, Mo., without encountering any navigation dams. A more detailed explanation and evaluation of this sampling scheme has been published by Moody (1993) in order to aid in the interpretation of the 1987–89 Lagrangian chemical data sets. For the three cruises in 1991 and 1992, this sampling scheme was more approximate because the numerous navigation dams on the Upper Mississippi River between Minneapolis, Minn., and St. Louis, Mo., made it difficult to follow the same mass of water and because extra time was taken to collect surficial bed-sediment samples in the pools behind the navigation dams. (Surficial bed-sediment data will be reported in a U.S. Geological Survey Open-File Report entitled "Hydrologic, sedimentologic, and chemical data for water and bed sediments in the navigation pools of the Upper Mississippi River, July 1991–April 1992.") The samples, however, were collected in downstream order in about one month's time. Sampling protocols and hydrologic data are described elsewhere (Nordin and others, 1983; Meade, 1985; Richey and others, 1986; Leenheer and others, 1989; Meade and Stevens, 1990; Moody and Troutman, 1992; Moody and Meade, 1992, 1993, 1995). One-liter subsamples were taken from the depth-integrated water and suspended-sediment (less than 63 µm) sample collected aboard the research vessel ACADIANA at each sampling site. These 1-L samples were stored in Teflon bottles, refrigerated, and shipped to the laboratory for analysis.

Sample Preparation and Analysis

During the July–August 1987 sampling cruise, the 1-L water subsamples were extracted by solid-phase extraction chromatography using cyclohexyl-modified silica cartridges (Analytichem International) and analyzed by gas chromatography-mass spectrometry using a modification of the method of Rostad and Pereira (1984). Because of the presence of artifacts in solid-phase cartridge blanks, this method was discontinued. Samples from all other cruises were extracted by a liquid-liquid extraction procedure and analyzed by gas chromatography-ion trap mass spectrometry (GC–ITMS) (Pereira and others, 1990; Pereira and Rostad, 1990).

Basically, this method consisted of filtration of the water samples through glass-fiber filters (Gelman Sciences, type A–E). A 1-L water sample was adjusted to pH 8.5 with a small amount of 10-percent potassium hydroxide solution. After the addition of 10 g of sodium chloride and an internal standard solution containing the atrazine analogue terbuthylazine, the sample was extracted with three volumes of methylene chloride (75, 50, and 50 mL). The combined methylene chloride extracts were dried over anhydrous sodium sulfate and concentrated in a Kuderna-Danish apparatus, using a small volume of benzene (as keeper-solvent), to a volume of approximately 5 mL. The extract was concentrated further to a volume of 100 µL under a slow stream of dry nitrogen. The extract was then analyzed by GC–ITMS in the full-scan mode. All compounds were confirmed by comparing their mass spectra and retention times to authentic standards analyzed under identical conditions. Concentration values reported are uncorrected for percent recovery. The lower limit of detection of analytes in Mississippi River water samples are as follows: desisopropylatrazine, norflurazon, and desmethylnorflurazon, 10 ng/L; cyanazine and cyanazineamide, 25 ng/L; all other analytes, 5 ng/L, with a signal to noise ratio greater than 5:1. As the study progressed and additional compounds were identified and confirmed, these compounds were added to the list of analytes determined by this method.

Error Analysis

Sampling errors are described by Moody and Meade (1992, 1993, 1995). Method precision studies were performed by spiking quintuplicate or triplicate samples of the Mississippi River water with the analytes of interest. An unspiked sample also was analyzed to determine background concentrations, which were subtracted from the spiked samples. Method precision data are listed in tables 3 and 4. Accuracy of the method was determined by performing recovery studies. For this purpose, Mississippi River water samples were spiked in triplicate with the analytes of interest. An unspiked sample also was analyzed to determine background concentrations, which were subtracted from the spiked samples. Recovery data for the analytes of interest are shown in tables 5 and 6.

Table 3.--Method precision results of analyses of Mississippi River water spiked with selected pesticides and their degradation products at about 500 nanograms per liter

[No precision results are listed for cyanazmeamide because of the non-availability of sufficient standard reference material. ng/L, nanogram per liter; --, no data]

Compound	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Mean[1] (ng/L)	Standard deviation (ng/L)	Relative standard deviation, percent
Triazine herbicides and their degradation products								
Ametryn	485	483	476	465	414	465 ± 36	29	6.2
Atrazine	517	445	511	540	487	500 ± 45	36	7.2
Cyanazine	487	481	507	445	420	468 ± 43	35	7.5
Desethylatrazine	344	354	346	355	309	432 ± 23	19	5.5
Desisopropylatrazine[2]	242	265	234	--	--	247 ± 40	16	6.5
Hexazinone	441	501	446	448	420	451 ± 37	30	6.7
Metribuzin	495	455	483	423	444	460 ± 36	29	6.3
Prometon	476	499	488	518	459	488 ± 28	22	4.6
Prometryn	503	483	481	494	436	479 ± 32	26	5.4
Simazine	483	504	506	532	466	498 ± 31	25	5.0
Chloroacetanilide herbicides and their degradation products								
Alachlor	492	455	490	483	423	469 ± 37	29	6.2
2-chloro-2′,6′-diethylacetanilide	537	495	503	478	431	489 ± 48	39	7.9
2-hydroxy-2′,6′-diethylacetanilide	205	182	188	163	135	175 ± 33	27	15.3
Metolachlor	494	477	516	476	417	476 ± 46	37	7.7
Miscellaneous pesticides and their transformation products								
Deet	468	437	479	393	404	436 ± 47	38	8.7
Desmethylnorflurazon	320	391	357	312	291	334 ± 49	40	11.9
Diazinon	493	503	486	454	426	472 ± 39	32	6.7
Fluometuron	507	454	472	450	381	453 ± 57	46	10.2
4-ketomolinate	443	437	445	442	415	436 ± 15	12	2.8
Norflurazon	449	515	449	491	451	471 ± 38	30	6.4
Thiobencarb	494	493	484	497	423	478 ± 39	31	6.5

[1]Mean ± error based on 95-percent confidence level.

[2]Determined in triplicate in a different experiment.

Table 4.--Method precision results of analyses of Mississippi River water spiked with selected organic compounds at about 500 nanograms per liter

[ng/L, nanogram per liter]

Compound	Sample					Mean[3] (ng/L)	Standard deviation (ng/L)	Relative standard deviation, percent
	1	2	3	4	5			
2,6-diethylaniline	388	337	357	346	317	349 ± 33	26	7.4
1,3,5-trimethyl-2,4,6-triazinetrione	433	416	411	384	365	402 ± 34	27	6.7
Tris-2-chloroethylphosphate	481	442	467	460	389	448 ± 44	36	8.0
Tris-2-chloropropylphosphate isomer A[1]	336	333	326	312	283	318 ± 27	22	6.9
Tris-2-chloropropylphosphate isomer B[2]	150	137	157	149	120	143 ± 18	14	10.5
Caffeine	338	358	331	361	313	340 ± 25	20	5.9

[1]Spiked at 0.36 microgram per liter.
[2]Spiked at 0.14 microgram per liter.
[3]Mean ± error based on 95-percent confidence level.

Table 5.--Method accuracy results determined by recovery of pesticides and degradation products from Mississippi River water

[Three replicates spiked at 500 ng/L; ng/L, nanogram per liter]

Compound	Mean recovery percent	Standard deviation (ng/L)	Relative standard deviation, percent
Triazine herbicides and their degradation products			
Ametryn	92	2.3	2.5
Atrazine	91	6.1	6.7
Cyanazine	114	5.9	5.2
Cyanazineamide	40	8.9	22
Desethylatrazine	75	3.8	5.1
Desisopropylatrazine	59	3.2	6.5
Hexazinone	90	6.0	6.7
Metribuzin	99	3.8	3.8
Prometon	91	1.5	1.6
Prometryn	87	4.6	5.3
Simazine	92	3.2	3.5
Chloroacetanilide herbicides and their degradation products			
Alachlor	94	4.5	4.8
2-chloro-2′,6′-diethylacetanilide	94	3.1	3.3
2-hydroxy-2′,6′-diethylacetanilide	113	2.6	2.3
Metolachlor	93	3.5	3.8
Miscellaneous pesticides and their transformation products			
Deet	84	2.6	3.1
Desmethylnorflurazon	122	9.1	7.5
Diazinon	94	6.4	6.8
Fluometuron	96	3.8	4.0
4-ketomolinate	87	3	3.4
Molinate	80	7.2	9.0
Norflurazon	106	2.9	2.7
Thiobencarb	87	4.0	4.6

Table 6.--Method accuracy results determined by recovery of organic contaminants from Mississippi River water

[Three replicates spiked at 500 ng/L; ng/L, nanogram per liter]

Compound	Mean recovery percent	Standard deviation of the mean	Relative standard deviation, percent
2,6-diethylaniline	75	3.8	5.1
1,3,5-trimethyl-2,4,6-triazinetrione	95	1.5	1.6
Tris-2-chloroethylphosphate	95	7.1	7.5
Tris-2-chloropropylphosphate isomer A[1]	94	12.2	13.0
Tris-2-chloropropylphosphate isomer B[2]	71	5.0	7.0

[1]Spiked at 0.36 milligram per liter.
[2]Spiked at 0.14 microgram per liter.

Quality Assurance Procedures

Prior to use, all laboratory glassware was washed with detergent, tap water, and distilled water and baked at 300°C overnight. Sodium chloride was baked at 400°C prior to use. All solvents were Burdick and Jackson GC–MS high-purity grade. Laboratory reagent and glassware blanks were devoid of the analytes of interest. A midlevel standard solution of the analytes of interest was analyzed immediately prior to sample analyses each day. Instrument calibration was checked daily.

All sampling equipment was rinsed with deionized organic-free water prior to sample collection. Field blanks and replicate samples from several sites were analyzed during each sampling trip. Except for trace levels of deet (an insect repellent), no analytes of interest were detected in the field blanks. Accordingly, the values reported for deet represent the value determined minus the blank value.

DATA COLLECTED

The concentration of pesticides and organic contaminants for the 1987–89 samples is presented in tables 7–15 and the mass transport is presented in figures 3–56. Similar data for the 1991–92 samples are presented in tables 16–27 and in figures 57–132. Distances are measured upstream from the mouth of the Lower Mississippi River at Head of Passes, La. The Upper Mississippi River miles begin at zero at the confluence of the Mississippi and Ohio Rivers at Cairo, Ill.; so, to determine Upper Mississippi River miles (on the figures), subtract 953.8 from the distances upriver from Head of Passes that are greater than 953.8. At river mile 314.5 above Head of Passes, about 25 percent of the Mississippi River water discharge is diverted by the U.S. Army Corps of Engineers from the Mississippi River into the Atchafalaya River and then into the Gulf of Mexico. This diversion is commonly seen as a step-like decrease between Vicksburg, Miss., and New Orleans, La., in the following figures showing mass transport of pesticides and organic contaminants. Similarly, contributions of pesticides and organic contaminants from the tributaries are shown as a step-like increase in the mass transport for the Mississippi River. The mass transport in kg/d is equal to the water discharge in m^3/s times the concentration in ng/L times 8.64×10^{-5}. The step-like increases shown in figures 3–132 are the result of a tributary and are drawn so that the rate of change or slope of the lines are equal upstream and downstream from the tributary or distributary.

Table 7.--Concentrations of triazine and chloroacetanilide herbicides and their degradation products in the Mississippi River and some of its tributaries for July–August 1987 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1987	Site name	Water discharge[1] (m^3/s)	Concentration of triazine and chloroacetanilide herbicides, in ng/L					
			Atrazine	Desethylatrazine	Desisopropylatrazine	Simazine	Alachlor	Metolachlor
7–19	Mississippi R. near Winfield, Mo.	1,370	700	210	ND	ND	ND	200
7–18	Illinois R. below Meredosia, Ill.	312	900	470	620	150	250	530
7–21	Mississippi R. at Hartford, Ill.	1,500	900	200	570	ND	ND	190
7–20	Missouri R. at Hermann, Mo.	2,640	1,500	380	230	ND	ND	450
7–22	Mississippi R. at St. Louis, Mo.	3,940	1,800	740	90	ND	280	630
7–23	Mississippi R. at Chester, Ill.	4,250	1,200	ND	ND	ND	ND	300
7–26	Ohio R. below Smithland Lock and Dam, Ill.	652	1,100	330	ND	170	ND	460
7–27	Ohio R. at Olmsted, Ill.	2,070	800	300	90	110	70	340
7–28	Mississippi R. below Hickman, Ky.	6,270	900	220	ND	ND	ND	260
7–30	Mississippi R. at Helena, Ark.	6,850	1,000	390	ND	50	110	360
7–31	White R. at Mile 11.5, Ark.	332	ND	ND	ND	ND	ND	ND
8–01	Arkansas R. at Mile 55.9, Ark.	790	700	120	370	ND	ND	40
8–02	Mississippi R. above Arkansas City, Ark.	7,630	800	280	ND	ND	ND	310
8–04	Mississippi R. below Vicksburg, Miss.	7,750	700	170	ND	ND	ND	190
8–06	Old R. Outflow Channel near Knox Landing, La.	2,050	700	140	ND	ND	ND	150
8–07	Mississippi R. near St. Francisville, La.	6,190	600	130	ND	ND	ND	150
8–09	Mississippi R. below Belle Chasse, La.[2]	6,190	700	ND	ND	ND	ND	150

[1]Discharges are listed by Moody and Meade (1992).

[2]Because of logistical problems, a discharge measurement at Belle Chasse was not made. The discharge value at Belle Chasse was assumed to be the same as the discharge value at St. Francisville.

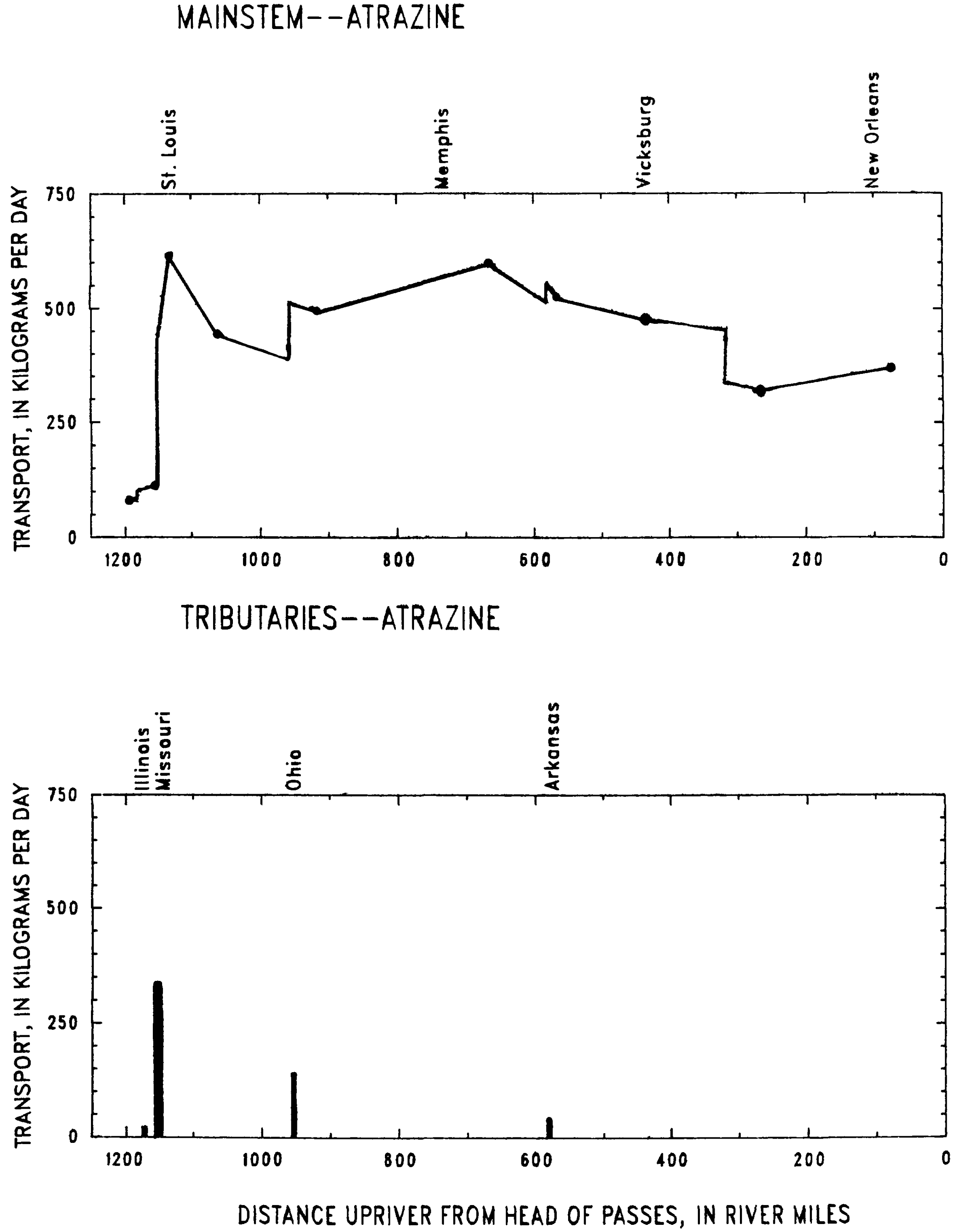


Figure 3.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 18 and August 9, 1987.

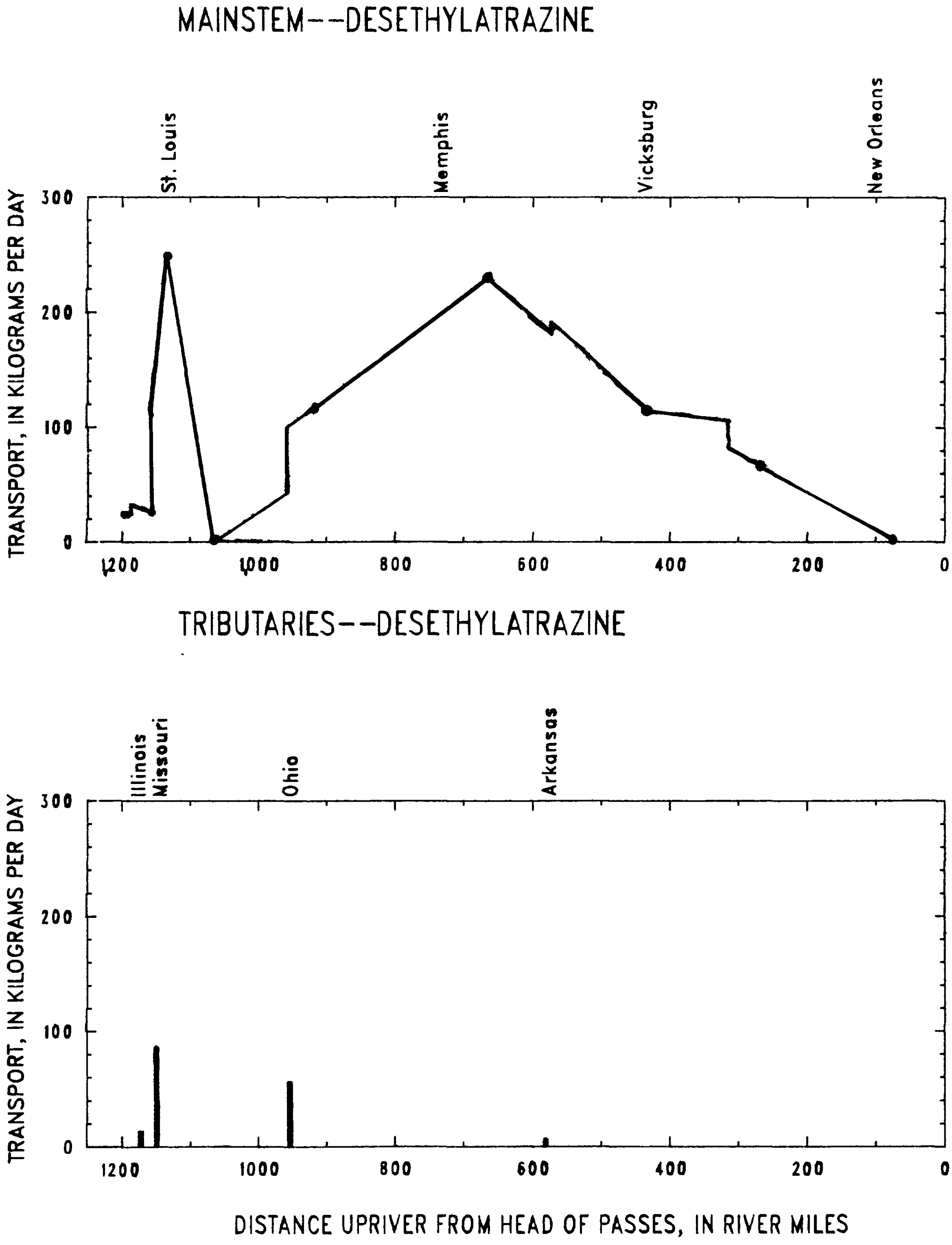


Figure 4.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 18 and August 9, 1987.

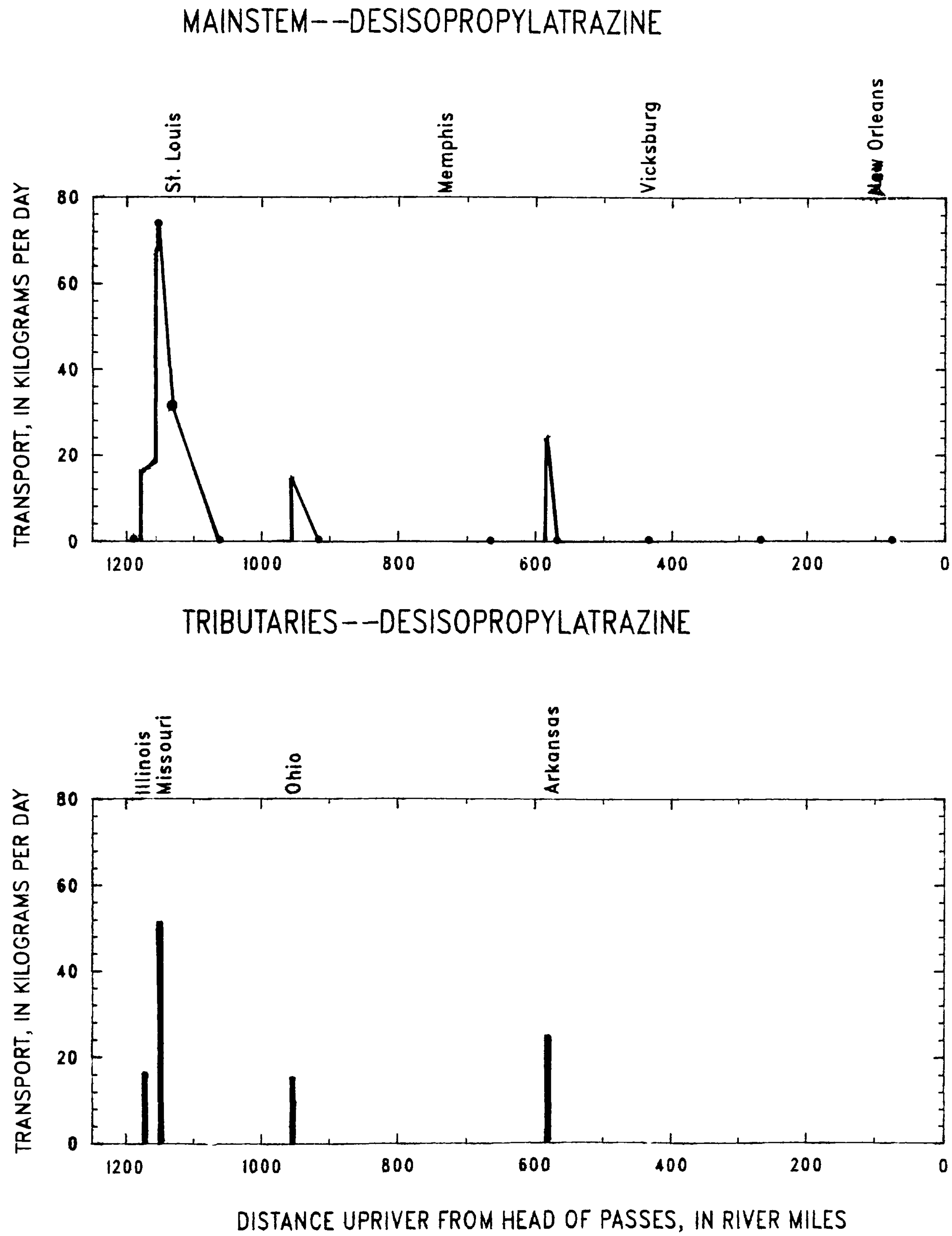


Figure 5.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 18 and August 9, 1987.

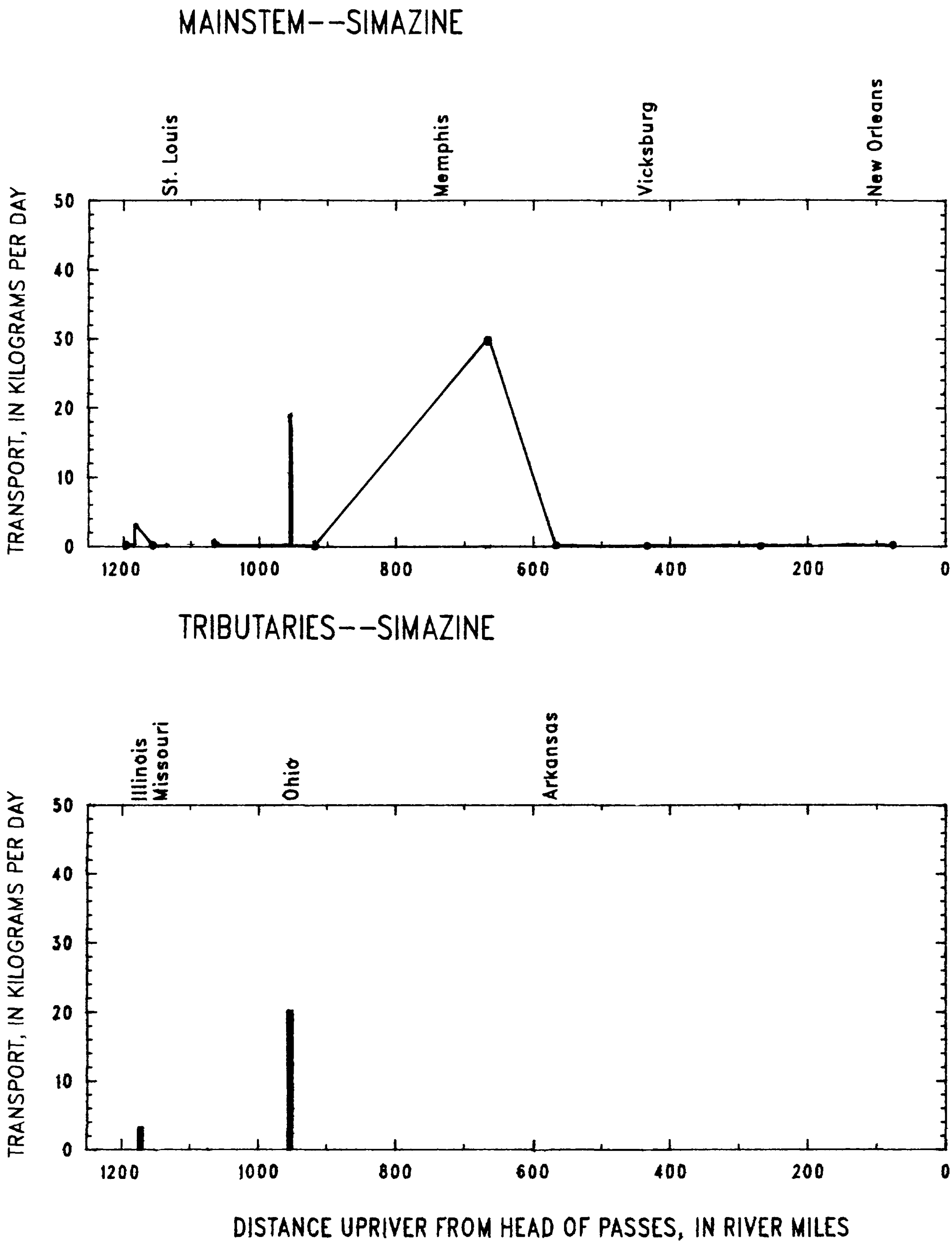


Figure 6.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 18 and August 9, 1987.

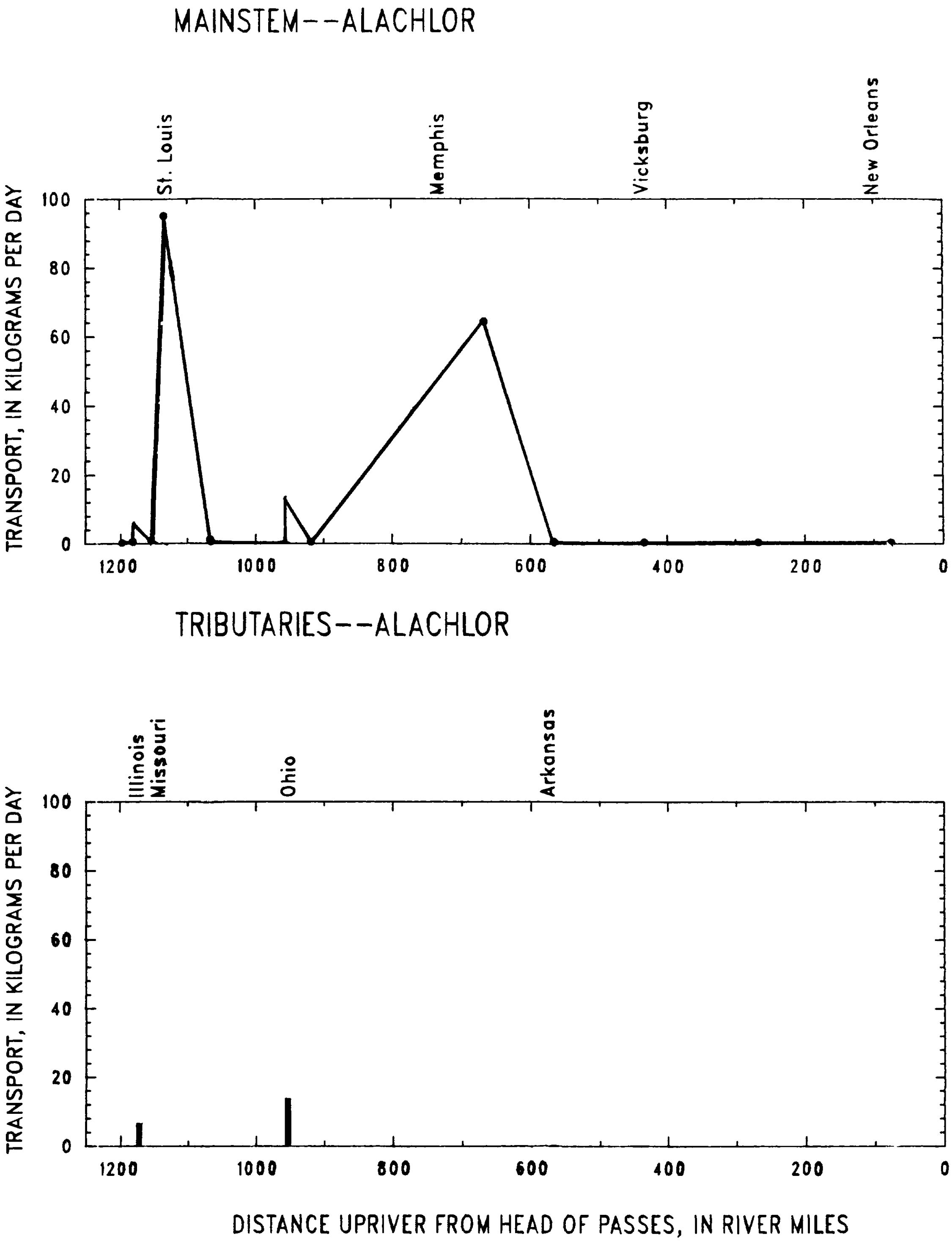


Figure 7.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 18 and August 9, 1987.

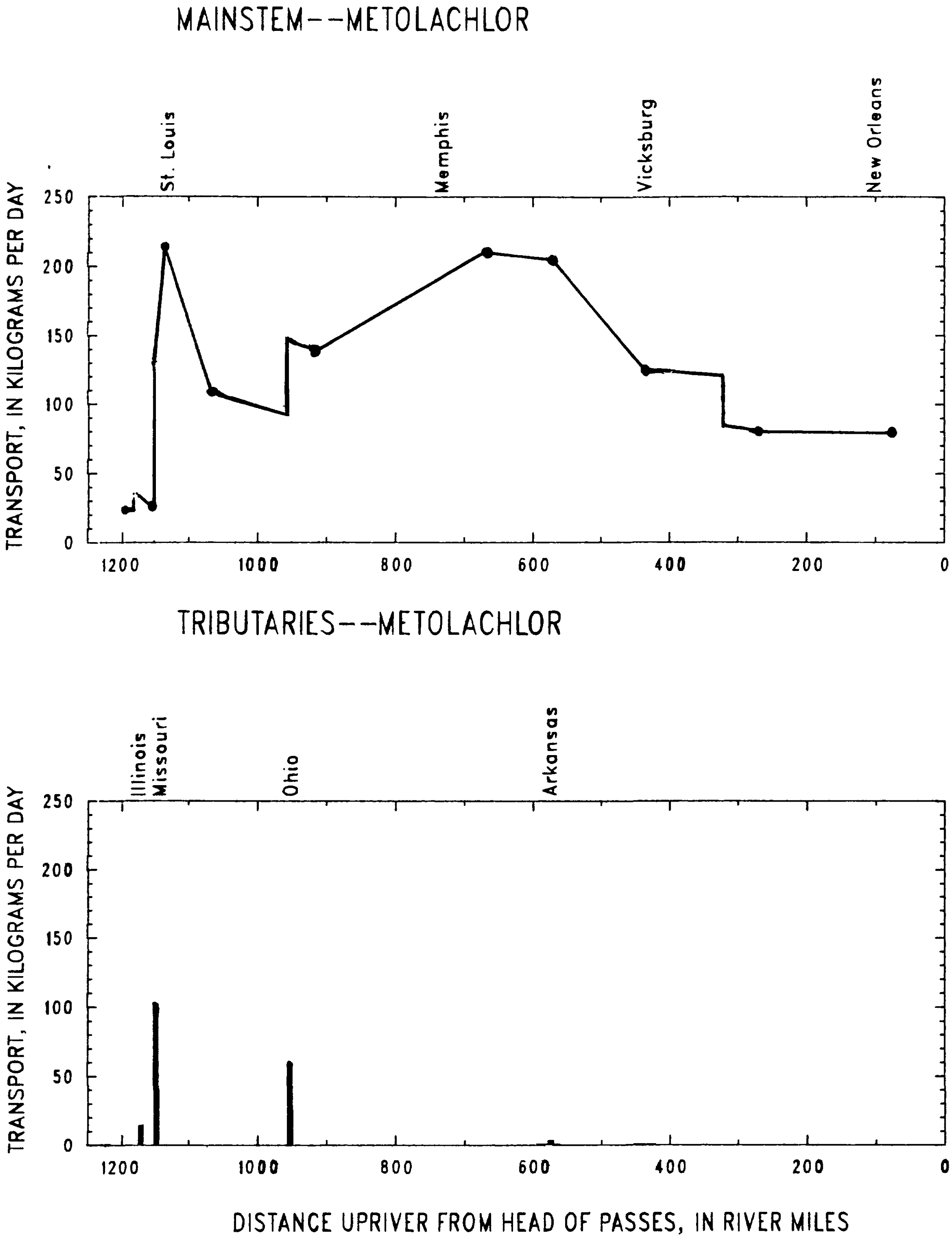


Figure 8.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 18 and August 9, 1987.

Table 8.--Concentrations of triazine and chloroacetanilide of herbicides and their degradation products in the Mississippi River and some of its tributaries for November-December 1987 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected; --, not measured]

Date 1987	Site name	Water discharge[1] (m^3/s)	Concentration of triazine and chloroacetanilide herbicides, in ng/L					
			Atrazine	Desethyl-atrazine	Desiso-propyl-atrazine	Simazine	Alachlor	Metolachlor
11–30	Mississippi R. near Winfield, Mo.	2,040	130	61	ND	50	99	47
11–29	Illinois R. below Meredosia, Ill.	262	150	66	ND	17	91	61
12–02	Missouri R. at St. Charles, Mo.	2,810	300	48	ND	8	18	170
12–03	Mississippi R. at St. Louis, Mo.	5,440	240	60	ND	14	79	160
12–05	Mississippi R. at Thebes, Ill.	5,190	240	54	12	13	77	120
12–06	Ohio R. at Olmsted, Ill.	4,200	170	55	ND	35	12	52
12–07	Mississippi R. below Hickman, Ky.[2]	8,820	250	69	19	23	56	100
			270	72	ND	20	57	110
12–08	Mississippi R. at Fulton, Tenn.	9,470	250	61	14	18	56	100
12–11	Mississippi R. at Helena, Ark.	8,770	200	54	ND	16	39	90
12–13	Mississippi R. above Arkansas City, Ark.	9,920	250	54	10	29	43	110
12–14	Yazoo R. at Mile 10, Miss.	177	92	ND	ND	13	8	27
12–14	Steele Bayou at Mile -0.5, Miss.[3]	--	38	ND	ND	12	ND	92
12–15	Mississippi R. below Vicksburg, Miss.	10,410	240	56	ND	32	44	97
12–17	Old R. Outflow Channel near Knox Landing, La.	1,830	220	42	ND	18	34	86
12–18	Mississippi R. near St. Francisville, La.	8,180	220	47	ND	25	34	84
12–20	Mississippi R. below Belle Chasse, La.	9,560	240	46	11	39	26	77

[1]Discharges are listed by Moody and Meade (1992).
[2]Duplicate sample collected.
[3]Discharge was not measured.

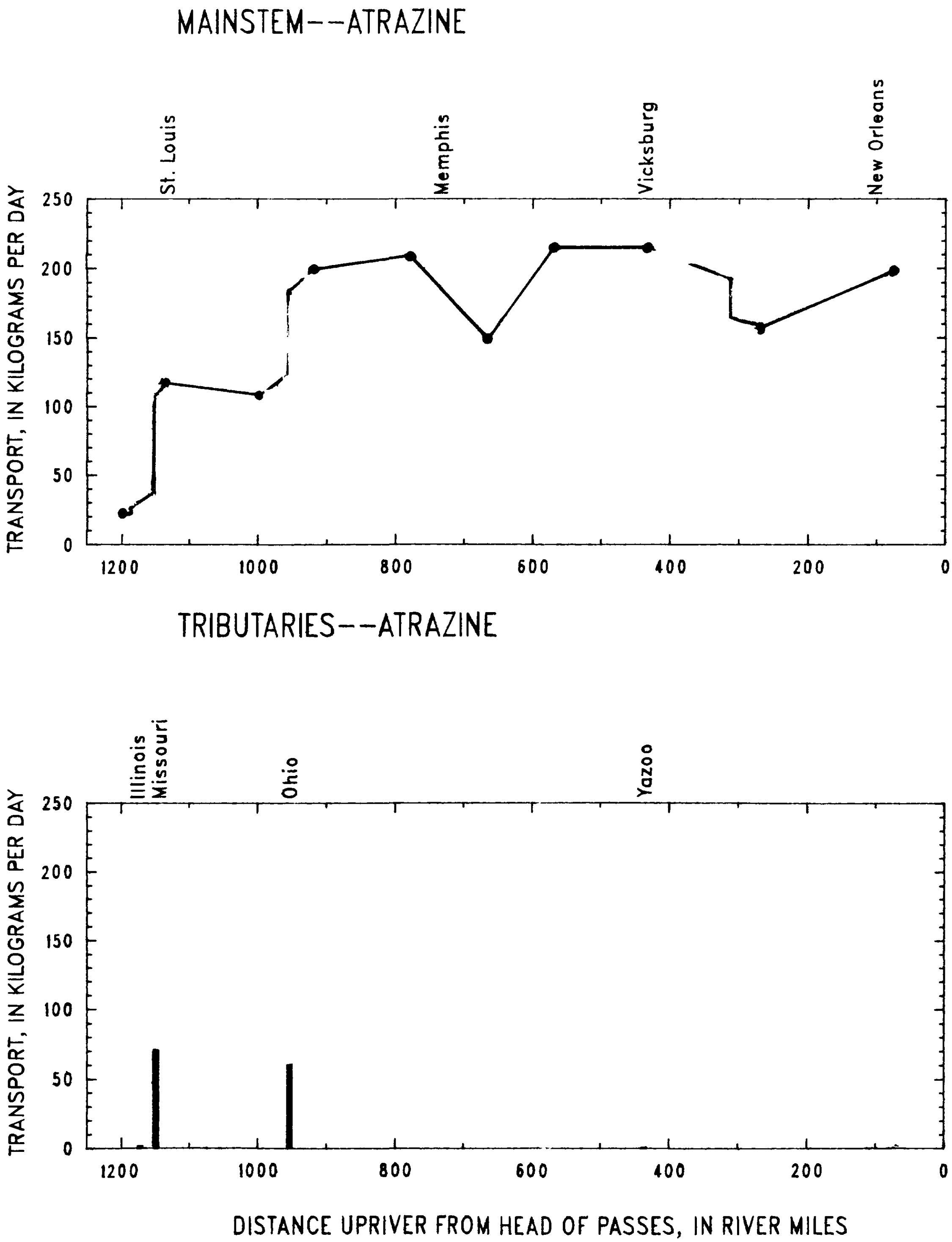


Figure 9.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

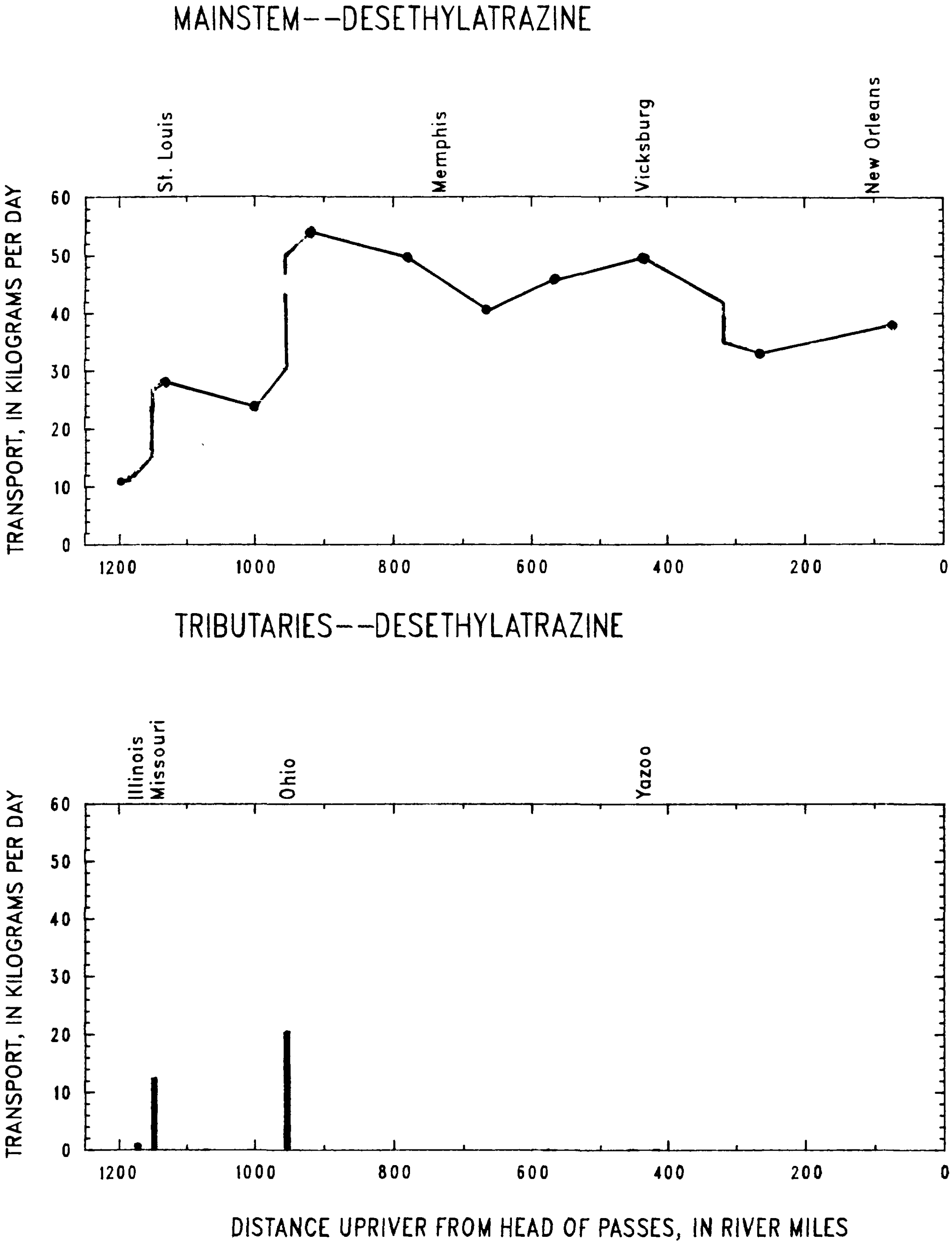


Figure 10.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

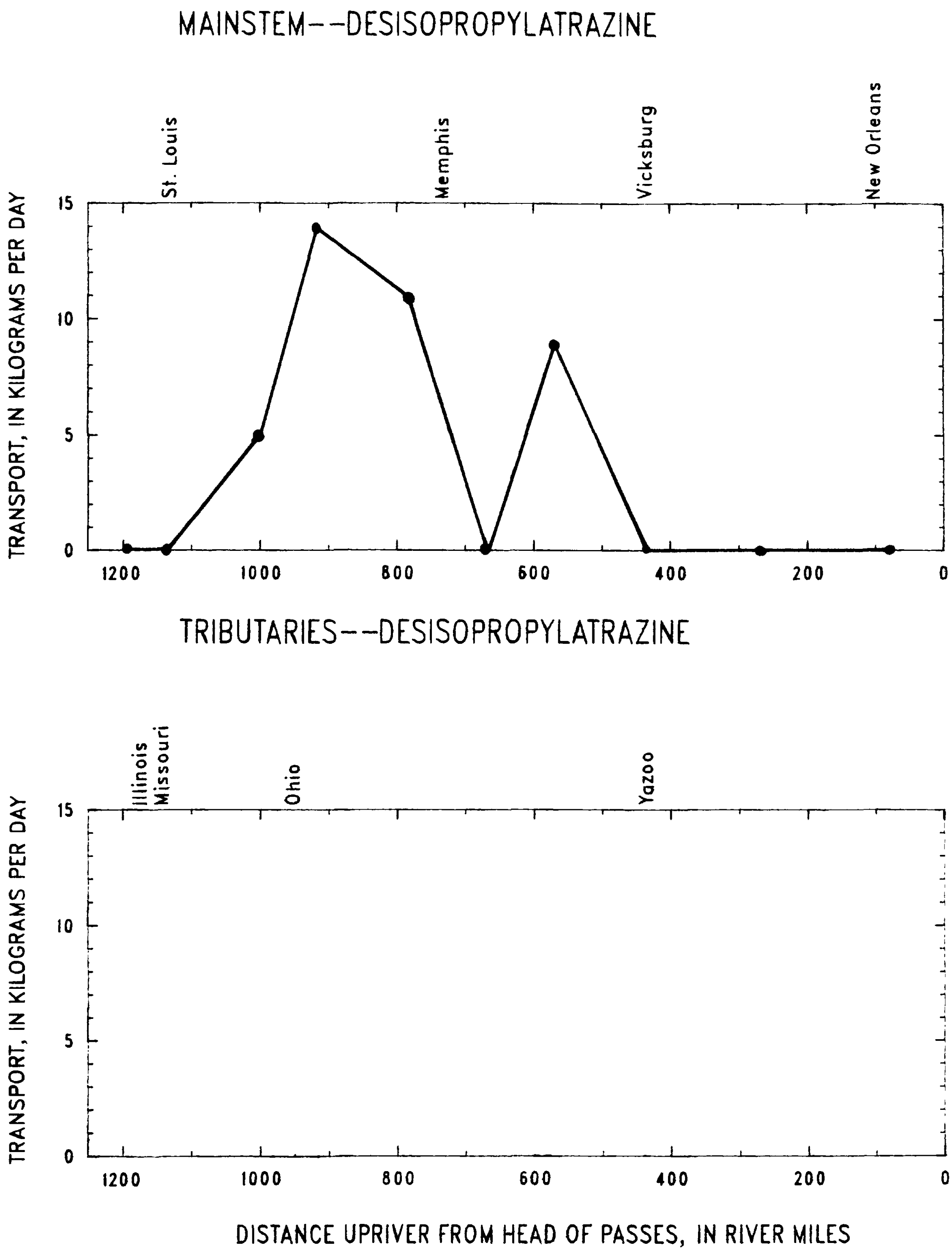


Figure 11.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

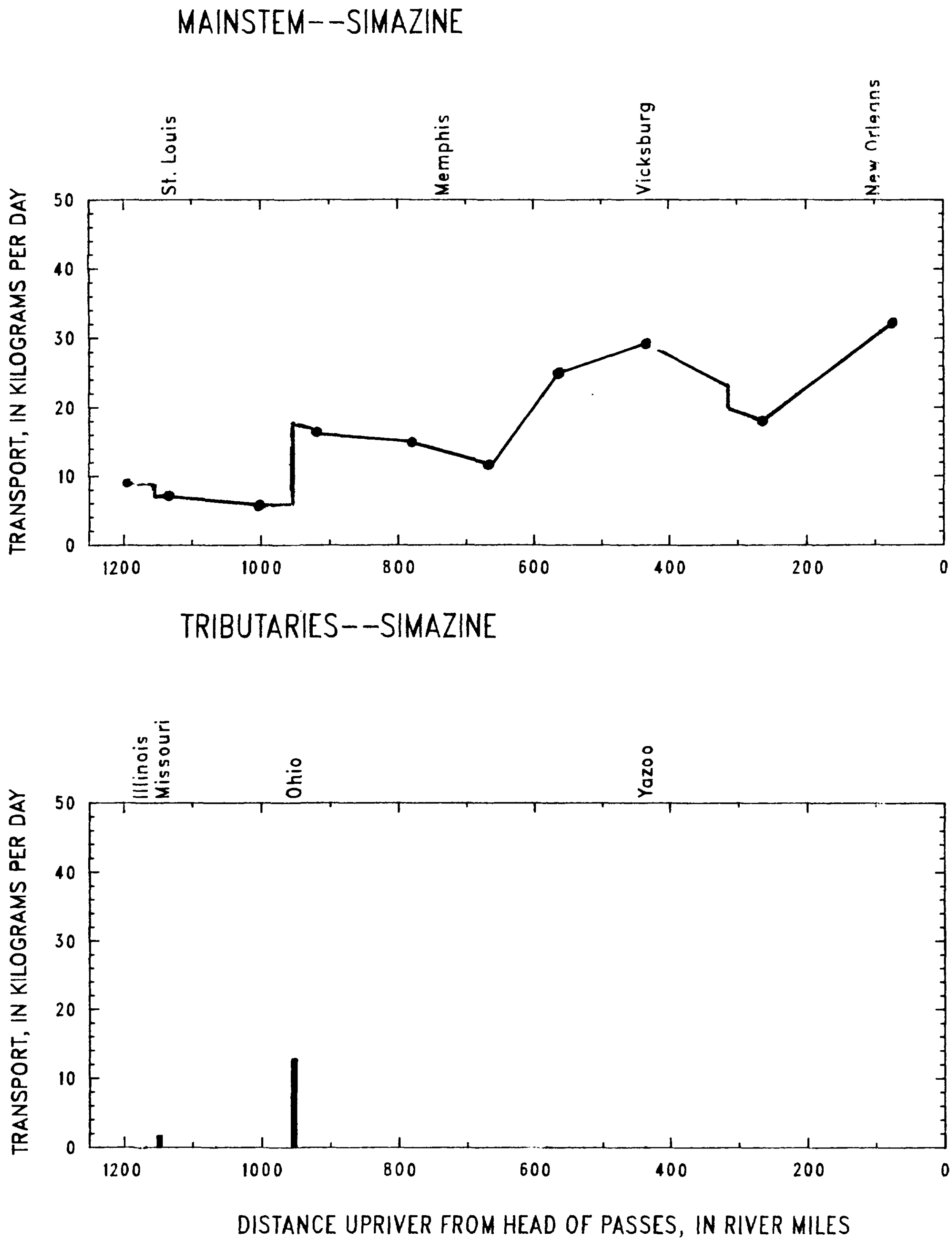


Figure 12.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

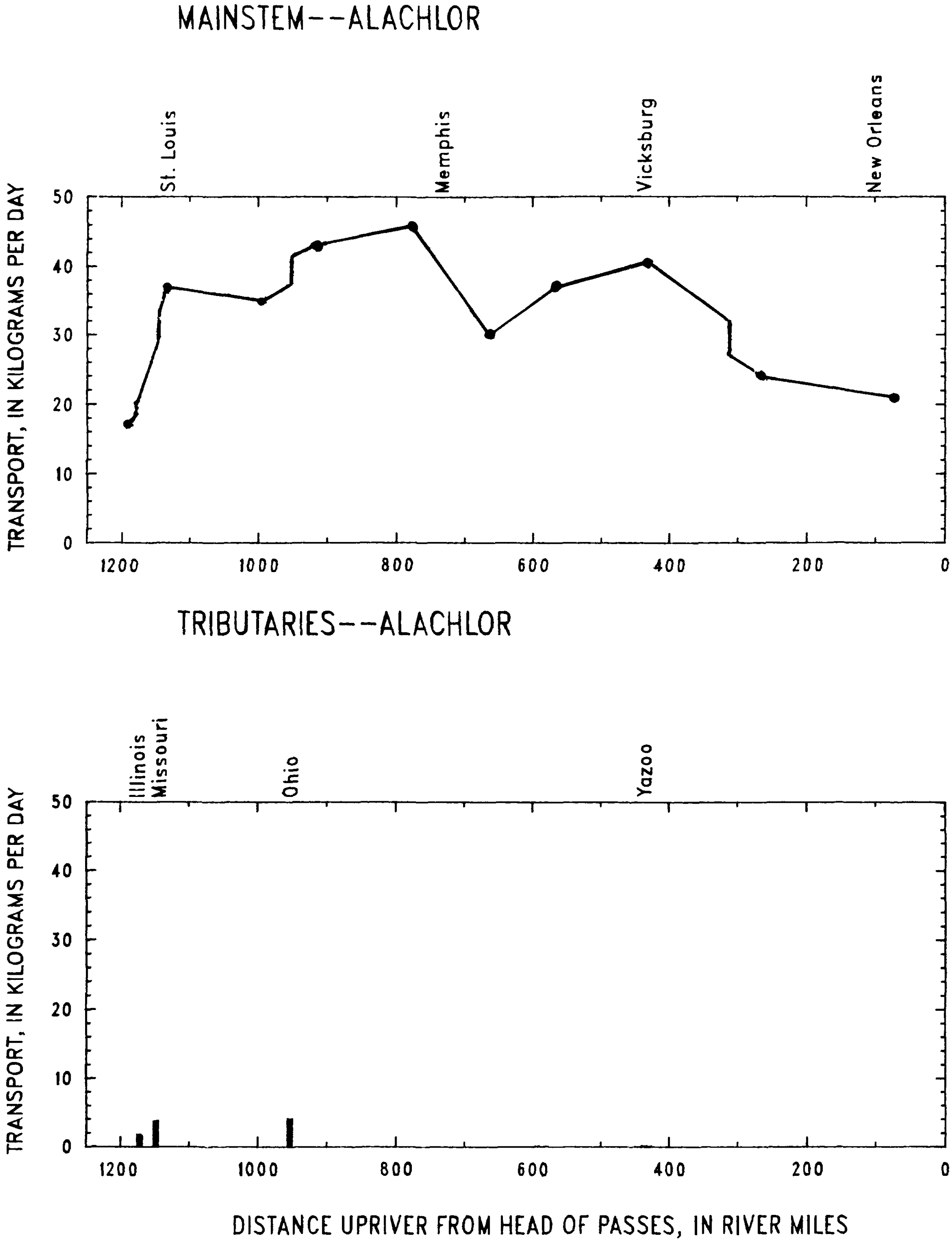


Figure 13.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

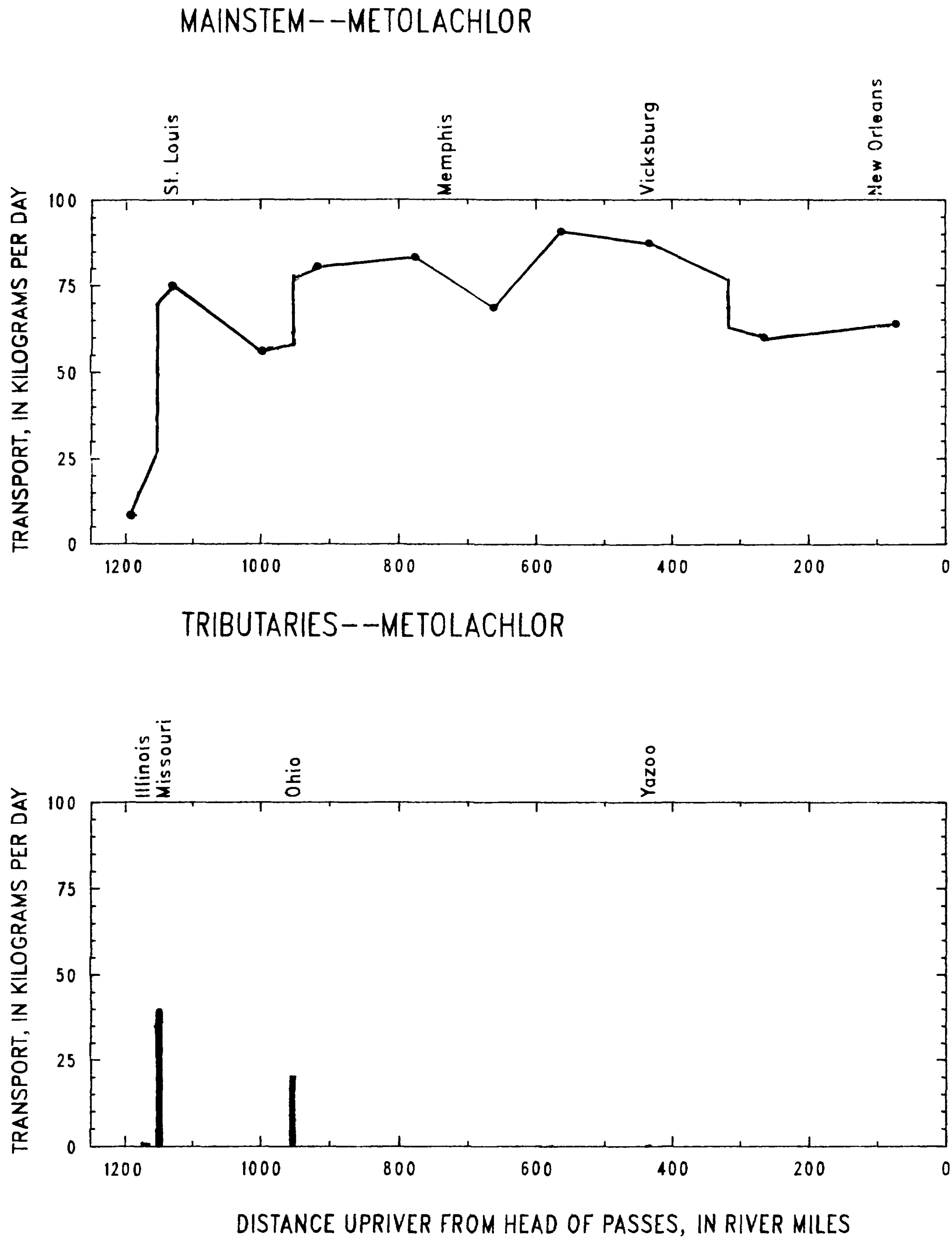


Figure 14.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

Table 9.--Concentrations of organic contaminants in the Mississippi River and some of its tributaries for November–December 1987 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1987	Site name	Water discharge[1] (m^3/s)	Concentration of organic contaminant, in ng/L	
			2,6-diethylaniline	1,3,5-trimethyl-2,4,6-triazinetrione
11–30	Mississippi R. near Winfield, Mo.	2,040	ND	ND
11–29	Illinois R. below Meredosia, Ill.	262	ND	ND
12–02	Missouri R. at St. Charles, Mo.	2,810	ND	ND
12–03	Mississippi R. at St. Louis, Mo.	5,440	640	ND
12–05	Mississippi R. at Thebes, Ill.	5,190	460	ND
12–06	Ohio R. at Olmsted, Ill.	4,200	ND	68
12–07	Mississippi R. below Hickman, Ky.[2]	8,820	300	36
			340	34
12–08	Mississippi R. at Fulton, Tenn.	9,470	190	53
12–11	Mississippi R. at Helena, Ark.	8,770	170	44
12–13	Mississippi R. above Arkansas City, Ark.	9,920	110	26
12–14	Yazoo R. at Mile 10, Miss.	177	ND	ND
12–14	Steel Bayou at Mile ~0.5, Miss.[3]	--	ND	ND
12–15	Mississippi R. below Vicksburg, Miss.	10,410	150	42
12–17	Old R. Outflow Channel near Knox Landing, La.	1,830	190	47
12–18	Mississippi R. near St. Francisville, La.	8,180	120	39
12–20	Mississippi R. below Belle Chasse, La.	9,560	ND	53

[1]Discharge are listed by Moody and Meade (1992).
[2]Duplicate sample collected.
[3]Discharge was not measured.

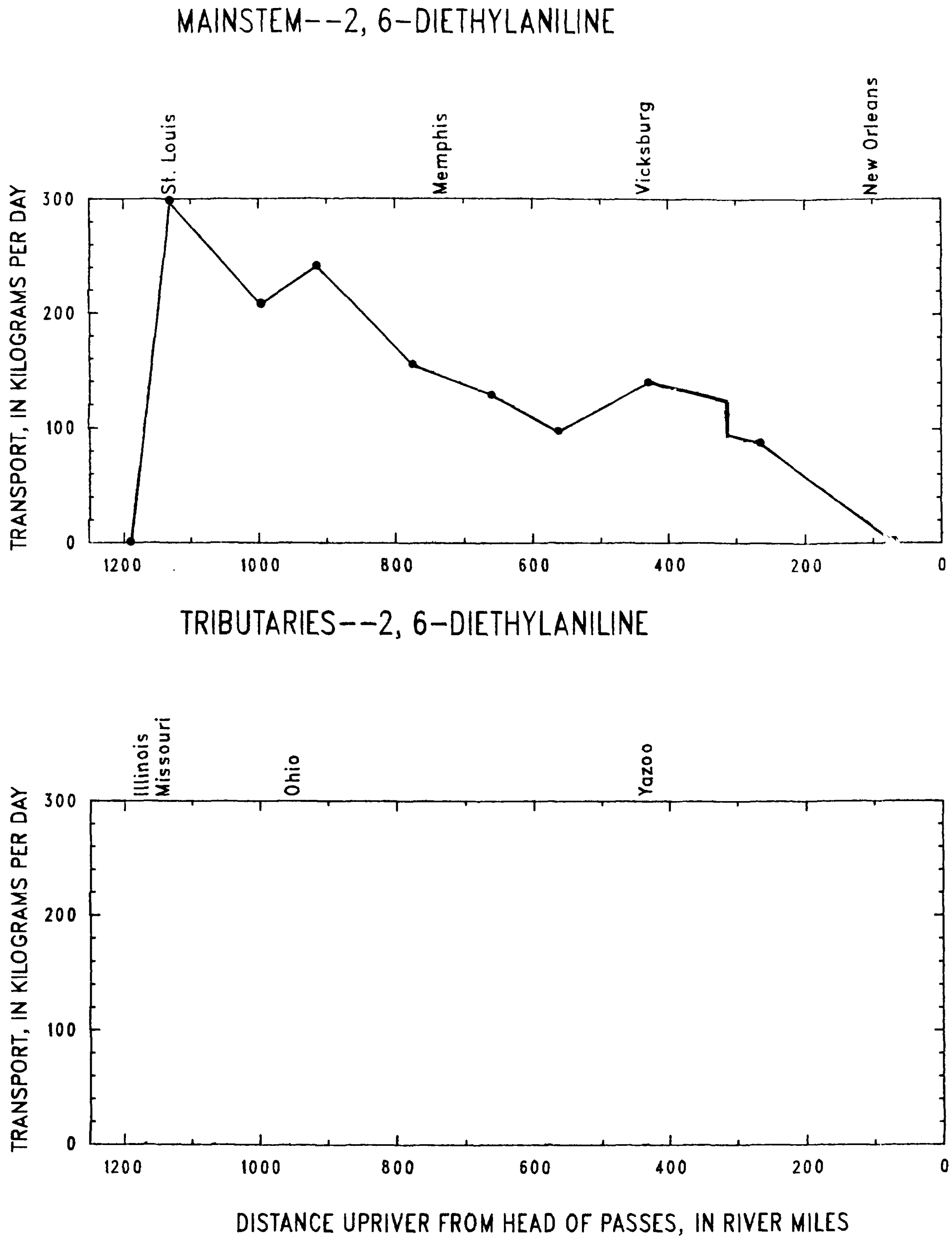


Figure 15.--Transport of 2,6-diethylaniline in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

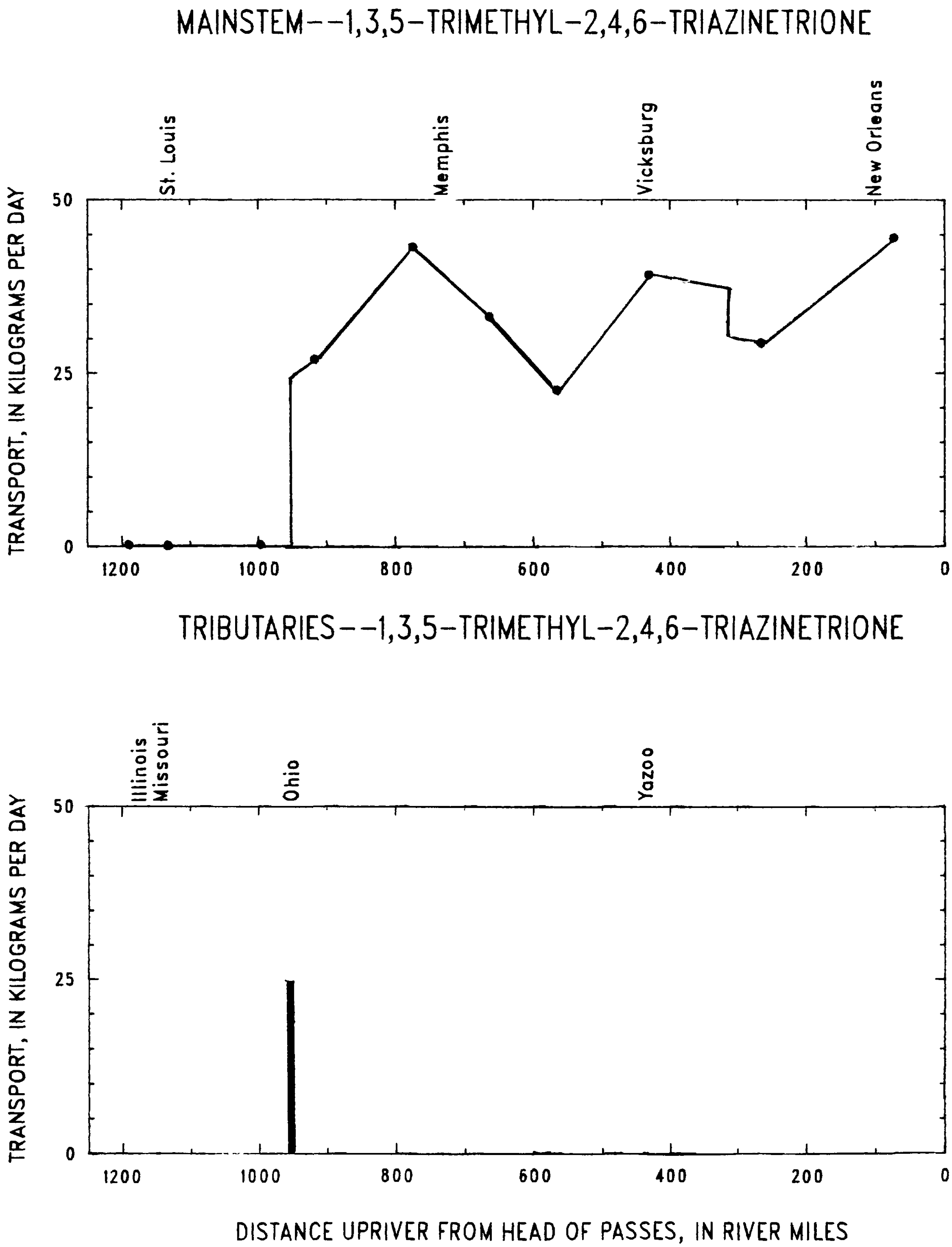


Figure 16.--Transport of 1,3,5-trimethyl-2,4,6-triazinetrione in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between November 29 and December 20, 1987.

Table 10.--Concentrations of triazine and chloroacetanilide herbicides and their degradation products in the Mississippi River and some of its tributaries for May–June 1988 cruise

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1988	Site name	Water discharge[1] (m^3/s)	Concentration of triazine and chloroacetanilide herbicides, in ng/L								
			Atrazine	Desethylatrazine	Desisopropylatrazine	Cyanazine	Simazine	Alachlor	2-chloro-2',6'-diethylacetanilide	2-hydroxy-2',6'-diethylacetanilide	Metolachlor
5–17	Mississippi R. near Winfield, Mo.	1,740	260	71	ND	33	19	150	ND	15	160
5–16	Illinois R. below Meredosia, Ill.	332	690	82	16	650	66	390	41	ND	220
5–19	Missouri R. at Hermann, Mo.	1,480	620	43	23	560	96	140	ND	ND	270
5–20	Mississippi R. at St. Louis, Mo.[2]	3,350	510	65	32	400	79	800	210	16	220
			470	67	20	450	27	720	180	19	240
			500	69	23	420	76	720	150	52	230
5–22	Mississippi R. at Thebes, Ill.	3,590	520	67	22	360	34	900	350	28	220
5–23	Ohio R. at Olmsted, Ill.[2]	3,230	260	40	27	43	78	36	ND	6	72
			260	33	24	80	81	35	ND	9	79
			270	40	45	93	80	43	11	ND	98
5–24	Mississippi R. below Hickman, Ky.	6,790	440	58	14	210	59	390	110	ND	160
5–26	Mississippi R. at Fulton, Tenn.[2]	7,170	500	66	19	140	57	540	240	10	160
			500	56	17	170	59	560	230	20	170
			490	66	22	200	130	600	250	ND	170
5–28	Mississippi R. at Helena, Ark.	7,050	480	48	12	160	46	510	180	6	160
5–29	White R. at Mile 11.5, Ark.	438	67	11	17	ND	ND	6	6	ND	46
5–30	Mississippi R. above Arkansas City, Ark.	8,160	510	67	16	210	50	390	120	9	170
6–01	Yazoo R. at Mile 10, Miss.	73	230	7	10	17	6	41	6	35	97
6–02	Mississippi R. below Vicksburg, Miss.	7,950	440	59	21	140	41	340	82	18	150
6–04	Old R. Outflow Channel near Knox Landing, La.	2,150	480	54	15	220	51	350	140	6	150
6–05	Mississippi R. near St. Francisville, La.	5,700	480	51	12	150	52	310	89	10	150
6–07	Mississippi R. below Belle Chasse, La.	5,570	340	49	35	50	21	210	60	ND	110

[1]Discharges are listed by Moody and Meade (1992).

[2]Triplicate samples collected.

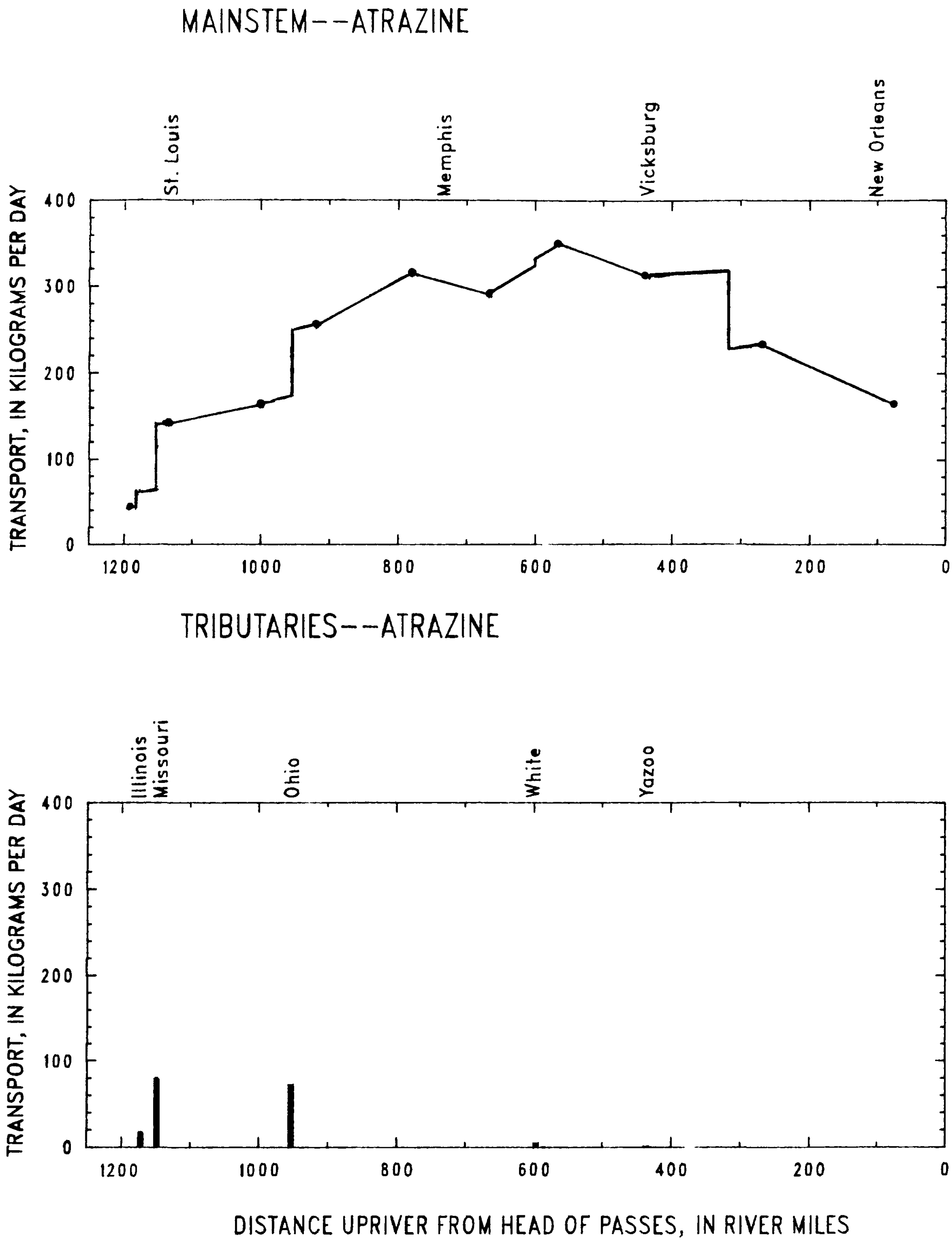


Figure 17.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

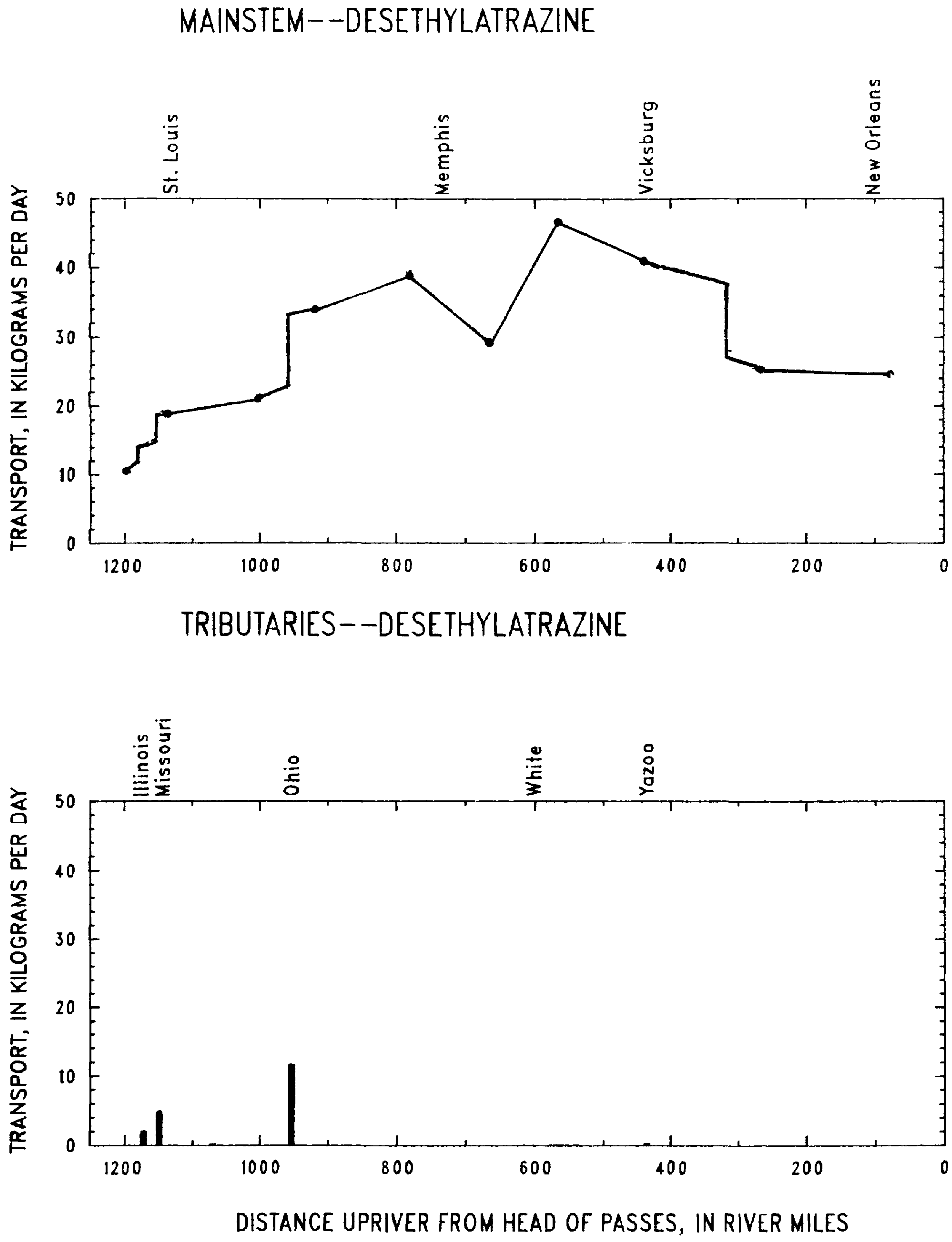


Figure 18.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

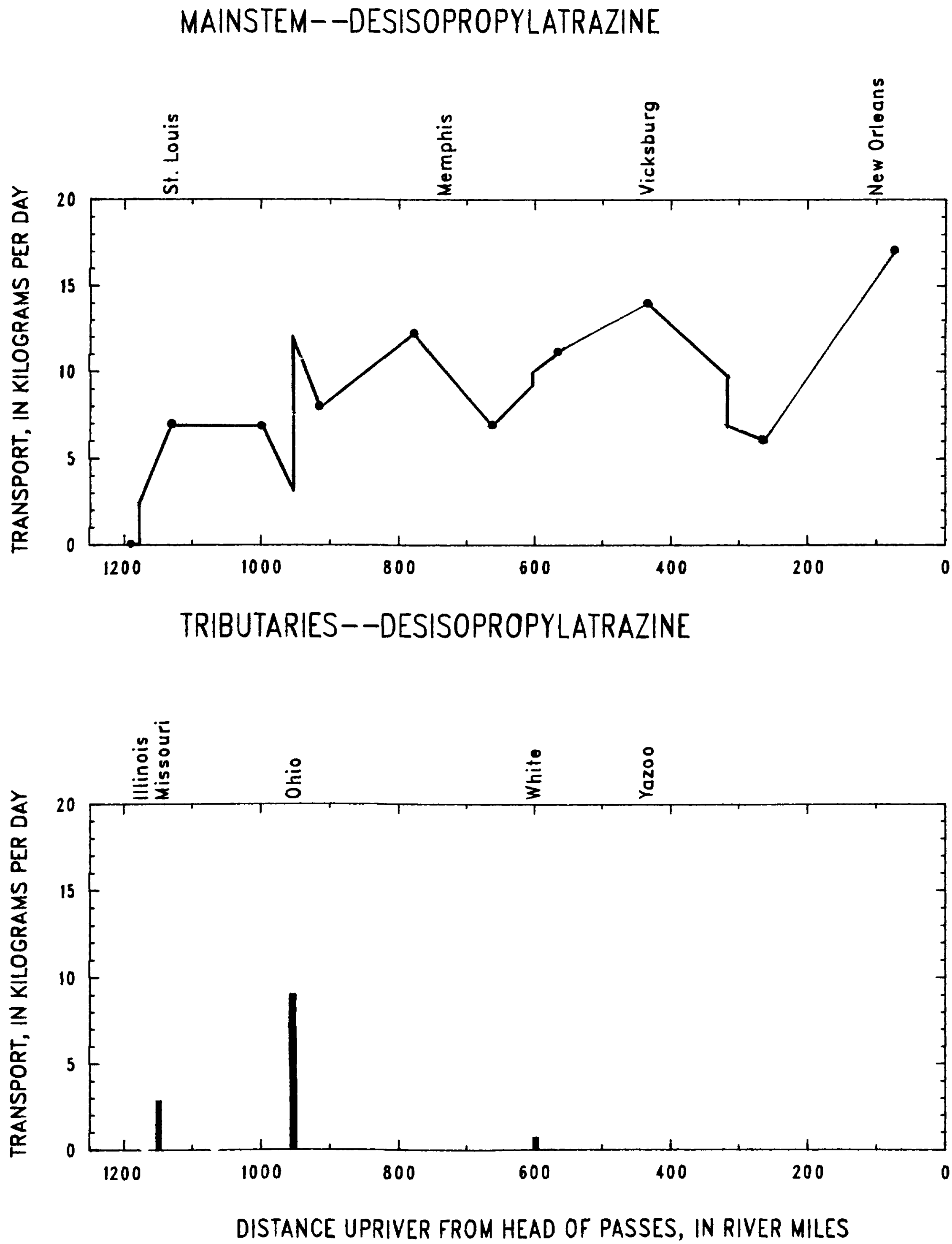


Figure 19.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

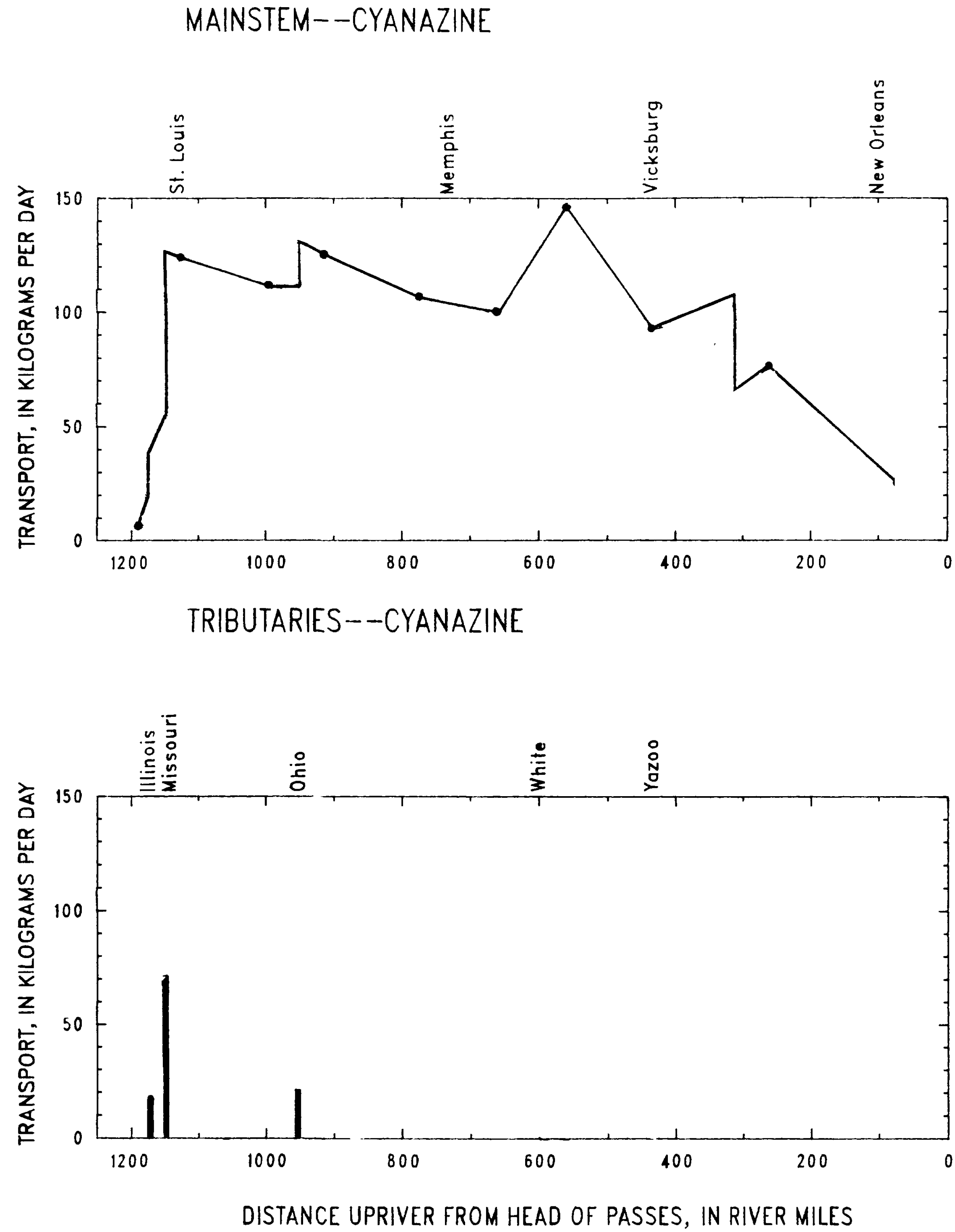


Figure 20.--Transport of cyanazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

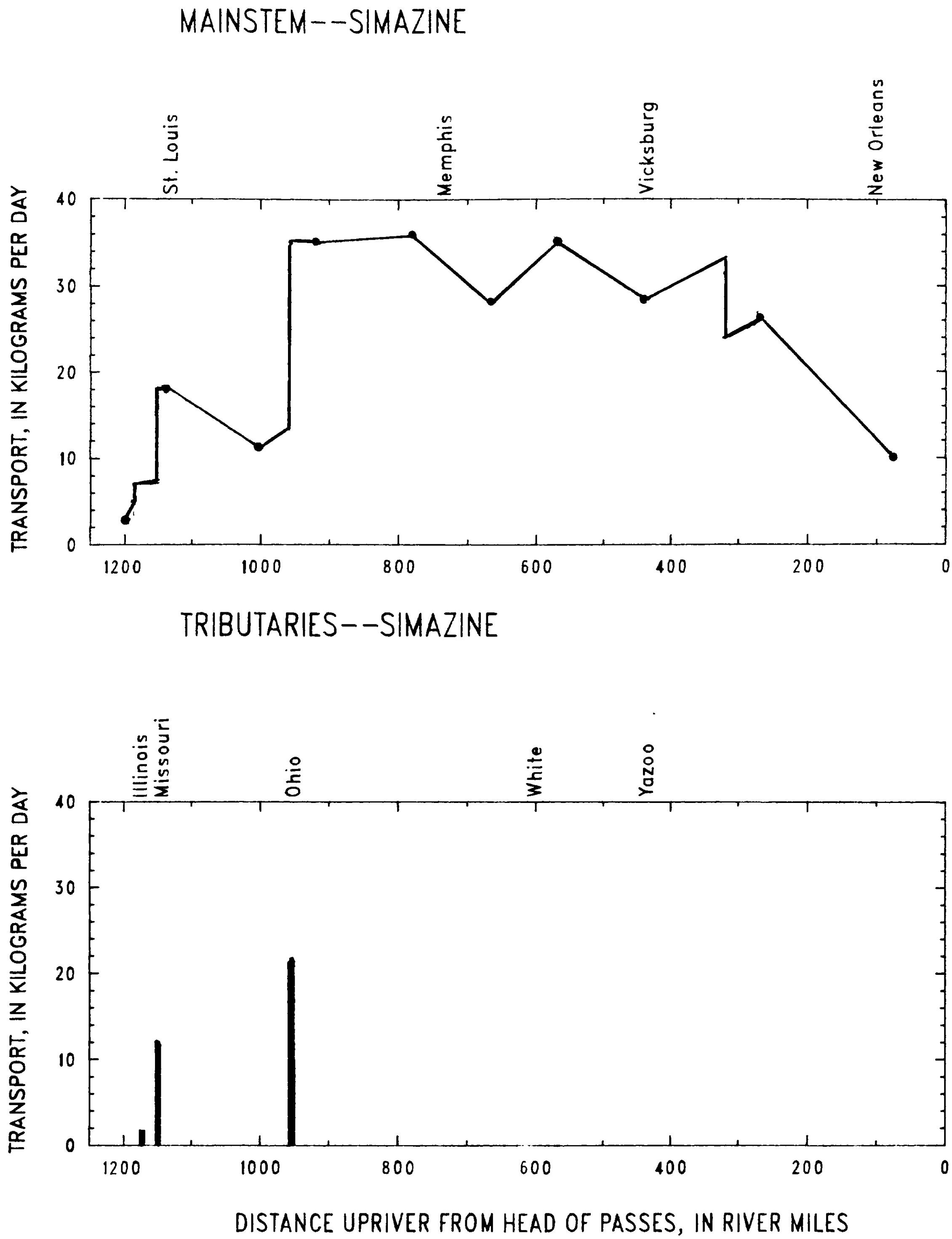


Figure 21.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

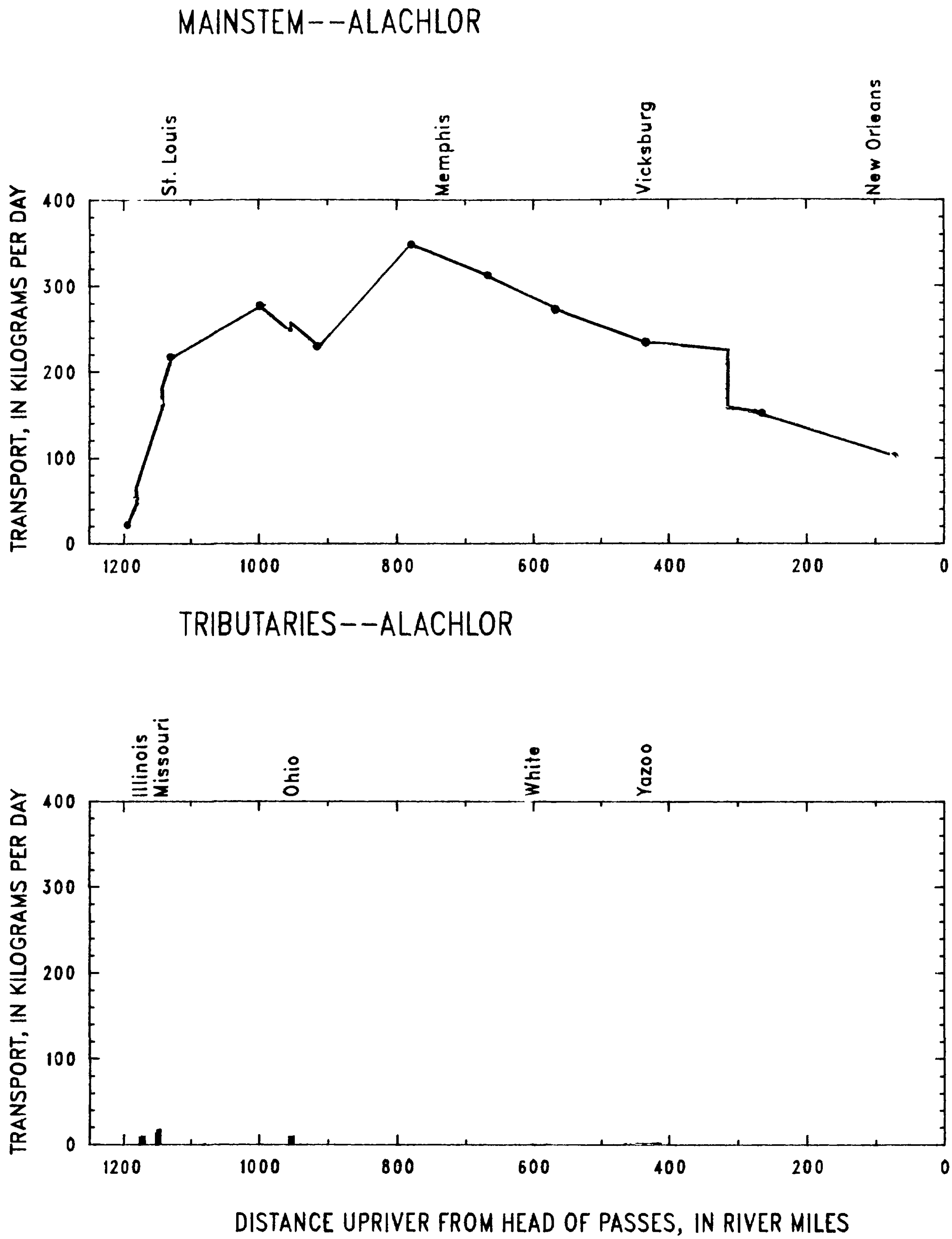


Figure 22.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

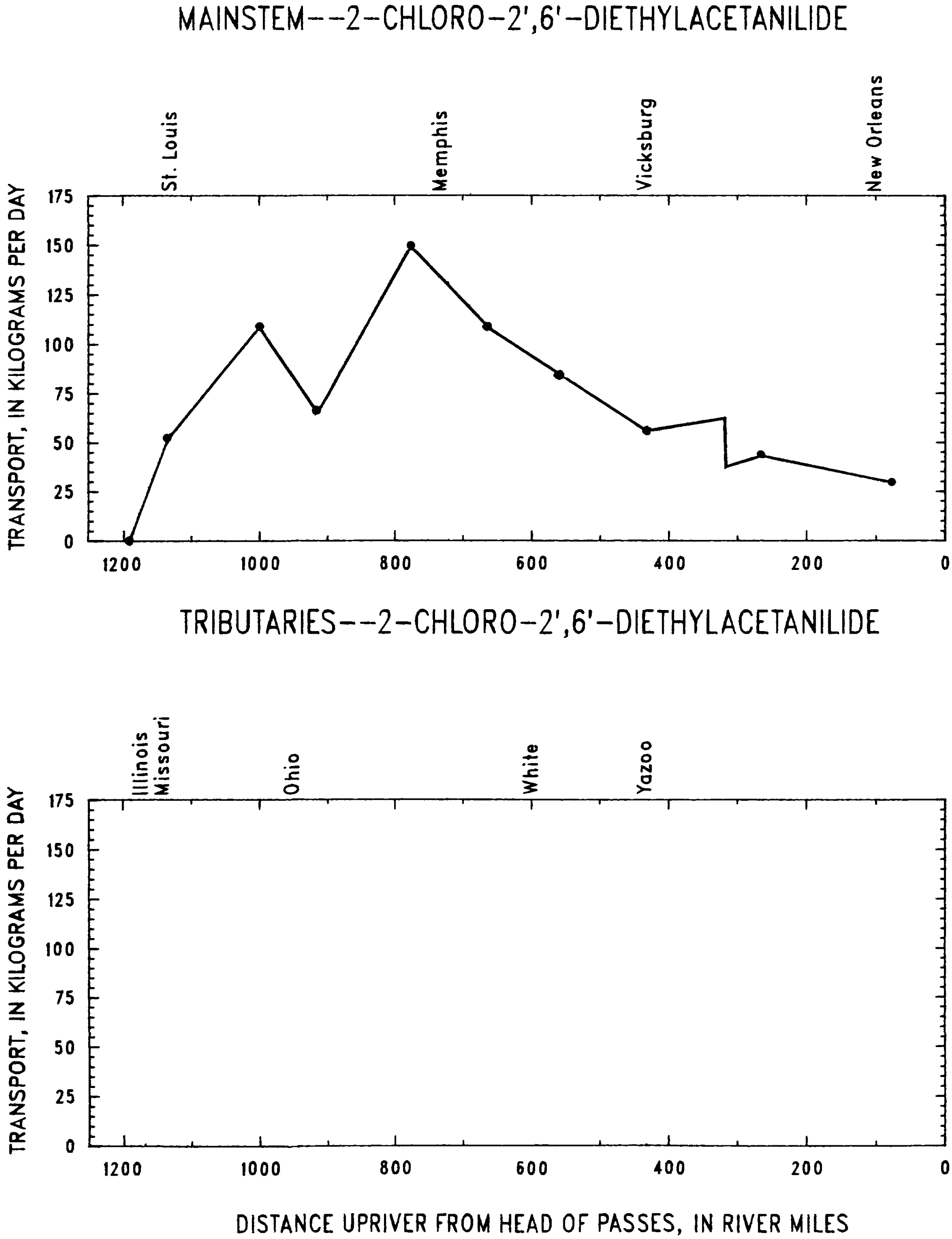


Figure 23.--Transport of 2-chloro-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

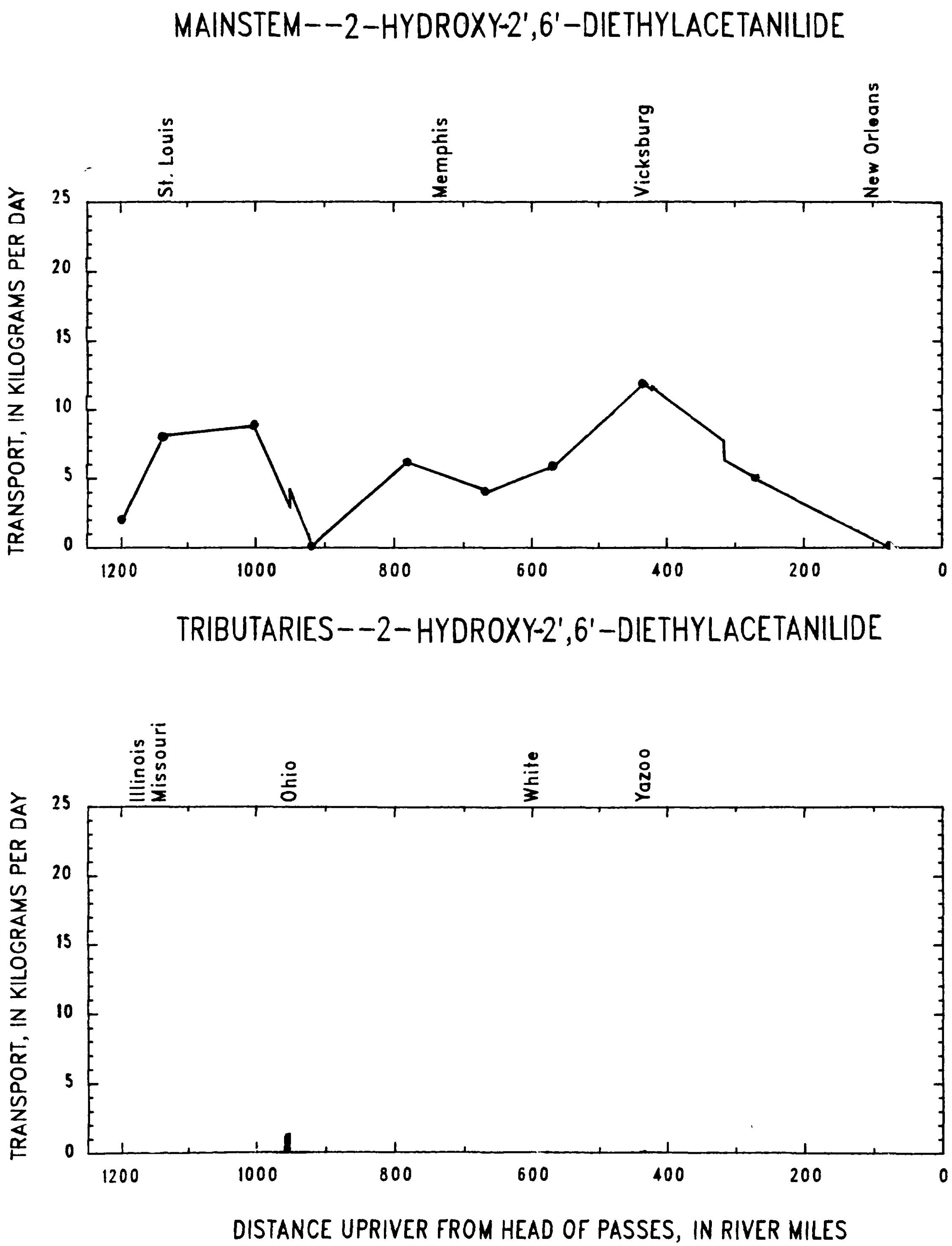


Figure 24.--Transport of 2-hydroxy-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

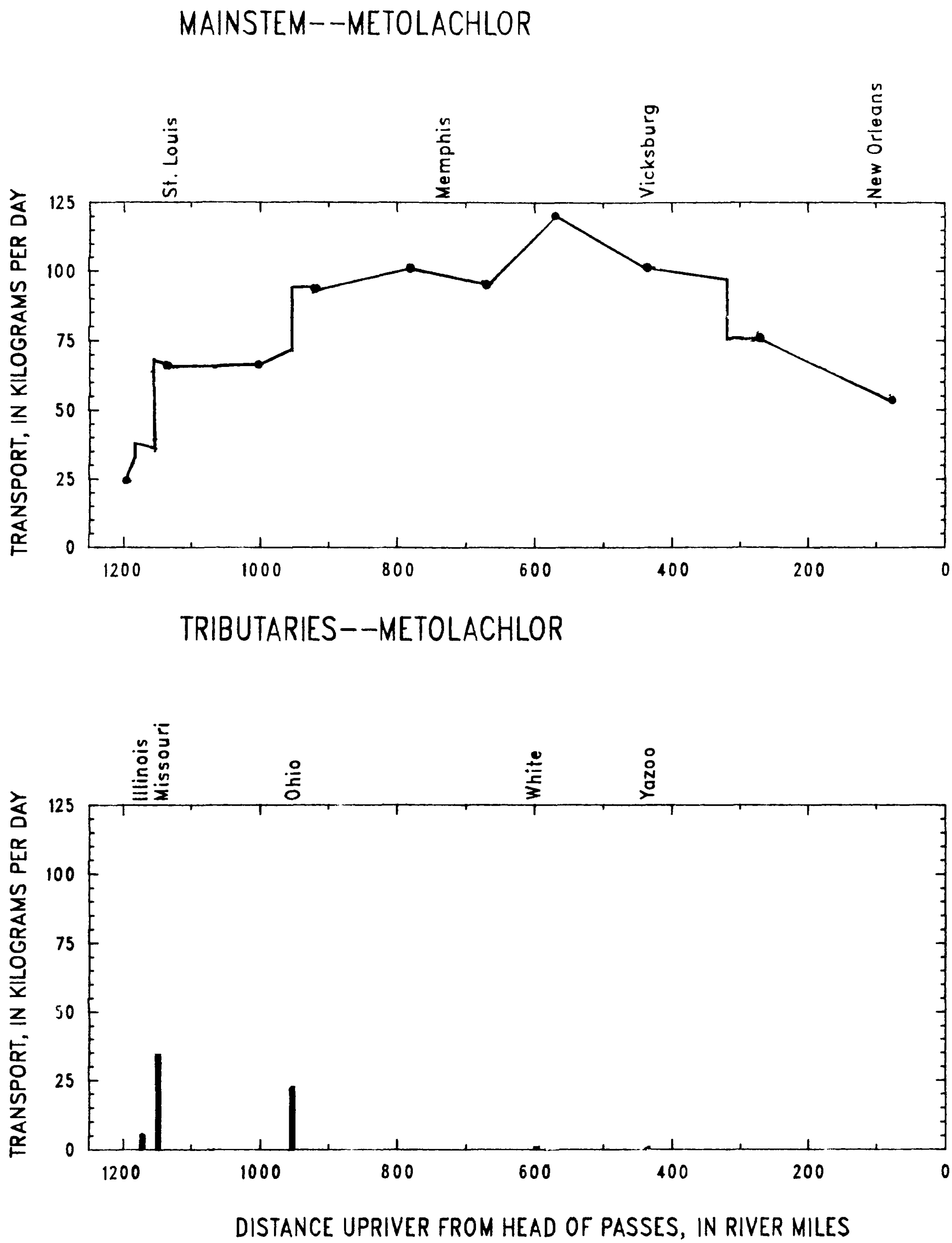


Figure 25.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

Table 11.--Concentrations of organic contaminants in the Mississippi River and some of its tributaries for May–June 1988 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1988	Site name	Water discharge[1] (m^3/s)	Concentration of organic contaminant, in ng/L				
			2,6-diethyl-aniline	1,3,5-trimethyl-2,4,6-triazine-trione	Tris-2-chloroethyl-phosphate	Tris-2-chloro-propyl-phosphate isomer A	Tris-2-chloro-propyl-phosphate isomer B
5–17	Mississippi R. near Winfield, Mo.	1,740	6	ND	25	22	27
5–16	Illinois R. below Meredosia, Ill.	332	ND	ND	1,400	1,300	560
5–19	Missouri R. at Hermann, Mo.	1,480	ND	ND	120	18	ND
5–20	Mississippi R. at St. Louis, Mo.[2]	3,350	920	ND	410	300	170
			840	ND	380	280	160
			800	ND	340	290	160
5–22	Mississippi R. at Thebes, Ill.	3,590	180	ND	340	280	150
5–23	Ohio R. at Olmsted, Ill.[2]	3,230	ND	240	29	25	ND
			ND	250	21	ND	ND
			ND	250	23	30	ND
5–24	Mississippi R. below Hickman, Ky.	6,790	250	110	160	170	95
5–26	Mississippi R. at Fulton, Tenn.[2]	7,170	200	93	180	150	100
			130	69	200	160	99
			160	85	200	160	100
5–28	Mississippi R. at Helena, Ark.	7,050	94	53	140	140	86
5–29	White R. at Mile 11.5, Ark.	438	ND	ND	ND	ND	ND
5–30	Mississippi R. above Arkansas City, Ark.	8,160	64	95	179	160	97
6–01	Yazoo R. at Mile 10, Miss.	73	ND	ND	24	13	ND
6–02	Mississippi R. below Vicksburg, Miss.	7,950	36	68	168	140	87
6–04	Old R. Outflow Channel near Knox Landing, La.	2,150	15	83	158	140	74
6–05	Mississippi R. near St. Francisville, La.	5,700	9	79	140	140	74
6–07	Mississippi R. below Belle Chasse, La.	5,570	18	40	150	140	84

[1]Discharges are listed by Moody and Meade (1992).
[2]Triplicate samples collected.

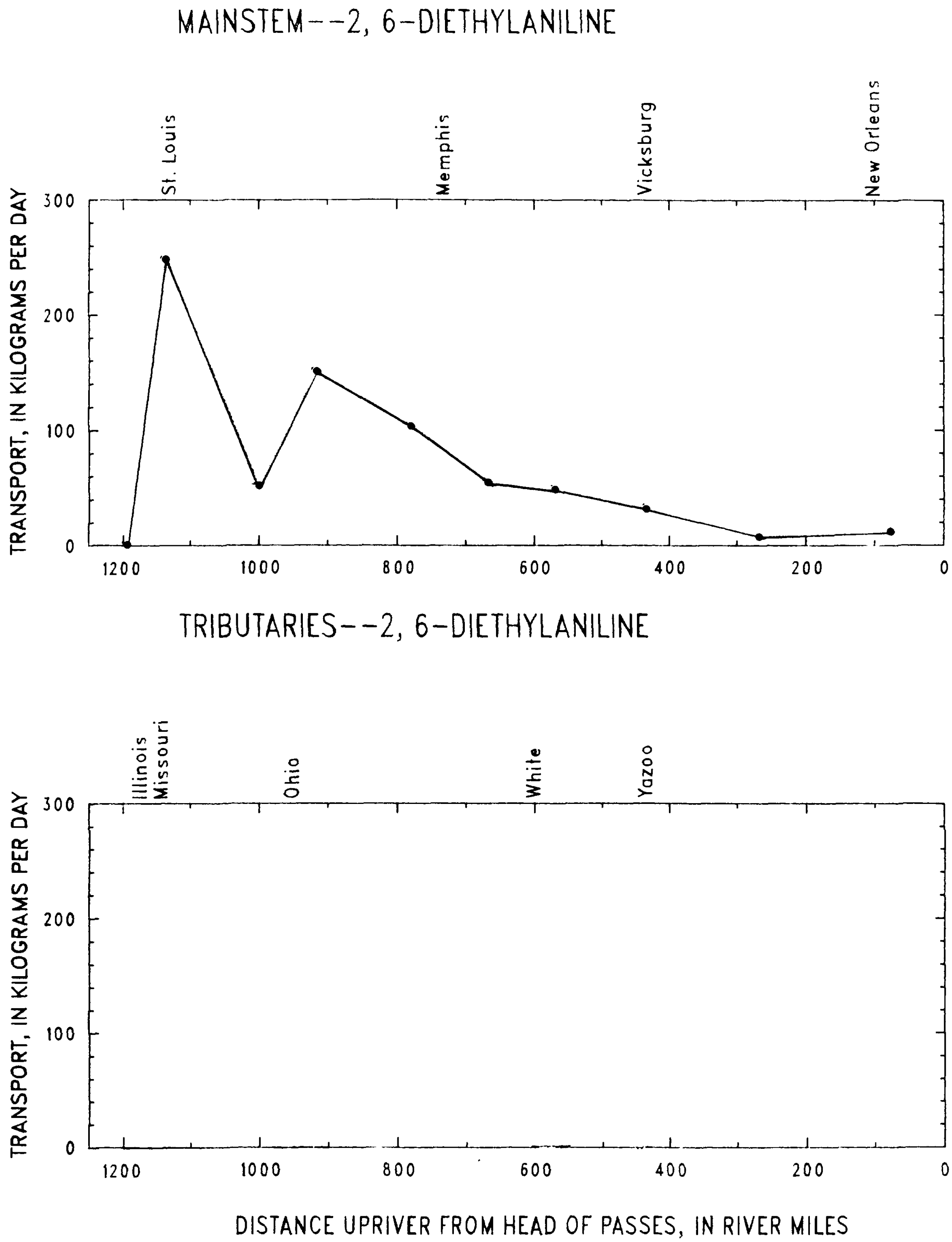


Figure 26.--Transport of 2,6-diethylaniline in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

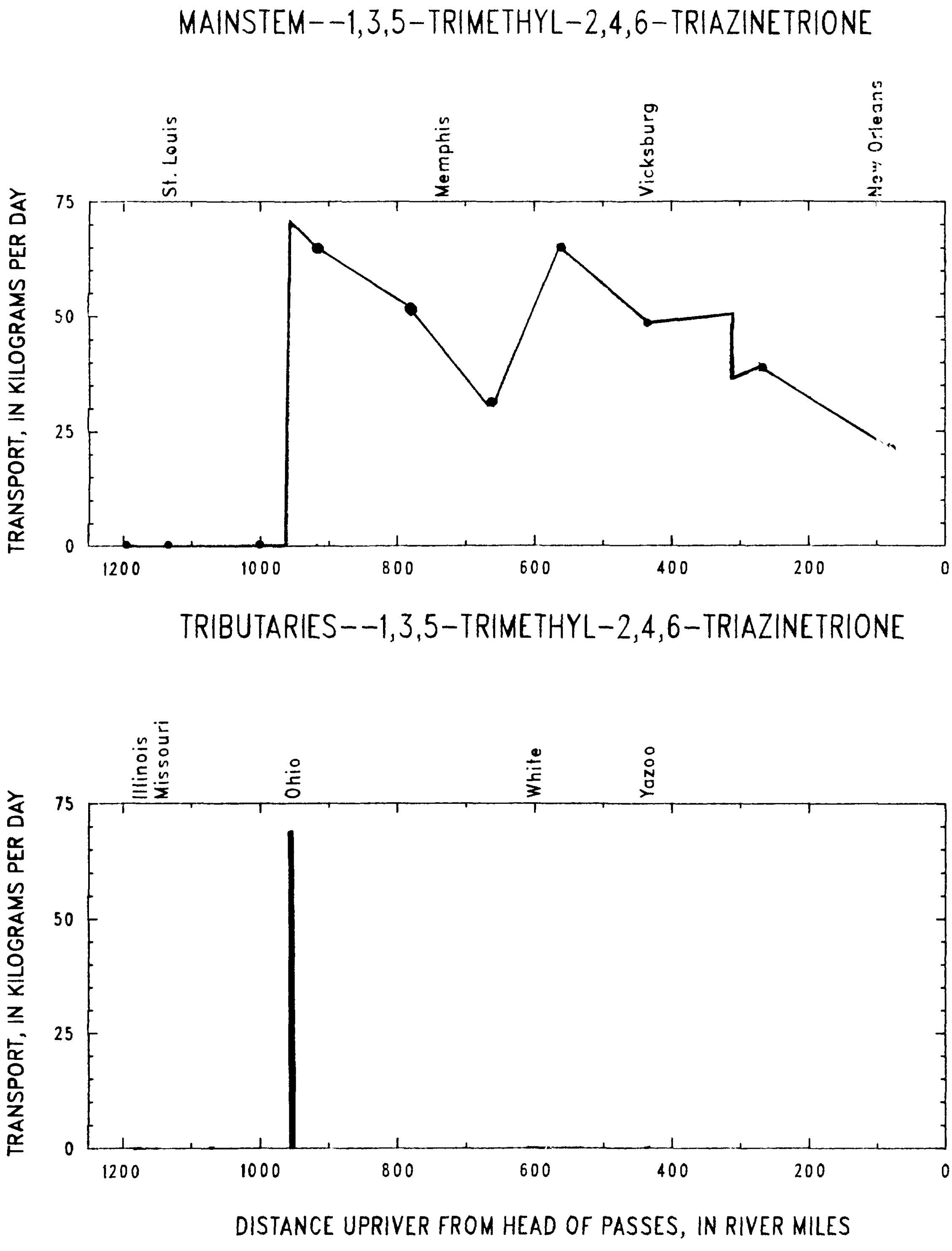


Figure 27.--Transport of 1,3,5-trimethyl-2,4,6-triazinetrione in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

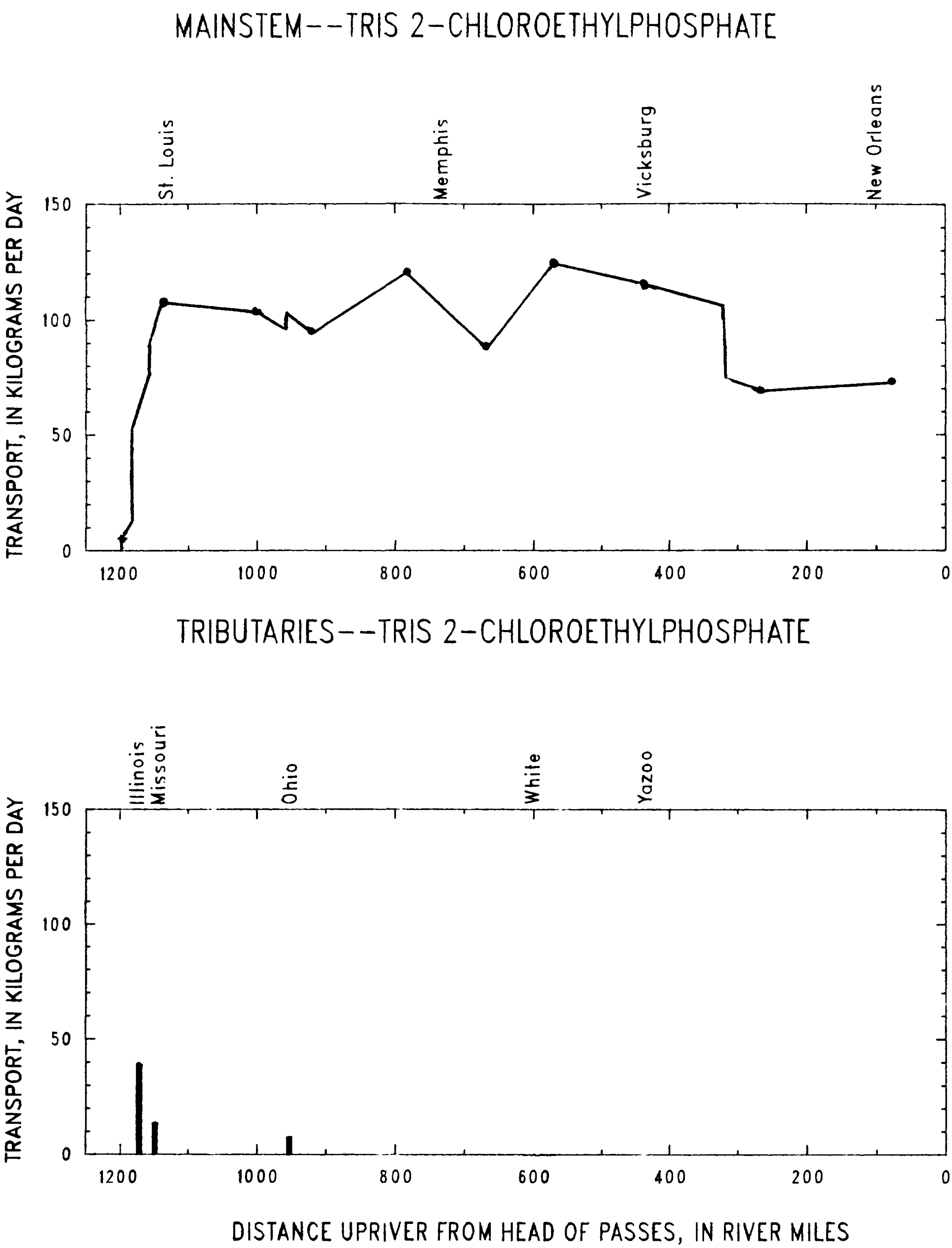


Figure 28.--Transport of tris-2-chloroethylphosphate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

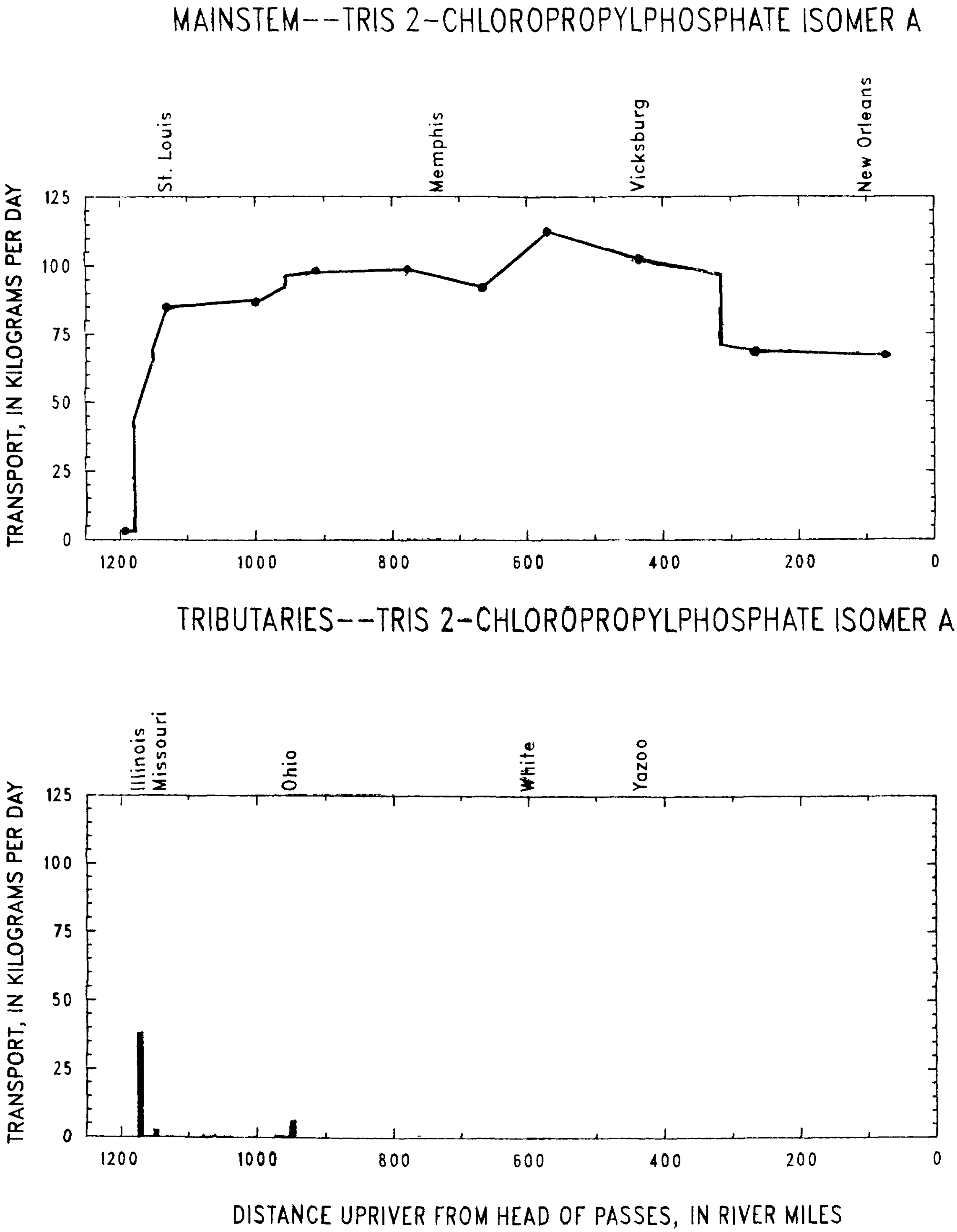


Figure 29.--Transport of tris-2-chloropropylphosphate isomer A in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

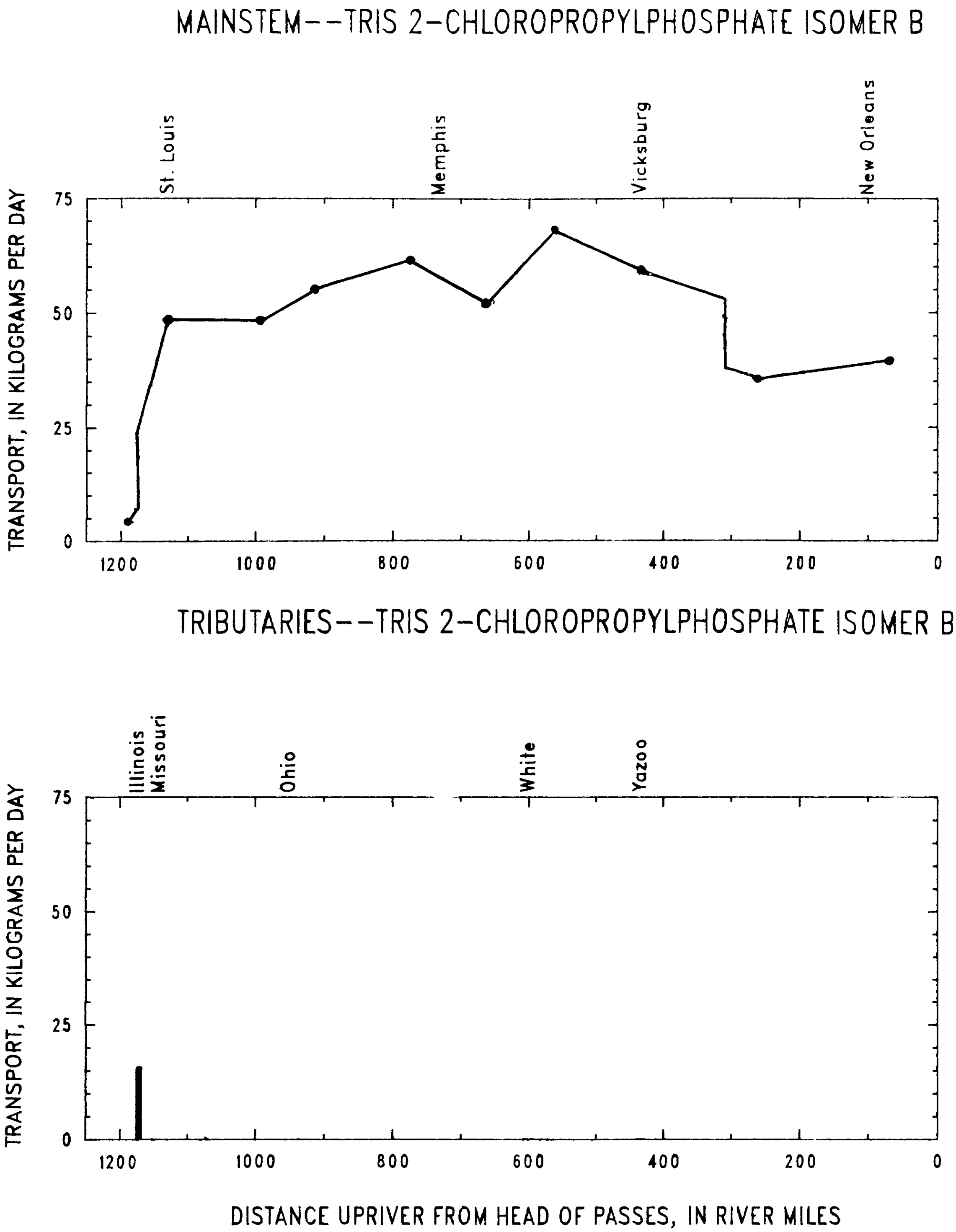


Figure 30.--Transport of tris-2-chloropropylphosphate isomer B in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between May 16 and June 7, 1988.

Table 12.--Concentrations of triazine and chloroacetanilide herbicides and their degradation products in the Mississippi River and some of its tributaries for March–April 1989 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1989	Site name	Water discharge[1] (m^3/s)	Concentration of triazine and chloroacetanilide herbicides, in ng/L						
			Atrazine	Desethylatrazine	Desisopropylatrazine	Simazine	Alachlor	2-chloro-2′,6′-diethylacetanilide	Metolachlor
3–10	Mississippi R. near Winfield, Mo.	850	180	39	ND	ND	280	ND	81
3–09	Illinois R. at Hardin, Ill.[2]	410	170	ND	ND	ND	99	ND	150
			180	ND	ND	ND	84	ND	160
3–12	Missouri R. at Hermann, Mo.	1,480	150	39	17	10	11	ND	61
3–13	Mississippi R. at St. Louis, Mo.	3,940	200	46	13	ND	640	17	160
3–15	Mississippi R. at Thebes, Ill.	4,890	200	54	ND	ND	430	42	170
3–16	Ohio R. at Olmsted, Ill.[2]	20,400	82	33	ND	16	ND	ND	110
			87	27	ND	13	ND	13	110
3–17	Mississippi R. below Hickman, Ky.	24,700	100	35	ND	ND	230	12	120
3–19	Mississippi R. below Fulton, Tenn.	24,800	110	30	ND	18	180	10	91
3–21	Mississippi R. at Helena, Ark.	25,900	120	35	ND	12	180	11	110
3–22	White R. at Mile 11.5, Ark.	1,500	ND	ND	ND	ND	ND	ND	ND
3–23	Arkansas R. at Pendleton, Ark.	1,900	420	53	ND	71	11	17	21
3–24	Mississippi R. above Arkansas City, Ark.	26,800	210	40	ND	24	170	15	120
3–26	Yazoo R. below Steele Bayou, Miss.	1,500	42	ND	ND	17	29	ND	120
3–27	Mississippi R. below Vicksburg, Miss.[2]	26,600	200	33	ND	24	170	16	110
			180	35	ND	13	170	12	120
3–29	Old R. Outflow Channel near Knox Landing, La.	6,160	180	33	ND	11	140	12	140
3–30	Mississippi R. near St. Francisville, La.	23,100	170	33	ND	ND	190	ND	120
4–01	Mississippi R. below Belle Chasse, La.	22,500	220	31	ND	28	160	11	130

[1]Discharges are listed by Moody and Meade (1993) with a discussion of errors.

[2]Duplicate samples collected.

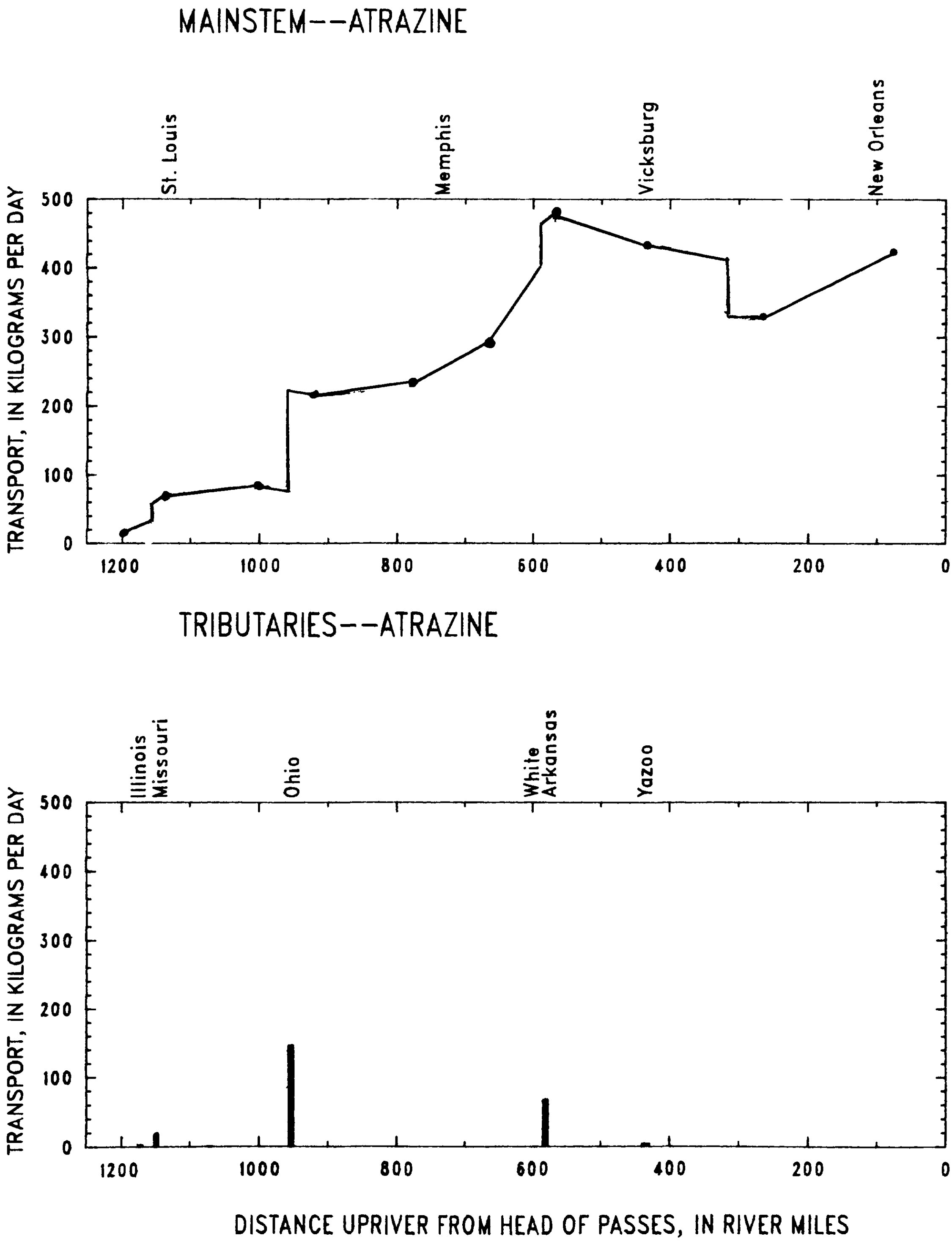


Figure 31.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

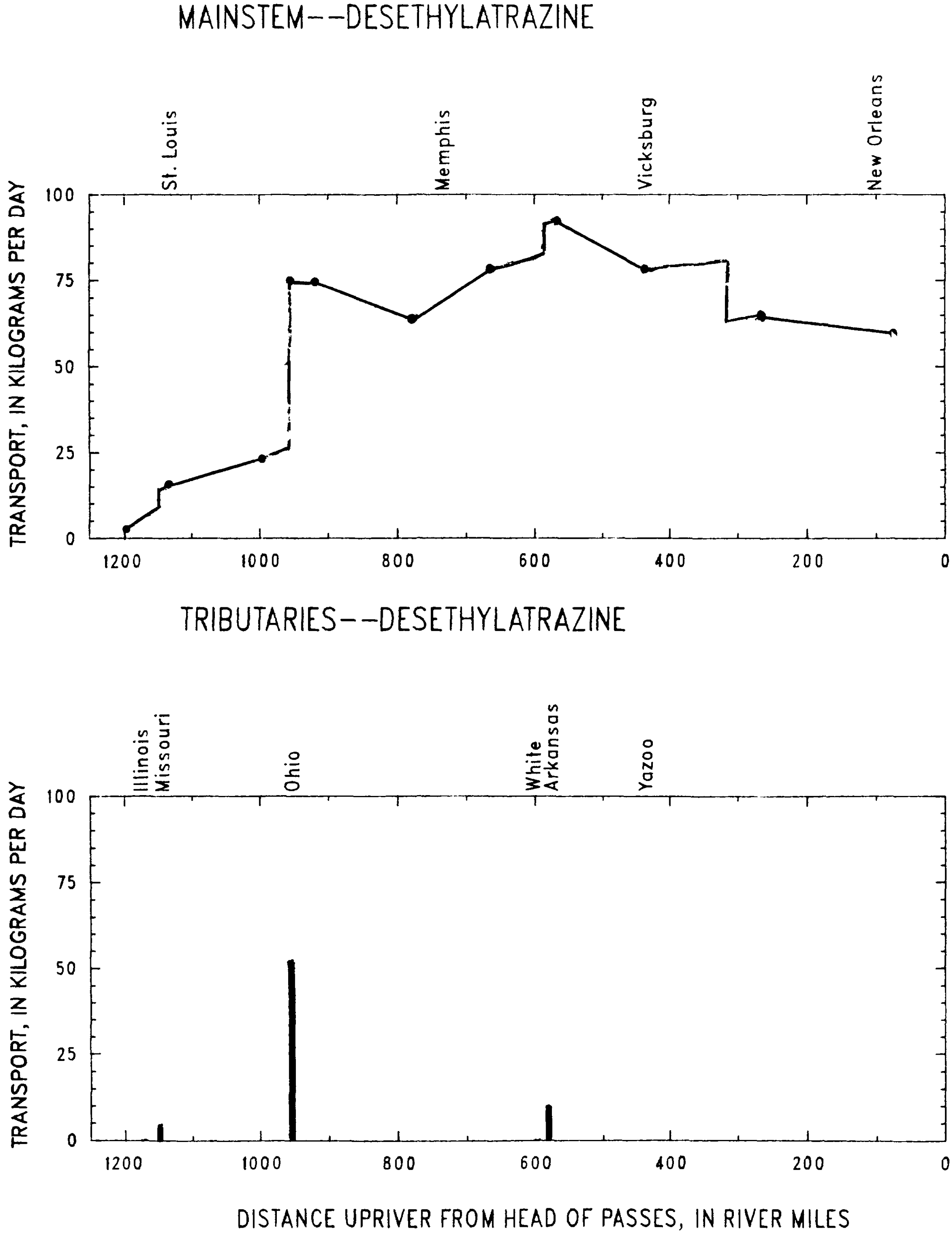


Figure 32.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

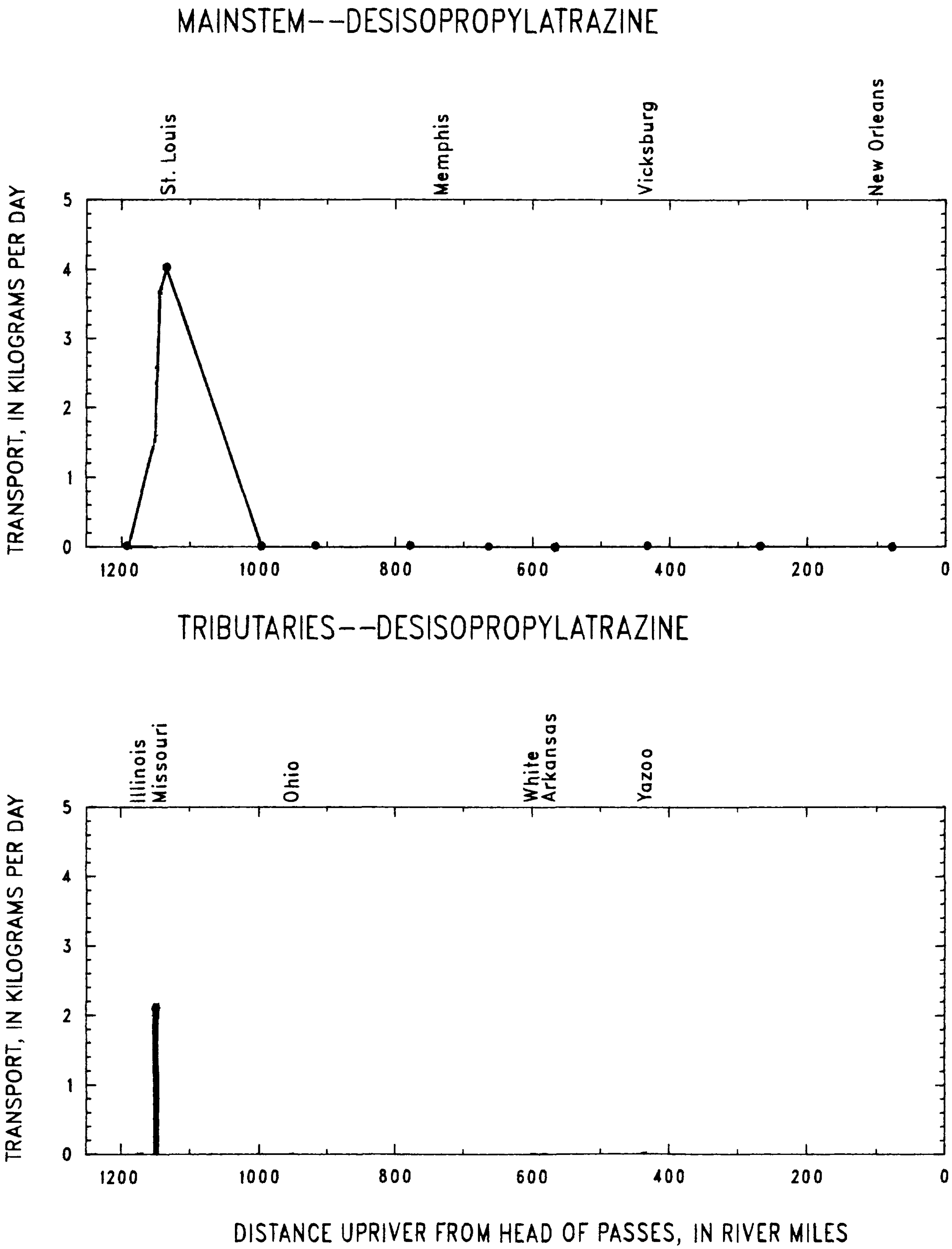


Figure 33.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

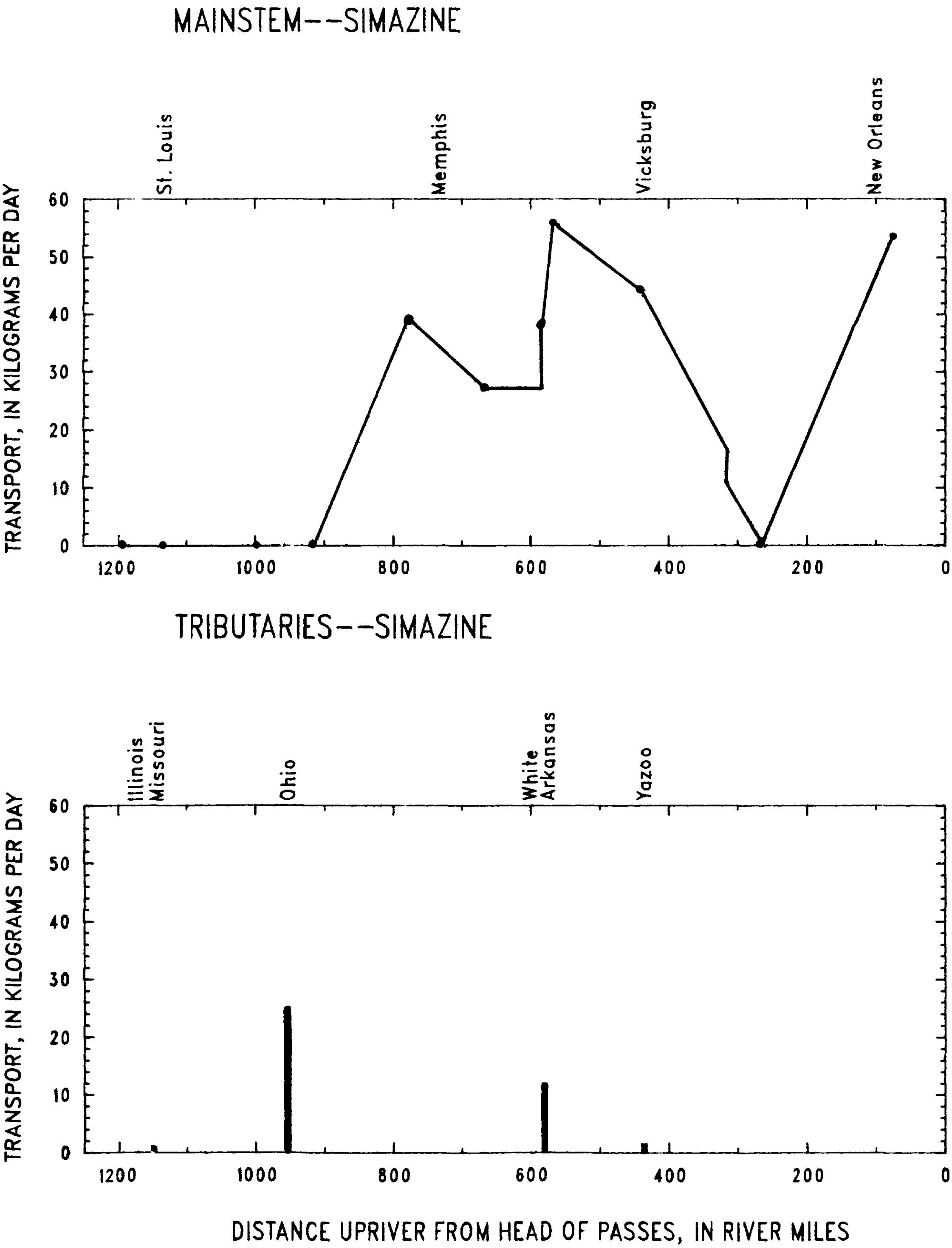


Figure 34.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

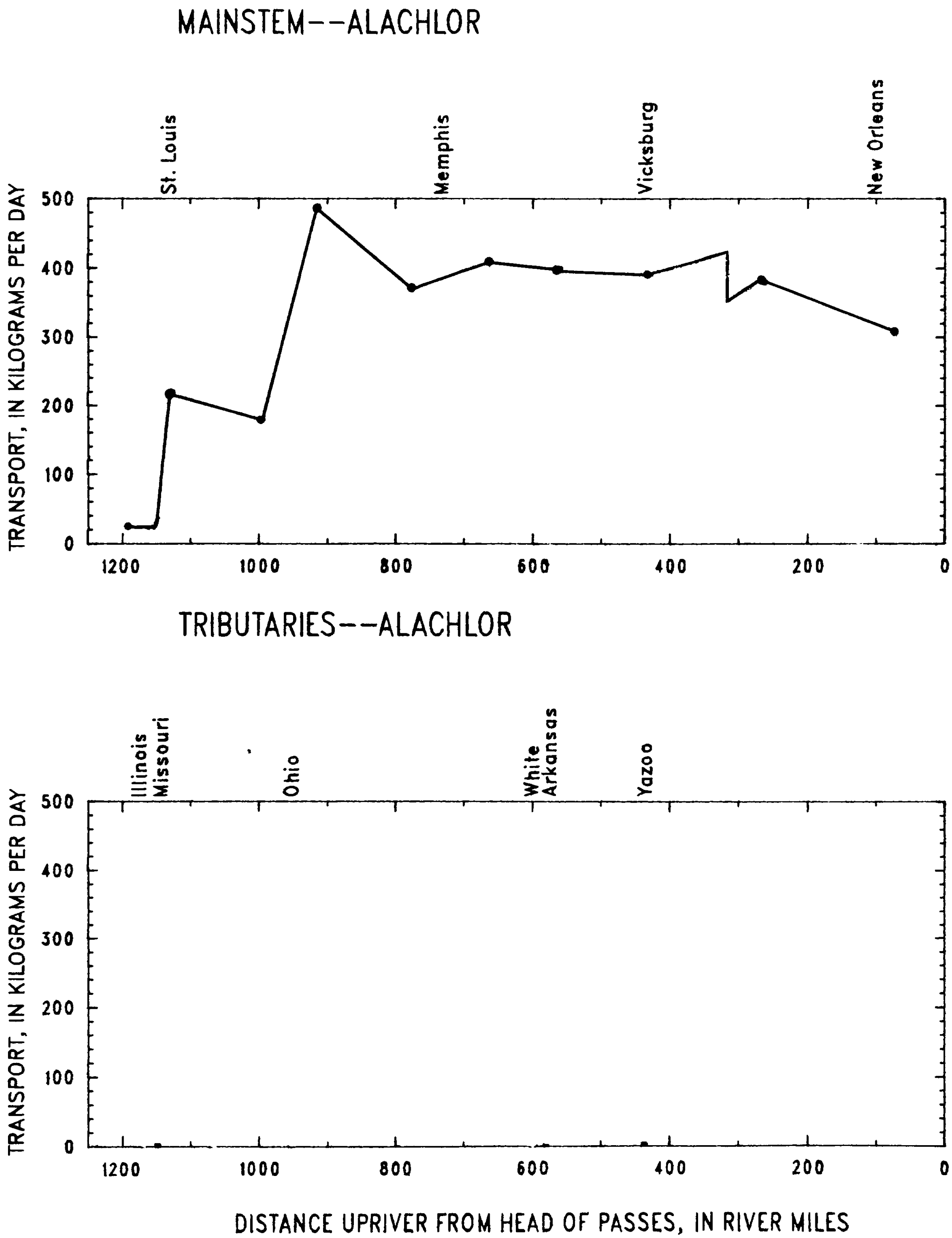


Figure 35.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

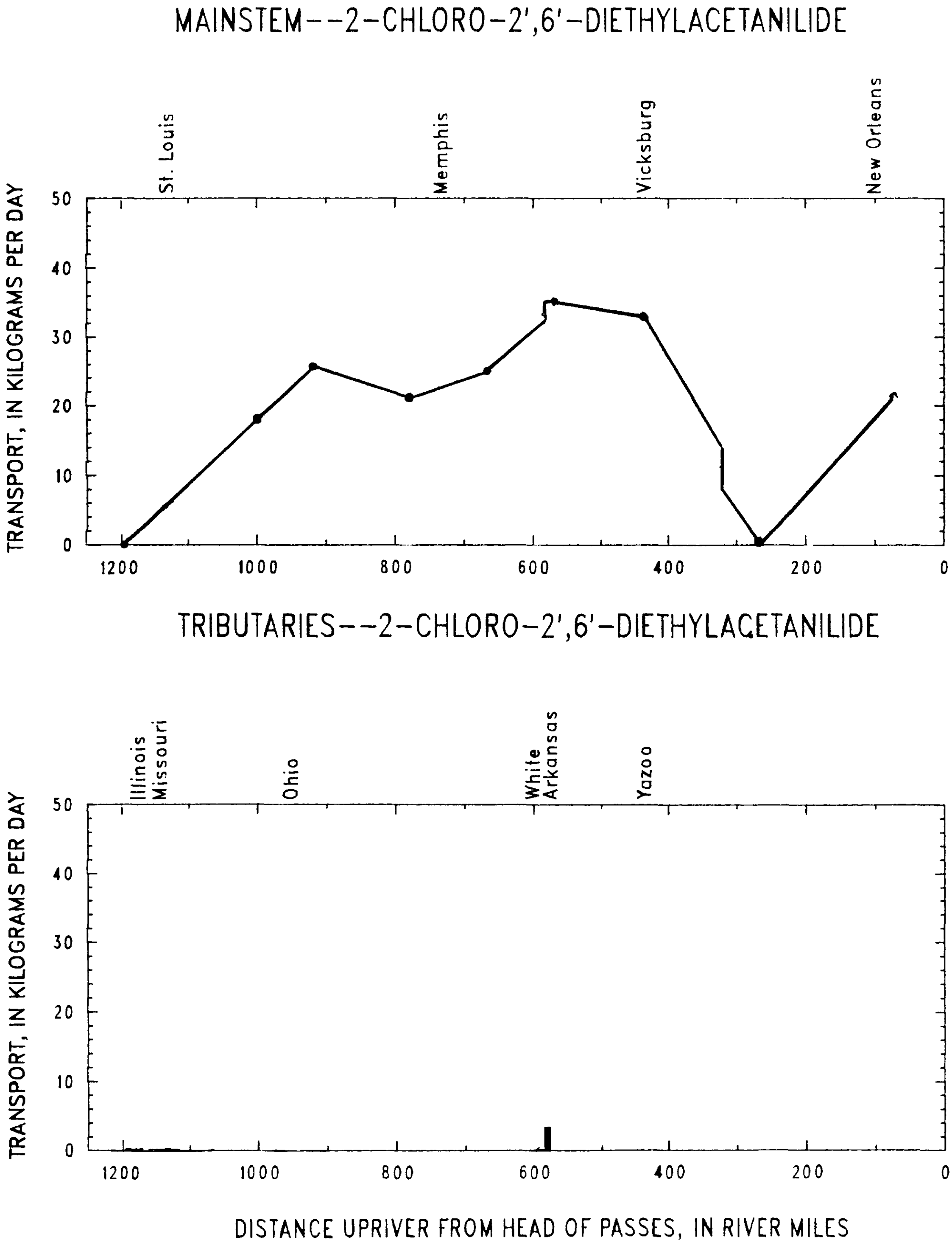


Figure 36.--Transport of 2-chloro-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

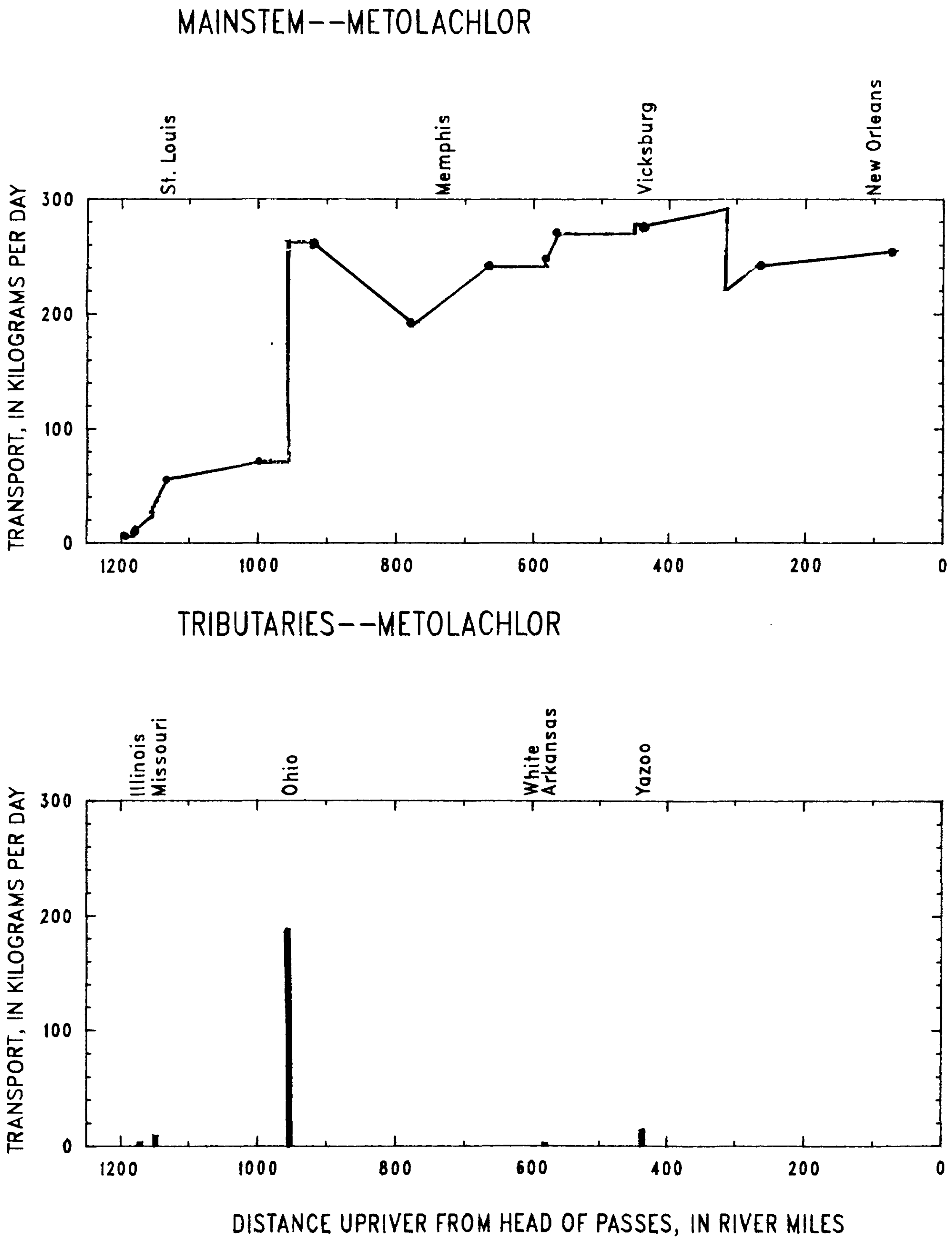


Figure 37.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

Table 13.--Concentrations of organic contaminants in the Mississippi River and some of its tributaries for March-April 1989 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1989	Site name	Water discharge[1] (m^3/s)	Concentration of organic contaminants, in ng/L				
			2,6-diethyl-aniline	1,3,5-trimethyl-2,4,6-triazine-trione	Tris-2-chloro-ethyl-phosphate	Tris-2-chloro-propyl-phosphate isomer A	Tris-2-chloro-propyl-phosphate isomer B
3–10	Mississippi R. near Winfield, Mo.	850	ND	ND	120	ND	ND
3–09	Illinois R. at Hardin, Ill.[2]	410	ND	ND	1,000	1,100	180
			ND	ND	1,000	1,100	180
3–12	Missouri R. at Hermann, Mo.	1,480	ND	ND	ND	ND	ND
3–13	Mississippi R. at St. Louis, Mo.	3,940	74	ND	300	720	130
3–15	Mississippi R. at Thebes, Ill.	4,890	17	ND	290	690	110
3–16	Ohio R. at Olmsted, Ill.[2]	20,400	ND	110	6	27	ND
			ND	91	13	36	ND
3–17	Mississippi R. below Hickman, Ky.	24,700	13	78	73	300	59
3–19	Mississippi R. below Fulton, Tenn.	24,800	ND	39	57	250	51
3–21	Mississippi R. at Helena, Ark.	25,900	ND	53	47	210	43
3–22	White R. at Mile 11.5, Ark.	1,500	ND	ND	ND	ND	ND
3–23	Arkansas R. at Pendleton, Ark.	1,900	ND	ND	46	100	ND
3–24	Mississippi R. above Arkansas City, Ark.	26,800	ND	33	46	220	43
3–26	Yazoo R. below Steele Bayou, Miss.	1,500	ND	ND	ND	ND	ND
3–27	Mississippi R. below Vicksburg, Miss.[2]	26,600	45	33	37	200	34
			32	24	14	160	39
3–29	Old R. Outflow Channel near Knox Landing, La.	6,150	51	31	16	200	30
3–30	Mississippi R. near St. Francisville, La.	23,100	30	31	12	210	30
4–01	Mississippi R. below Belle Chasse, La.	22,500	28	29	17	180	35

[1]Discharges are listed by Moody and Meade (1993) with a discussion of errors.

[2]Duplicate samples collected.

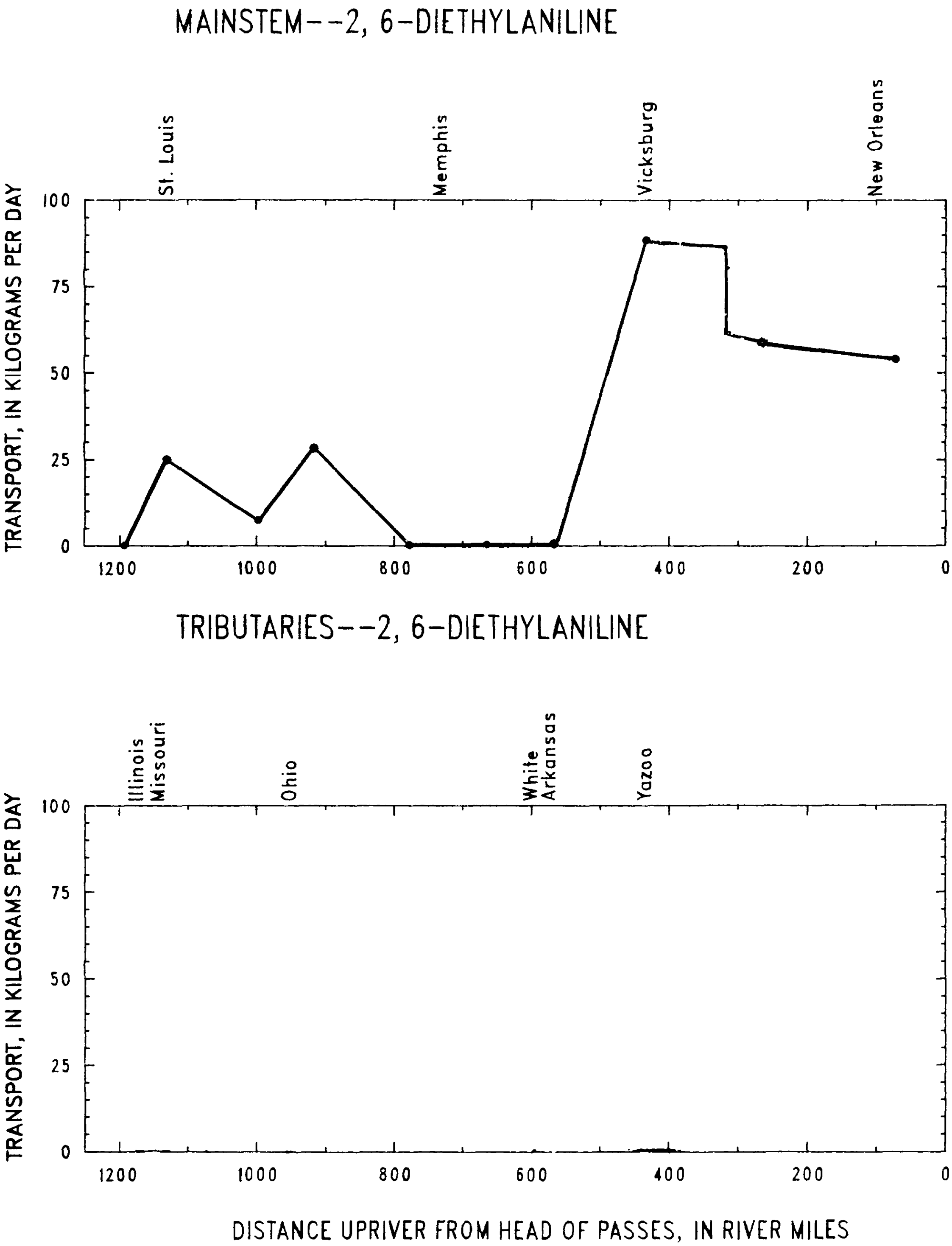


Figure 38.--Transport of 2,6-diethylaniline in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

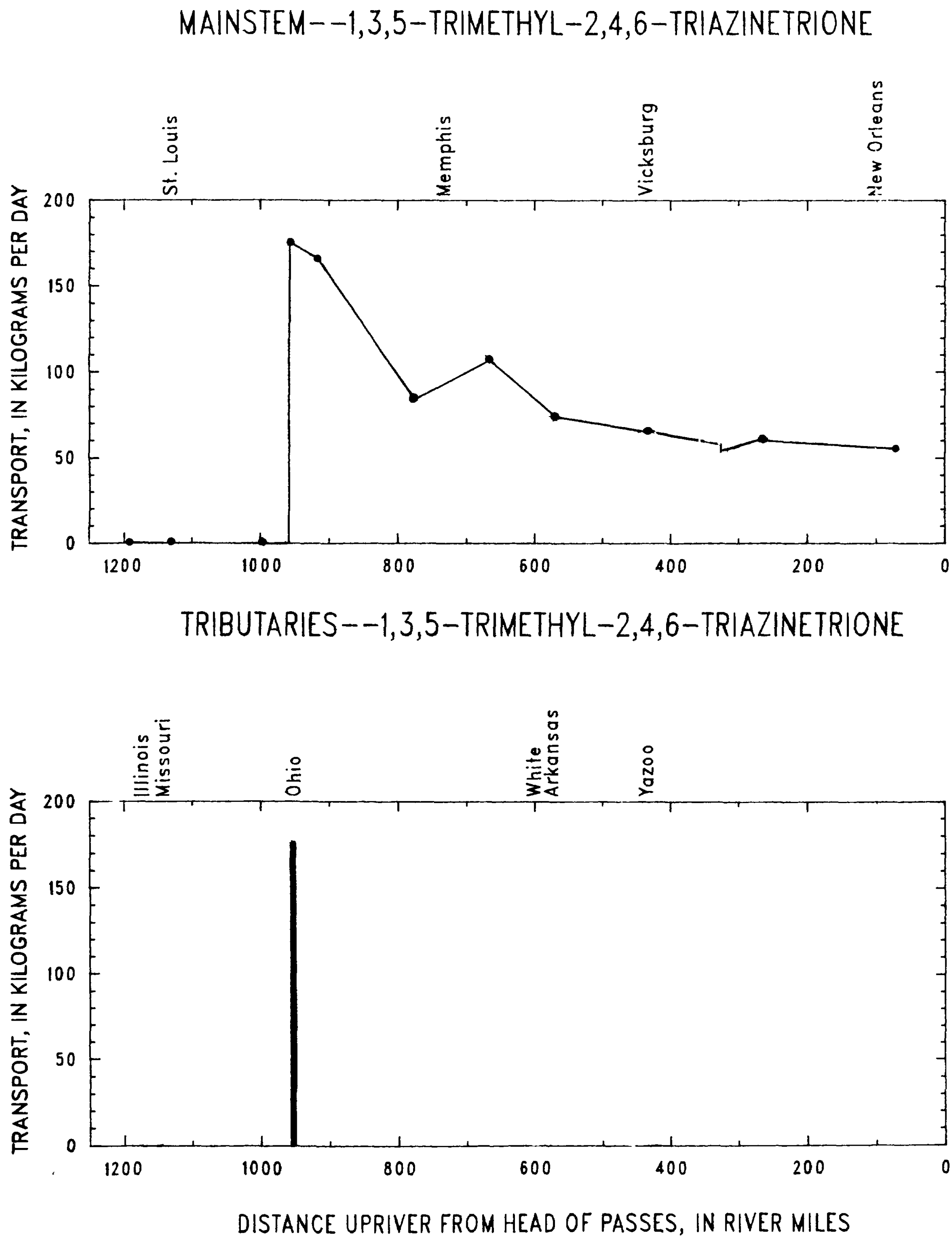


Figure 39.--Transport of 1,3,5-trimethyl-2,4,6-triazinetrione in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

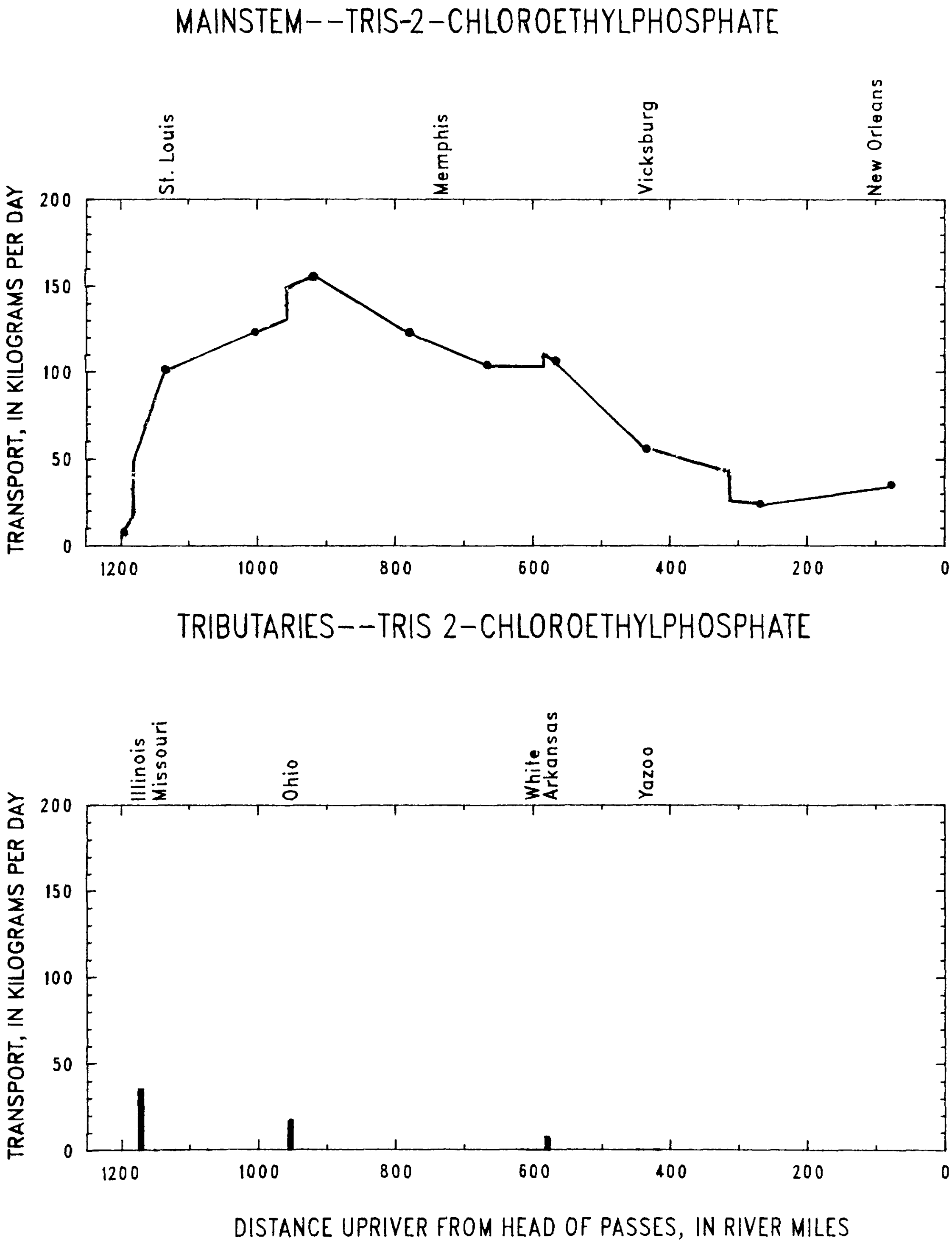


Figure 40.--Transport of tris-2-chloroethylphosphate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

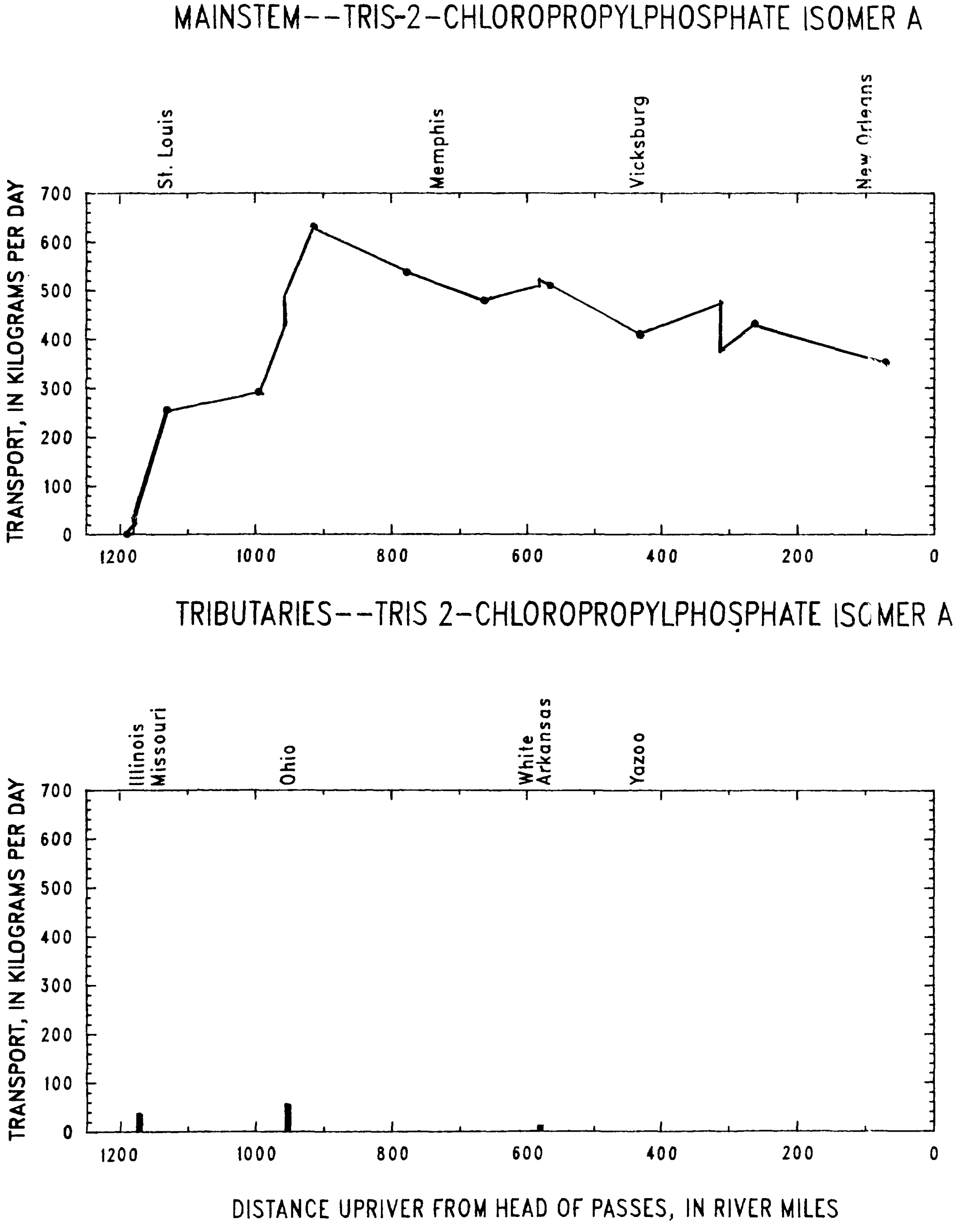


Figure 41.--Transport of tris-2-chloropropylphosphate isomer A in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

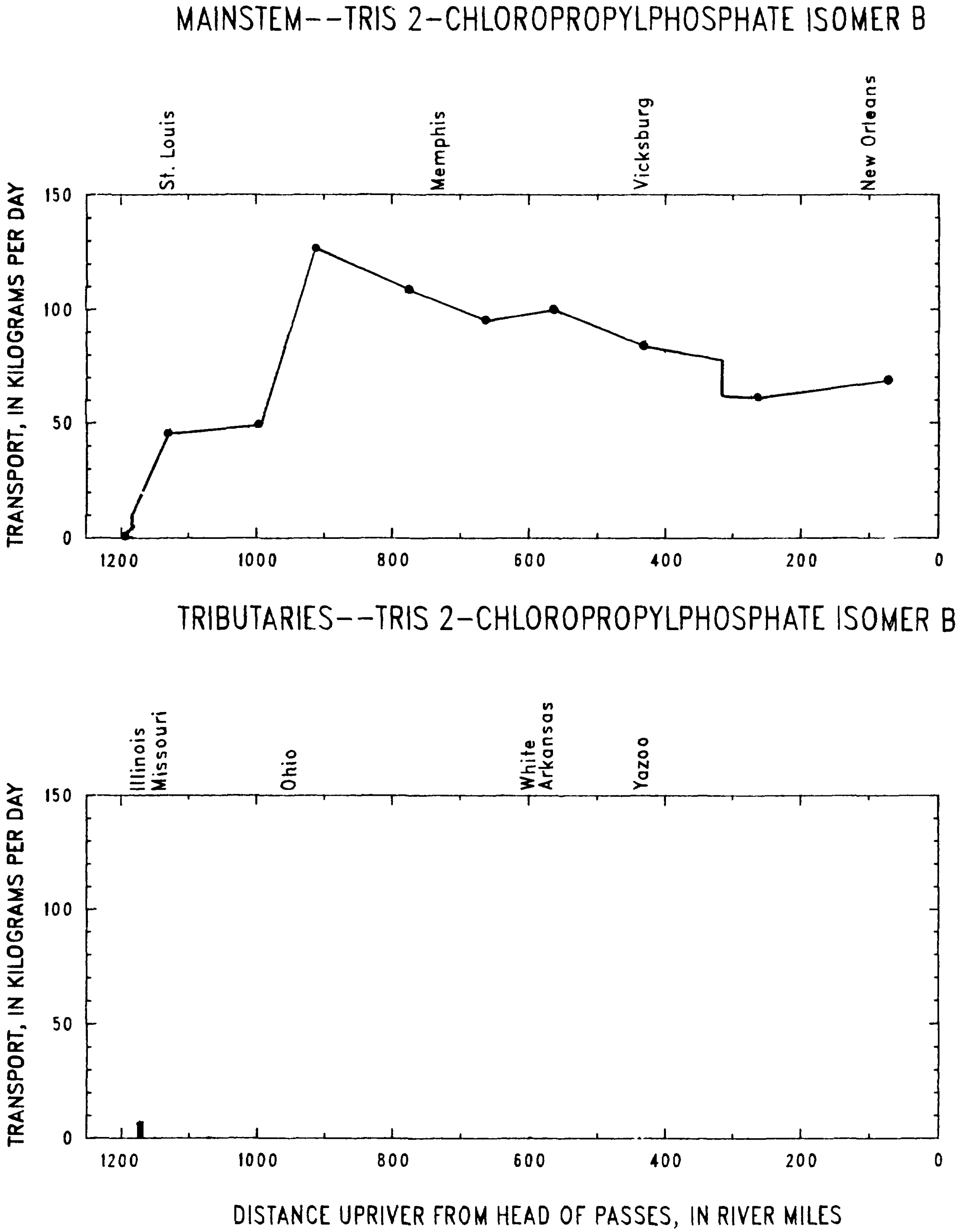


Figure 42.--Transport of tris-2-chloropropylphosphate isomer B in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between March 9 and April 1, 1989.

Table 14.--Concentrations of triazine and chloroacetanilide herbicides and their degradation products in the Mississippi River and some of its tributaries for June 1989 cruise

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1989	Site name	Water discharge[1] (m^3/s)	Concentration of triazine and chloroacetanilide herbicides, in ng/L								
			Atrazine	Desethylatrazine	Desisopropylatrazine	Cyanazine	Simazine	Alachlor	2-chloro-2'6'-diethylacetanilide	2-hydroxy-2'6'-diethylacetanilide	Metolachlor
6–05	Mississippi R. near Winfield, Mo.	2,320	1,300	78	22	1,000	140	700	19	34	620
6–04	Illinois R. at Hardin, Ill.	780	1,900	229	140	930	190	450	11	36	1,200
6–07	Missouri R. at Hermann, Mo.	1,760	1,200	51	ND	1,400	140	390	10	ND	1,000
6–08	Mississippi R. at St. Louis, Mo.[2]	4,760	1,300	87	66	730	150	590	57	31	660
			1,400	100	38	980	200	620	58	35	750
6–10	Mississippi R. at Thebes, Ill.	5,230	1,200	100	13	720	190	540	54	18	650
6–11	Ohio R. at Olmsted, Ill.[2]	8,760	1,500	190	ND	620	320	440	10	7	820
			1,900	190	10	760	290	420	7	12	840
6–12	Mississippi R. below Hickman, Ky.	14,100	1,800	180	ND	840	280	490	23	10	810
6–14	Mississippi R. at Fulton, Tenn.	15,300	1,300	170	ND	720	160	440	18	ND	740
6–17	Mississippi R. at Helena, Ark.	16,900	1,300	200	70	640	230	450	22	ND	830
6–18	White R. at Mile 11.5, Ark.	770	250	12	ND	38	20	12	ND	ND	160
6–19	Arkansas R. at Pendleton, Ark.	3,600	360	38	ND	46	27	20	ND	11	49
6–20	Mississippi R. above Arkansas City, Ark.	23,300	930	150	41	460	190	300	ND	ND	570
6–22	Yazoo R. below Steele Bayou, Miss.	1,070	340	26	29	63	ND	110	ND	ND	660
6–23	Mississippi R. below Vicksburg, Miss.[2]	24,800	1,100	130	43	410	160	240	8	8	530
			1,200	130	ND	500	91	240	6	5	550
6–25	Old R. Outflow Channel near Knox Landing, La.	4,890	1,250	160	52	510	190	240	ND	ND	520
6–26	Mississippi R. near St. Francisville, La.	19,000	1,100	120	17	350	180	210	ND	ND	480
6–28	Mississippi R. below Belle Chasse, La.	20,100	1,100	110	28	330	180	230	ND	ND	520

[1]Discharges are listed by Moody and Meade (1993) with a discussion of errors.

[2]Duplicate samples collected.

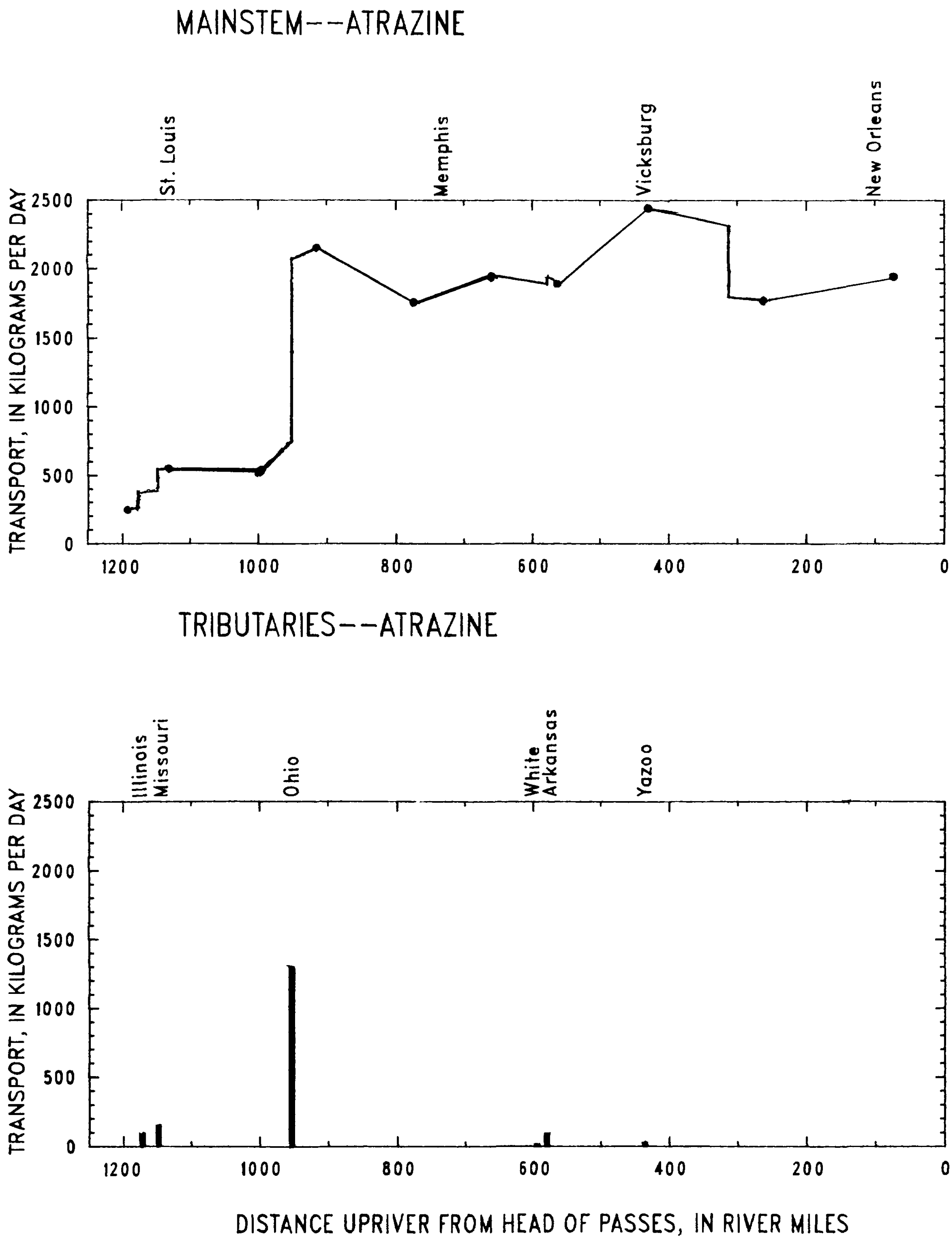


Figure 43.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

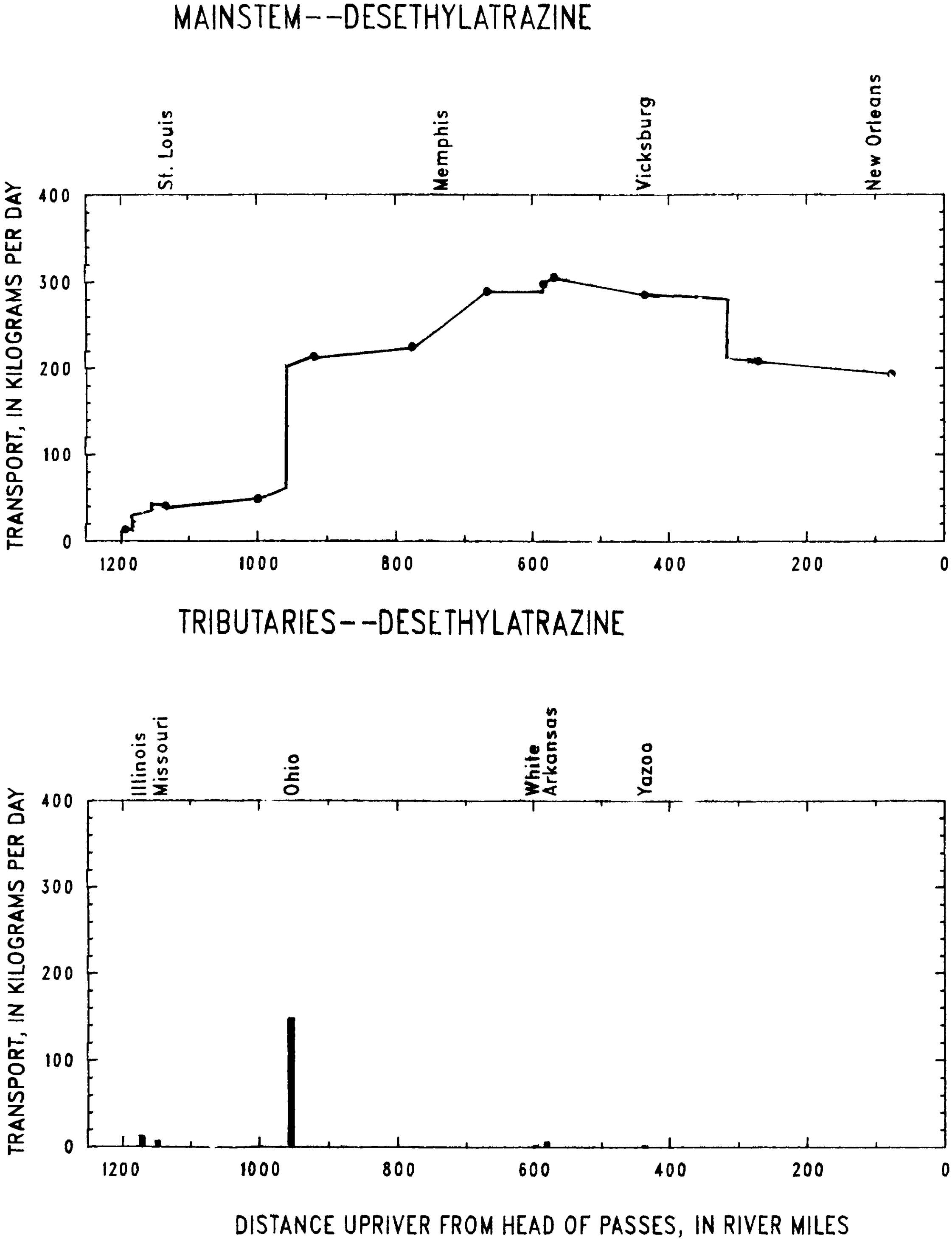


Figure 44.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

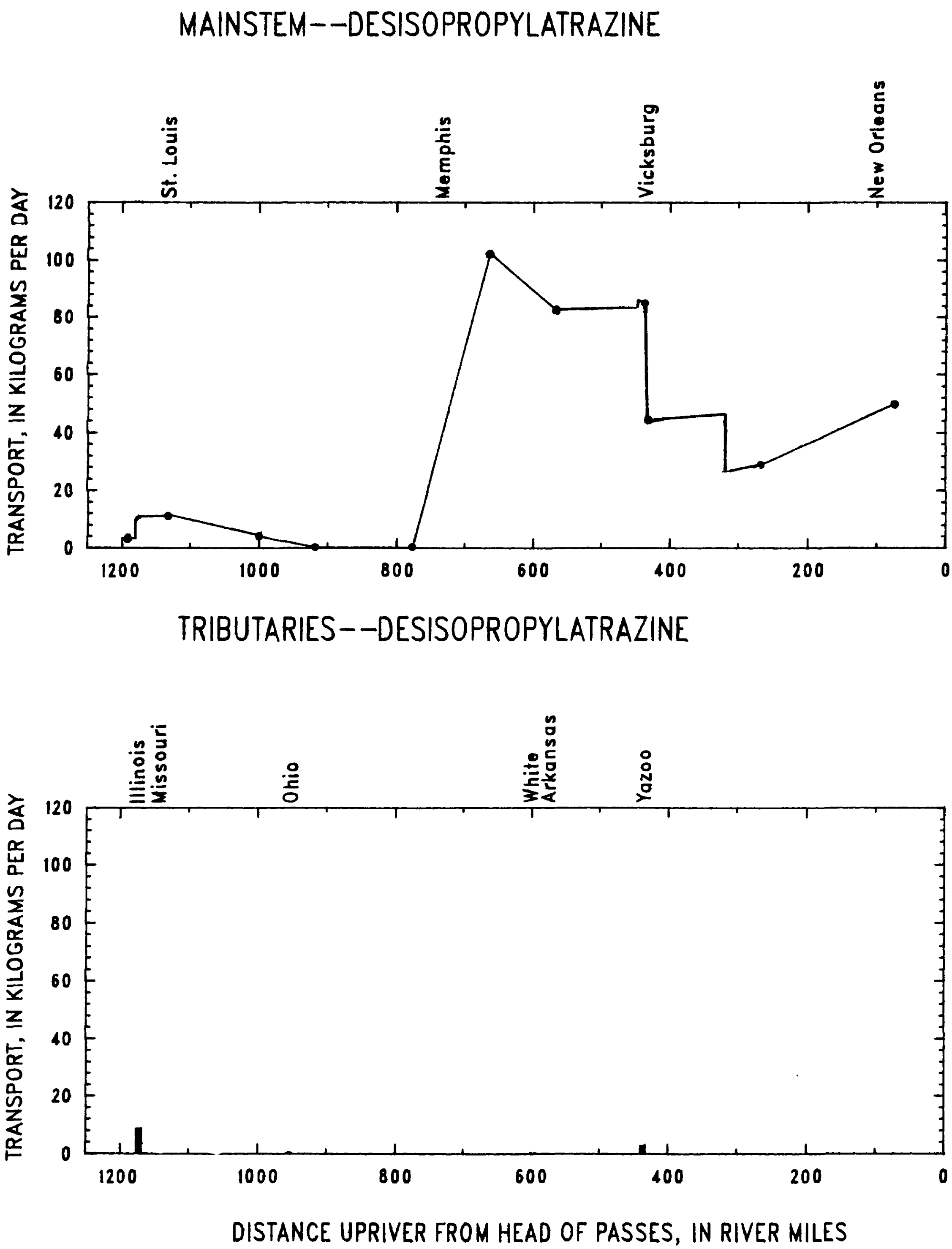


Figure 45.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

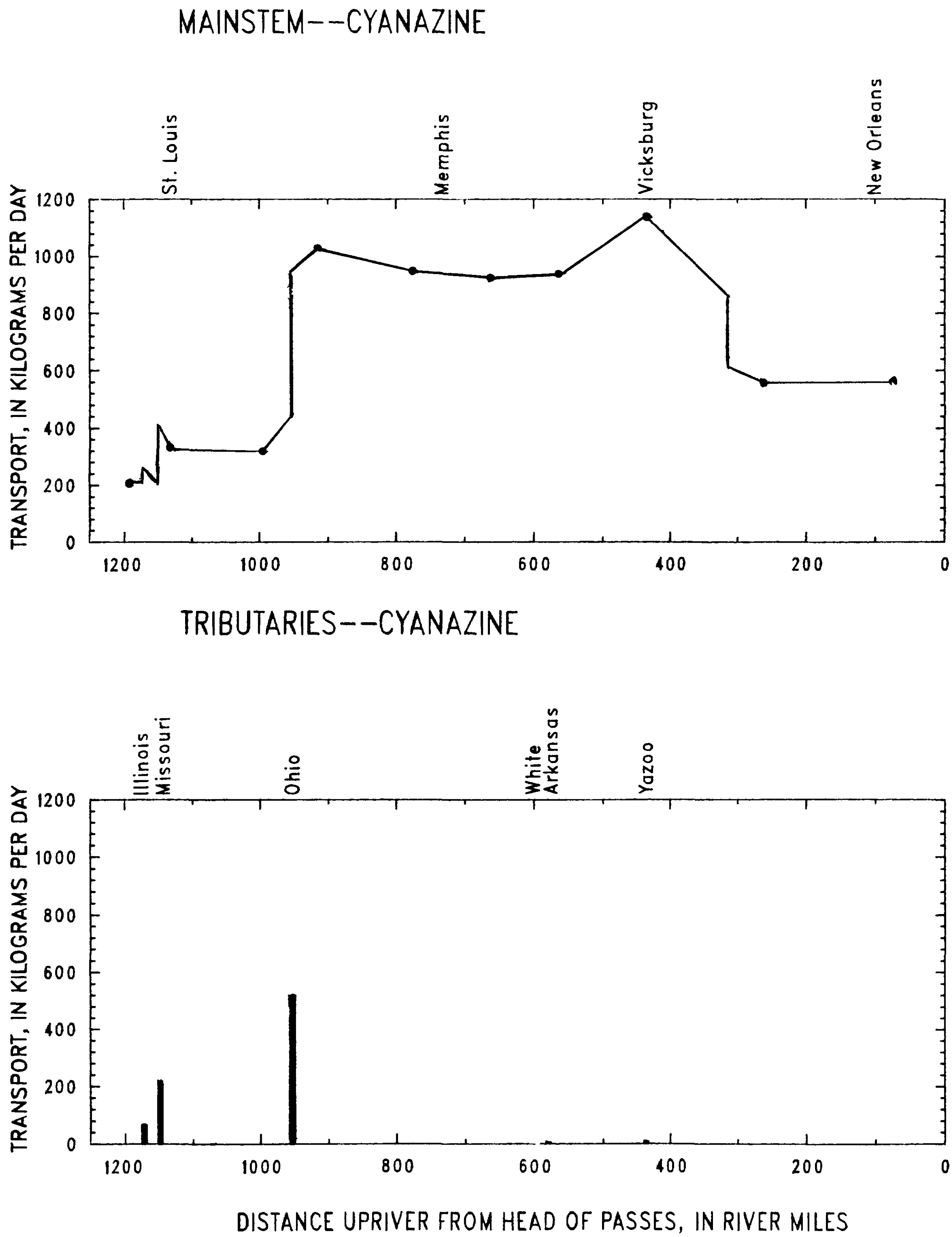


Figure 46.--Transport of cyanazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

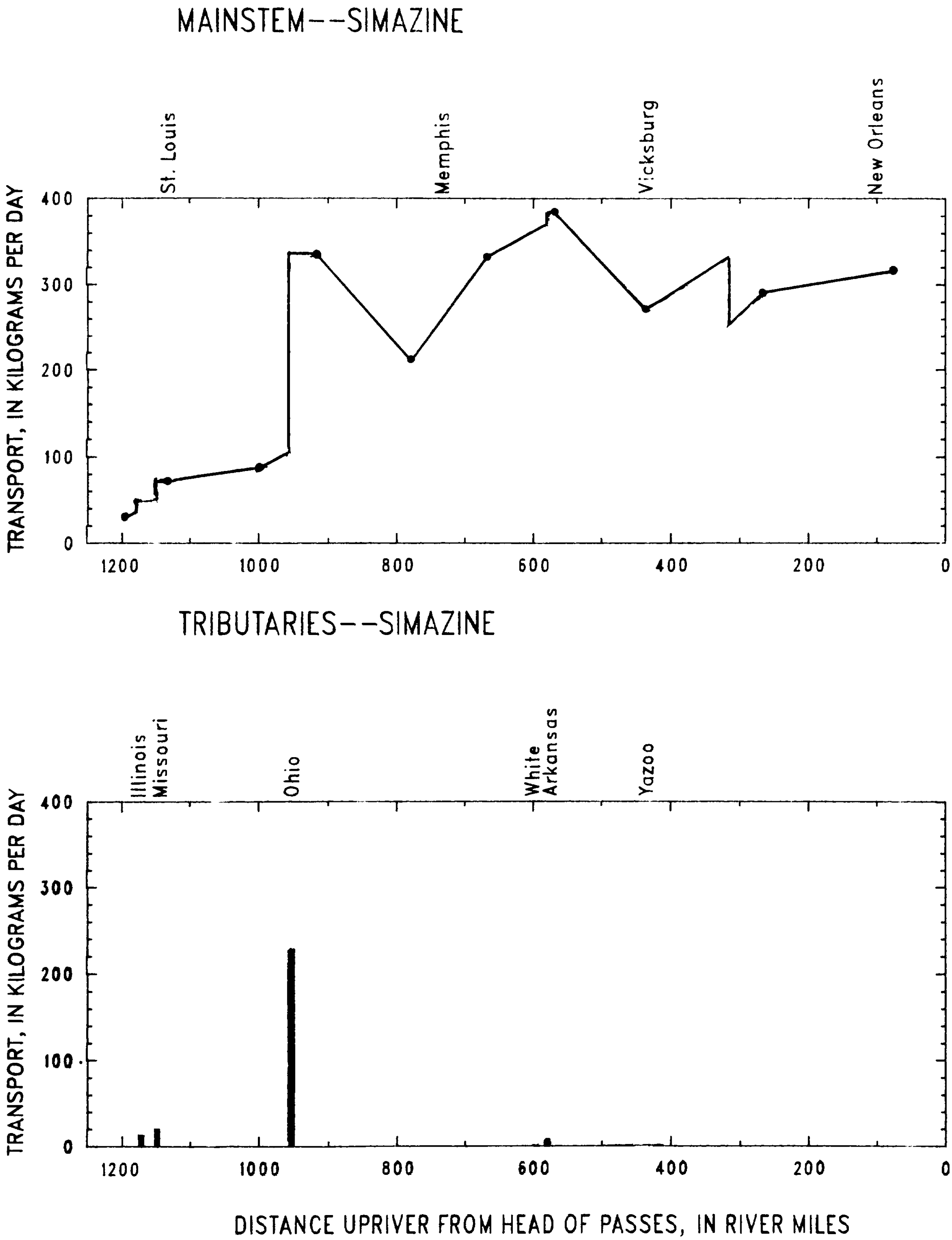


Figure 47.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

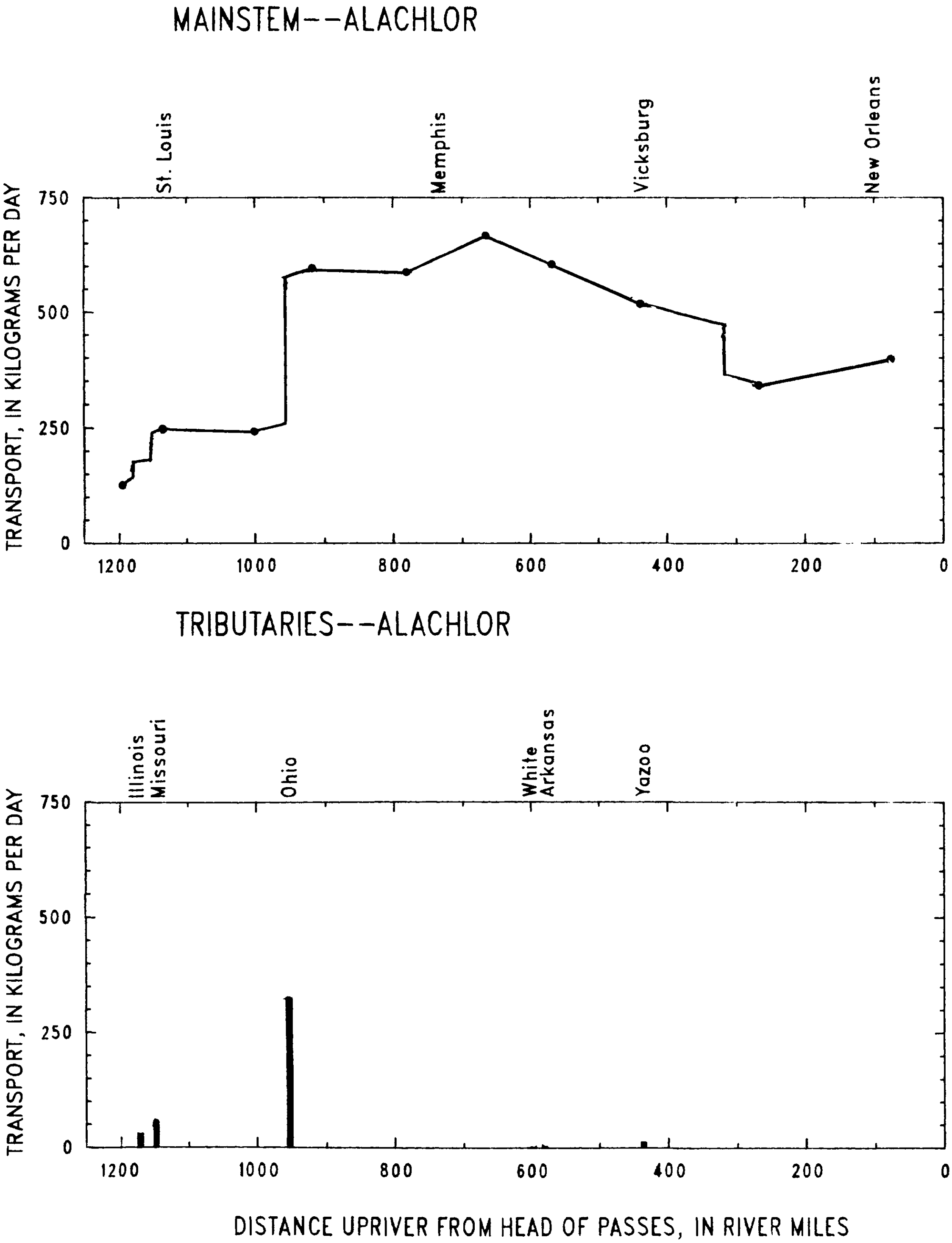


Figure 48.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

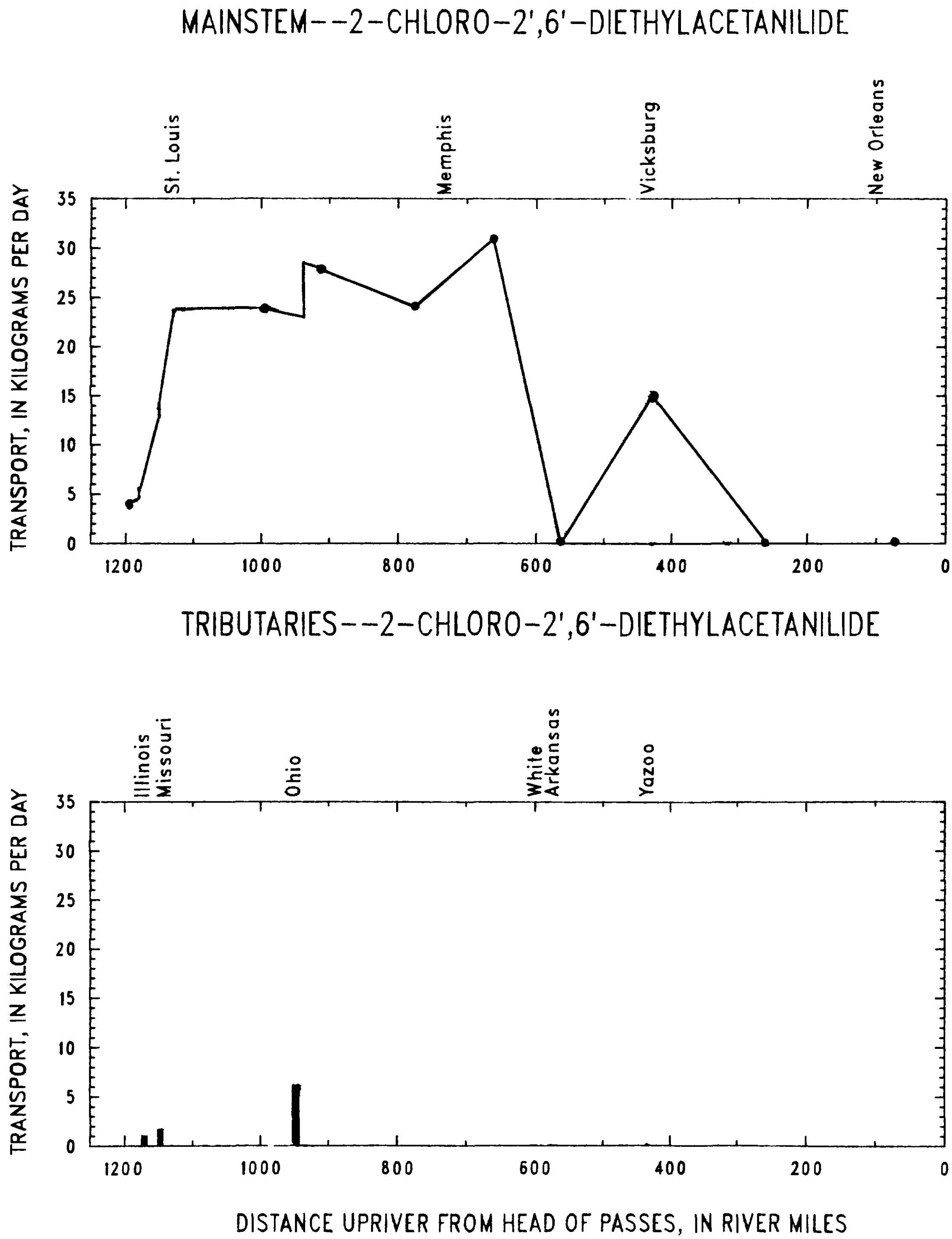


Figure 49.--Transport of 2-chloro-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

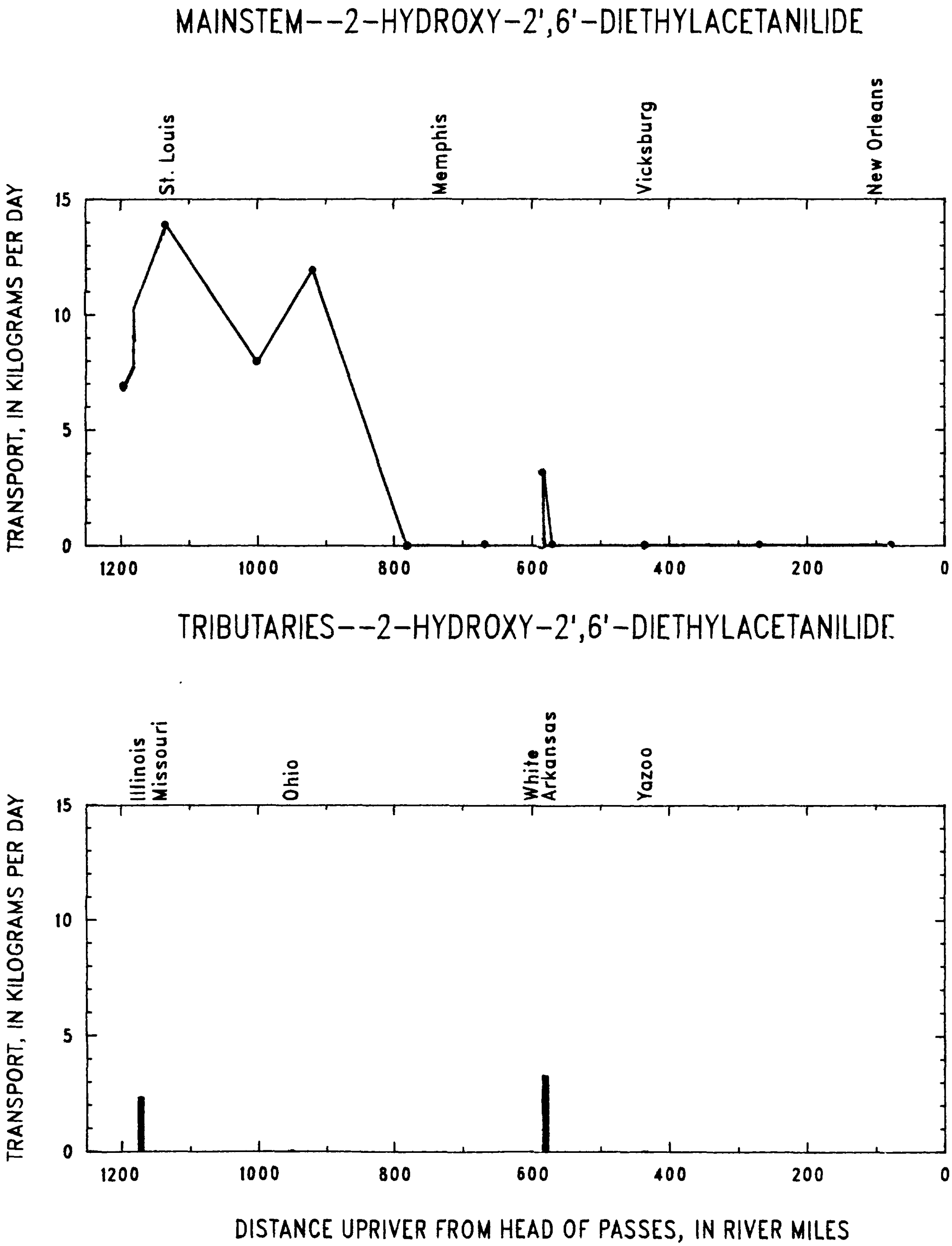


Figure 50.--Transport of 2-hydroxy-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

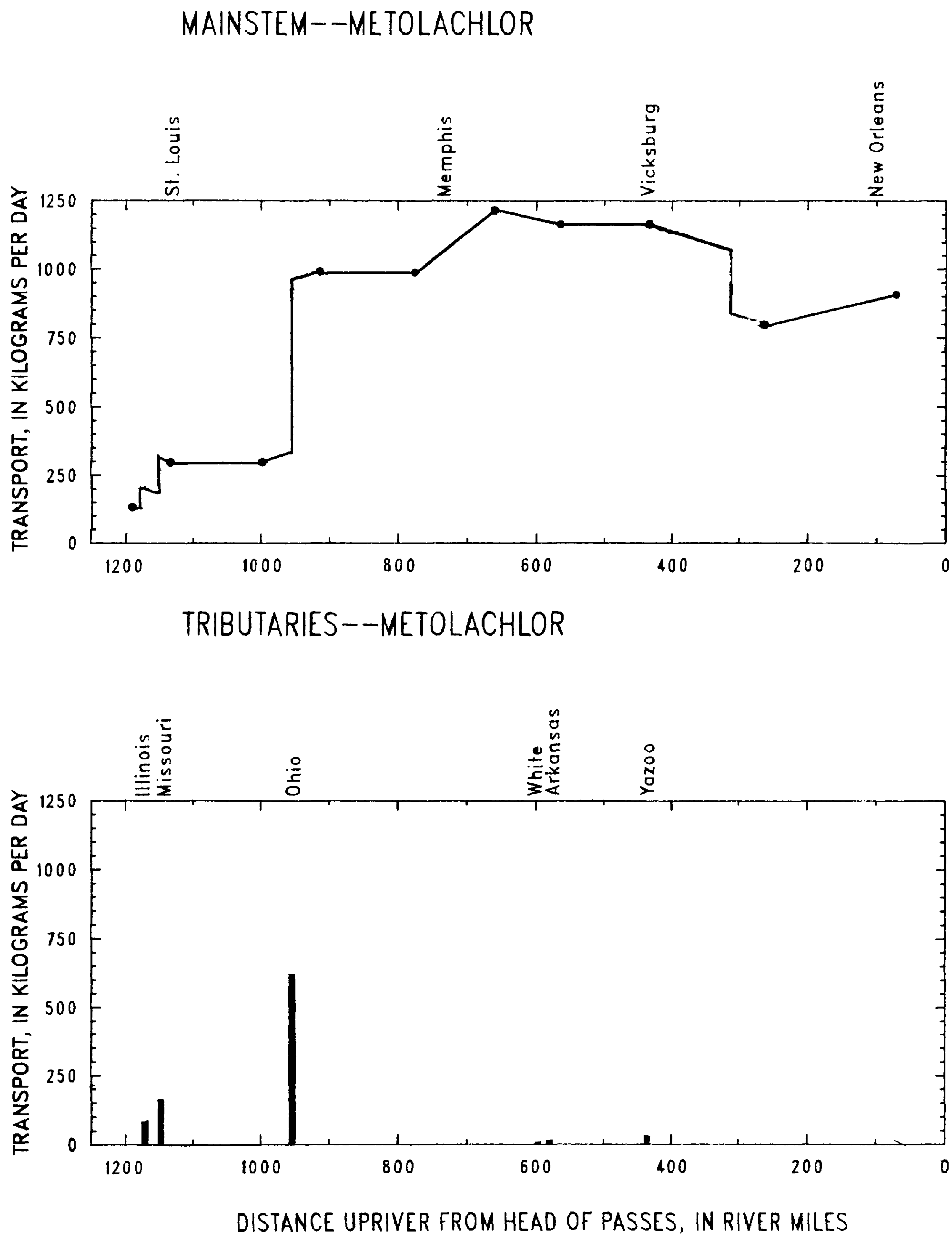


Figure 51.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

Table 15.--Concentrations of organic contaminants in the Mississippi River and some of its tributaries for June 1989 cruise

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1989	Site name	Water dis-charge[1] (m^3/s)	Concentration of organic contaminants in ng/L				
			2,6-diethyl-aniline	1,3,5-trimethyl-2,4,6-triazine-trione	Tris-2-chloro-ethyl-phosphate	Tris-2-chloro-propyl-phosphate isomer A	Tris-2-chloro-propyl-phosphate isomer B
6–05	Mississippi R. near Winfield, Mo.	2,320	ND	ND	74	25	5
6–04	Illinois R. at Hardin, Ill.	780	ND	ND	430	700	530
6–07	Missouri R. at Hermann, Mo.	1,760	ND	ND	8	18	8
6–08	Mississippi R. at St. Louis, Mo.[2]	4,760	84	ND	100	330	760
			110	ND	110	350	830
6–10	Mississippi R. at Thebes, Ill.	5,230	17	ND	88	220	170
6–11	Ohio R. at Olmsted, Ill.[2]	8,760	10	110	10	8	14
			13	64	13	12	15
6–12	Mississippi R. below Hickman, Ky.	14,100	ND	59	36	80	69
6–14	Mississippi R. at Fulton, Tenn.	15,300	ND	35	36	84	63
6–17	Mississippi R. at Helena, Ark.	16,900	ND	61	23	69	39
6–18	White R. at Mile 11.5, Ark.	770	ND	ND	ND	22	8
6–19	Arkansas R. at Pendleton, Ark.	3,600	ND	ND	10	28	13
6–20	Mississippi R. above Arkansas City, Ark.	23,300	ND	42	20	39	20
6–22	Yazoo R. below Steele Bayou, Miss.	1,070	ND	ND	8	15	ND
6–23	Mississippi R. below Vicksburg, Miss.[2]	24,800	ND	38	19	33	98
			ND	28	19	37	93
6–25	Old R. Outflow Channel near Knox Landing, La.	4,890	ND	34	16	41	19
6–26	Mississippi R. near St. Francisville, La.	19,000	ND	39	15	31	21
6–28	Mississippi R. below Belle Chasse, La.	20,100	ND	46	14	35	26

[1]Discharges are listed by Moody and Meade (1993) with a discussion of errors.
[2]Duplicate samples collected.

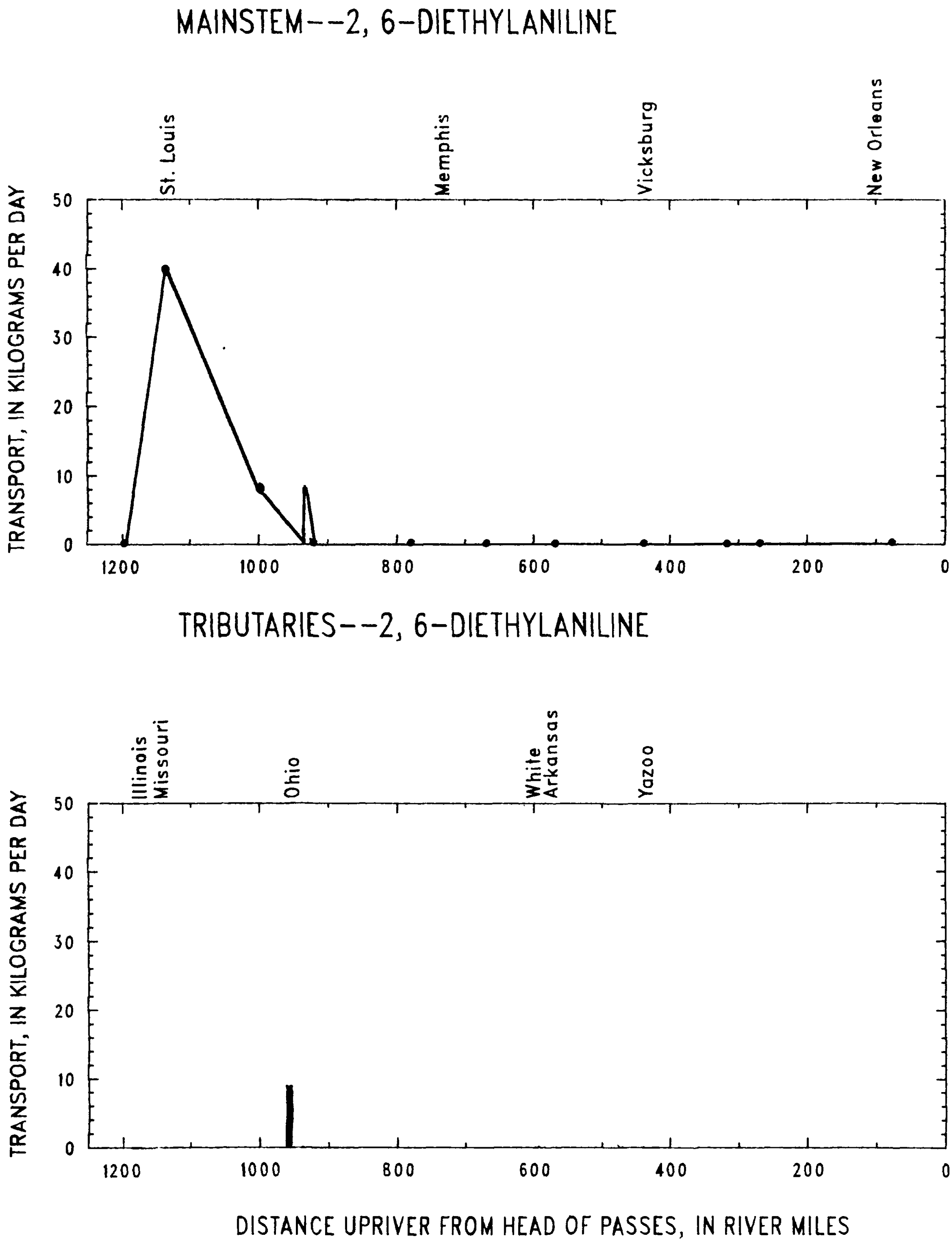


Figure 52.--Transport of 2,6-diethylaniline in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

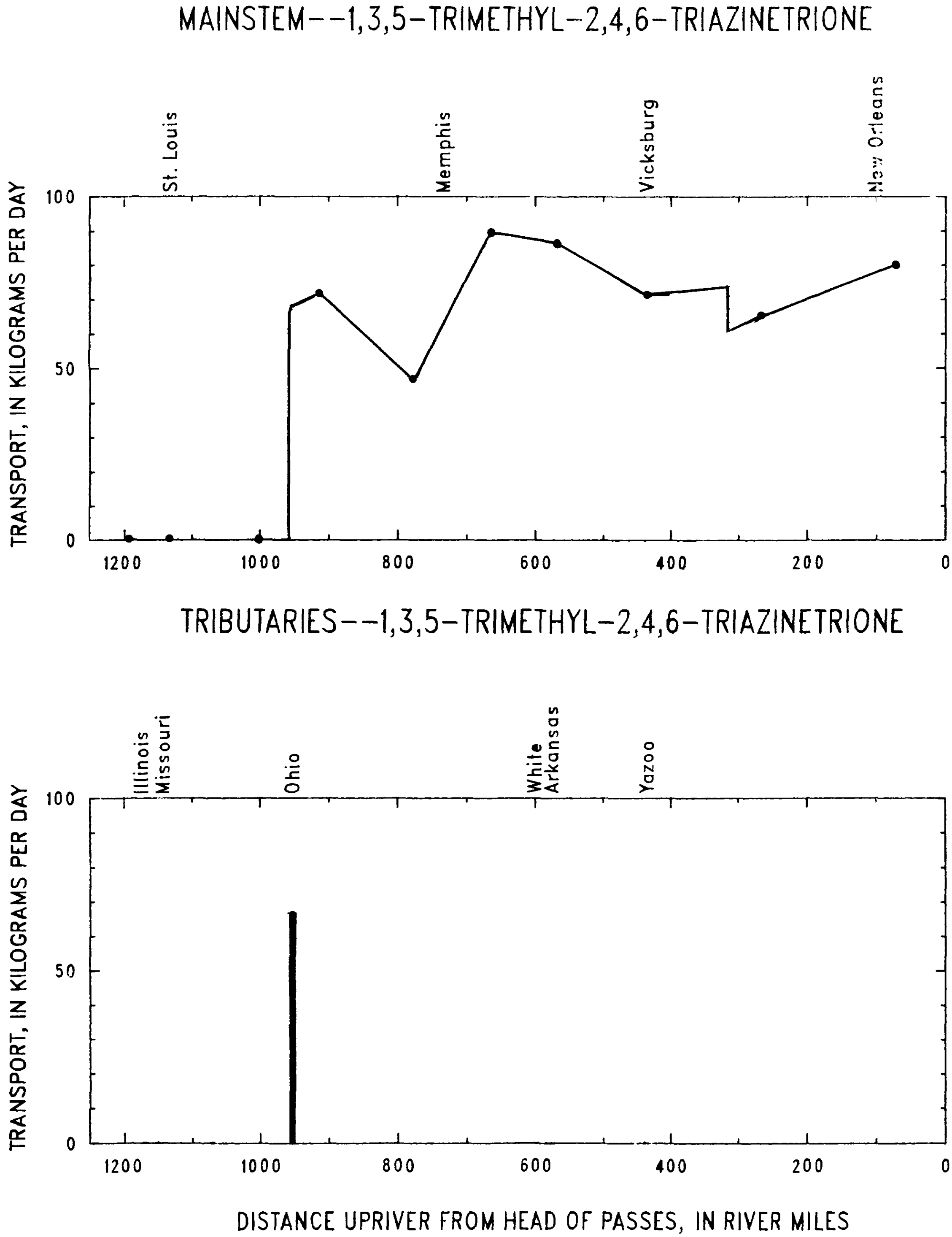


Figure 53.--Transport of 1,3,5-trimethyl-2,4,6-triazinetrione in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

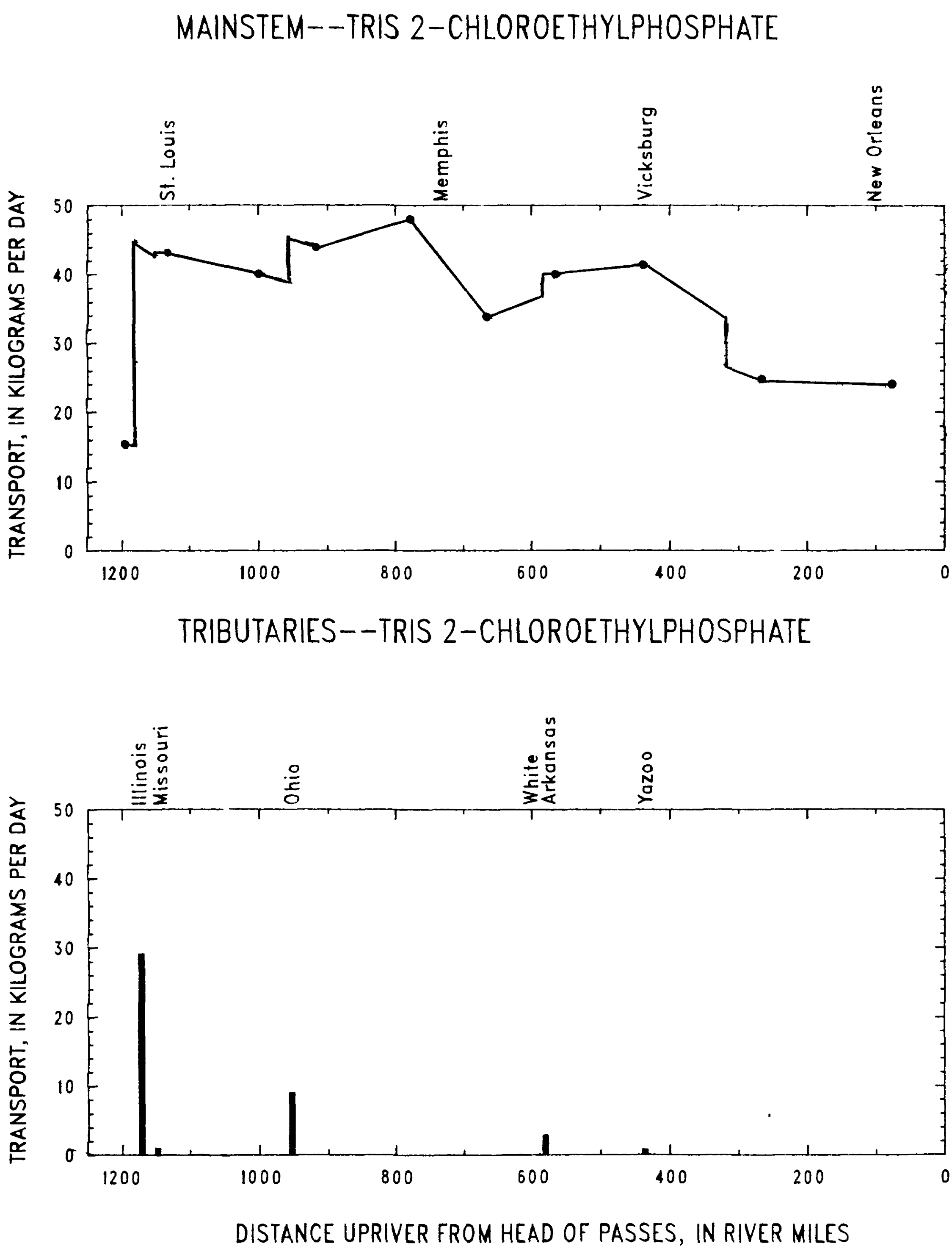


Figure 54.--Transport of tris-2-chloroethylphosphate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

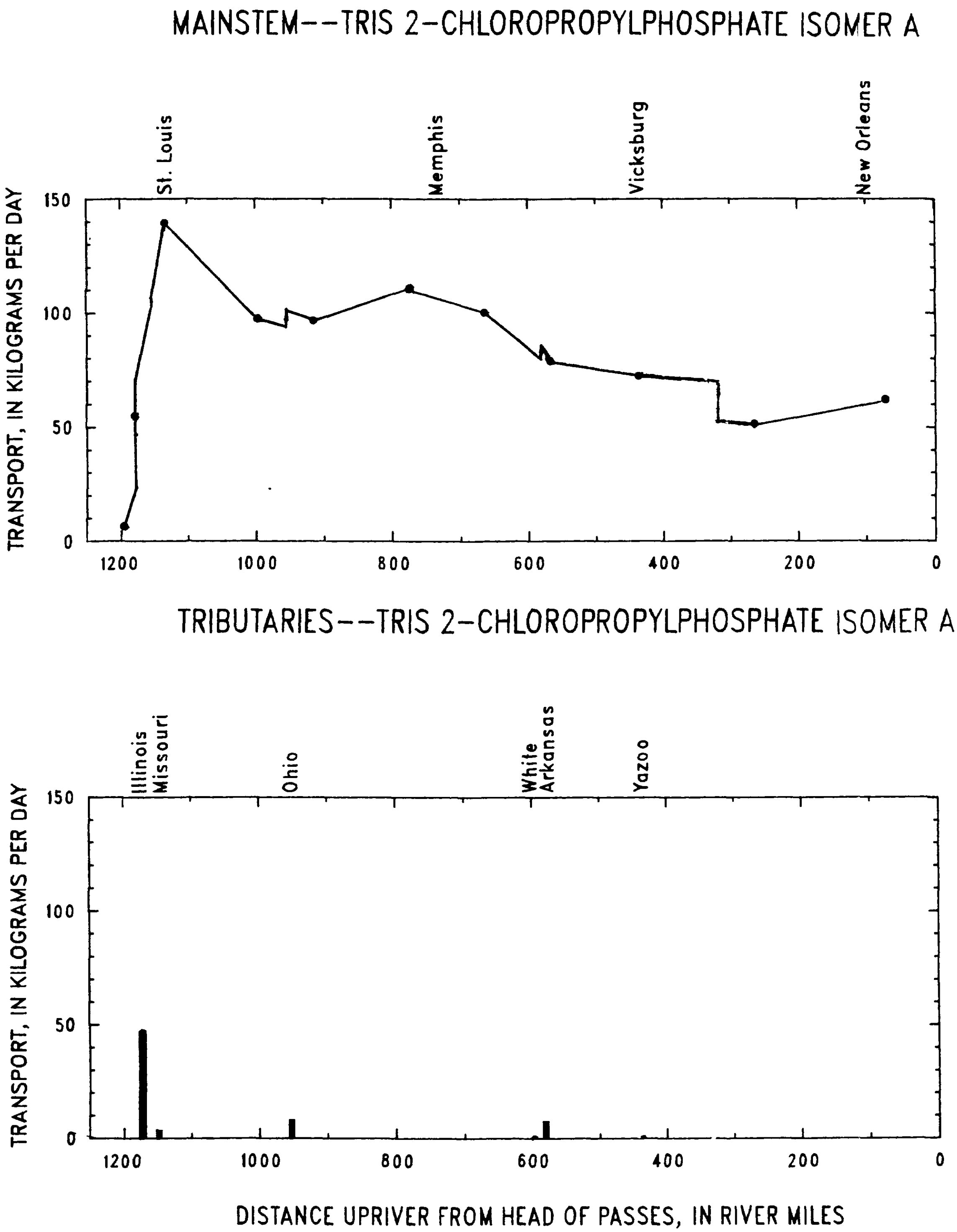


Figure 55.--Transport of tris-2-chloropropylphosphate isomer A in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

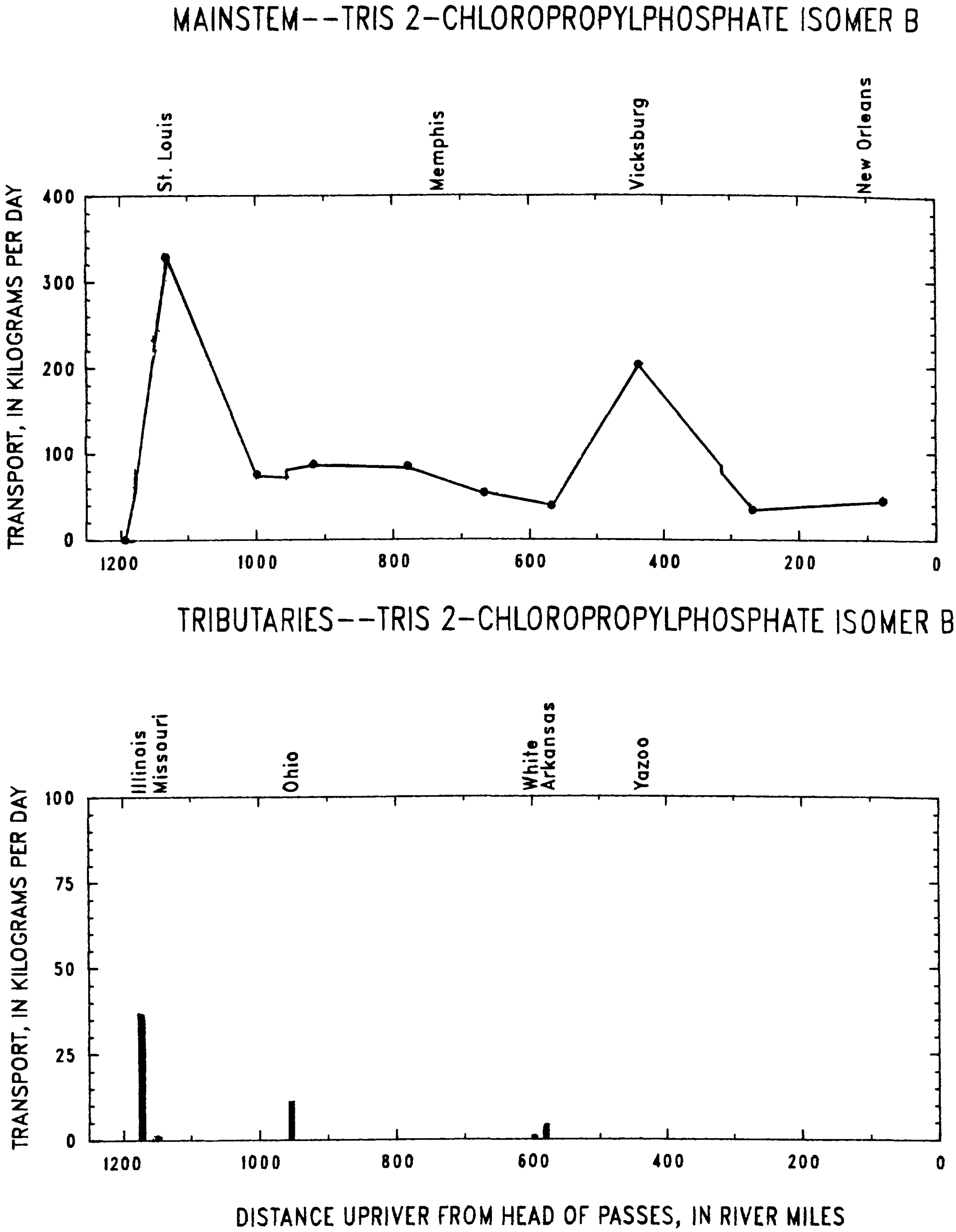


Figure 56.--Transport of tris-2-chloropropylphosphate isomer B in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between June 4 and June 28, 1989.

Table 16.--Concentrations of triazine herbicides and their transformation products in the Mississippi River and some of its tributaries for July–August 1991 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of triazine herbicides, in ng/L										
			Ametryn	Atrazine	Desethylatrazine	Desisopropylatrazine	Cyanazine	Cyanazine-amide	Hexazinone	Metribuzin	Prometon	Prometryn	Simazine
7–05	Mississippi R. above St. Anthony Falls, Minn.	470	ND	730	140	55	410	50	ND	8	10	ND	25
7–06	Minnesota R. at Mile 3.5, Minn.[2]	600	ND	900	150	150	970	210	ND	37	22	ND	27
			ND	880	150	150	980	220	ND	39	22	ND	23
7–08	Mississippi R. at Hastings, Minn.	980	ND	790	150	100	790	110	ND	19	19	ND	29
7–08	St. Croix R. at Mile 0.5, Wis.	260	ND	280	44	ND	43	ND	ND	ND	ND	ND	19
7–10	Mississippi R. near Pepin, Wis.[2]	1,350	ND	720	130	110	850	130	ND	23	21	ND	45
			ND	720	130	99	850	110	ND	24	19	ND	42
7–10	Chippewa R. at Mile 1.7, Wis.	160	ND	280	51	ND	35	ND	ND	ND	ND	ND	15
7–12	Mississippi R. at Trempealeau, Wis.	1,440	ND	630	110	88	690	86	ND	18	16	ND	37
7–15	Mississippi R. below Lock and Dam 9, Wis.	1,590	ND	640	120	77	660	84	ND	13	14	ND	36
7–15	Wisconsin R. at Mile ~1.0, Wis.	145	ND	220	76	16	97	ND	ND	ND	ND	ND	53
7–18	Mississippi R. at Clinton, Iowa	1,850	ND	540	110	62	590	68	ND	8	12	ND	30
7–20	Rock R. at Mile ~1.0, Ill.	68	5	400	180	51	330	26	ND	ND	15	ND	85
7–20	Iowa R. at Mile ~1.0, Iowa	200	ND	720	180	63	260	31	ND	ND	16	ND	28
7–21	Mississippi R.at Keokuk, Iowa	2,050	ND	630	130	56	610	100	ND	ND	11	ND	27
7–22	Des Moines R. at Mile ~1.0, Iowa	623	ND	1,500	200	84	940	83	ND	16	12	ND	24
7–24	Mississippi R. near Winfield, Mo.	2,730	ND	1,300	210	91	760	95	ND	16	14	ND	36
7–25	Illinois R. at Hardin, Ill.	260	7	510	130	66	230	ND	ND	ND	68	ND	66
7–27	Missouri R.at St. Charles, Mo.	1,100	ND	840	130	29	180	ND	ND	ND	10	ND	15
7–28	Kaskaskia R.at Mile 1.5, Ill.	7	13	4,700	860	340	780	69	ND	170	45	ND	260
7–29	Mississippi R. at Thebes, Ill.	4,390	ND	1,100	200	77	640	71	ND	11	21	ND	33
7–30	Ohio R. at Olmsted, Ill.[2]		ND	420	72	11	86	ND	ND	ND	31	ND	49
		2,410	ND	480	91	34	110	ND	ND	ND	38	ND	62
8–01	White R. at Mile 1.2, Ark.	374	ND	54	5	ND	ND	ND	ND	ND	ND	ND	8
8–01	Arkansas R.at Mile 0.0, Ark.	480	ND	320	69	25	ND	ND	ND	ND	18	ND	31
8–02	Yazoo R. at Mile ~3.0, Miss.	640	ND	160	15	ND	590	ND	71	77	ND	75	22

Table 16.–Concentrations of triazine herbicides and their transformation products in the Mississippi River and some of its tributaries for July–August 1991 cruise–Continued

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of triazine herbicides, in ng/L										
			Ametryn	Atrazine	Desethyl-atrazine	Desisopropyl-atrazine	Cyanazine	Cyanazine-amide	Hexazinone	Metribuzin	Prometon	Prometryn	Simazine
8–03	Mississippi R. below Vicksburg, Miss.[2]	8,750	ND	950	150	52	420	51	22	16	19	5	39
			ND	920	140	39	420	38	26	15	15	5	35
8–05	Mississippi R. near St. Francisville, La.	6,190	ND	1,000	150	53	450	41	43	20	15	8	44
8–07	Mississippi R. below Belle Chasse, La.	4,340	ND	1,100	160	50	490	47	16	23	14	6	47

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.
[2]Duplicate samples collected.

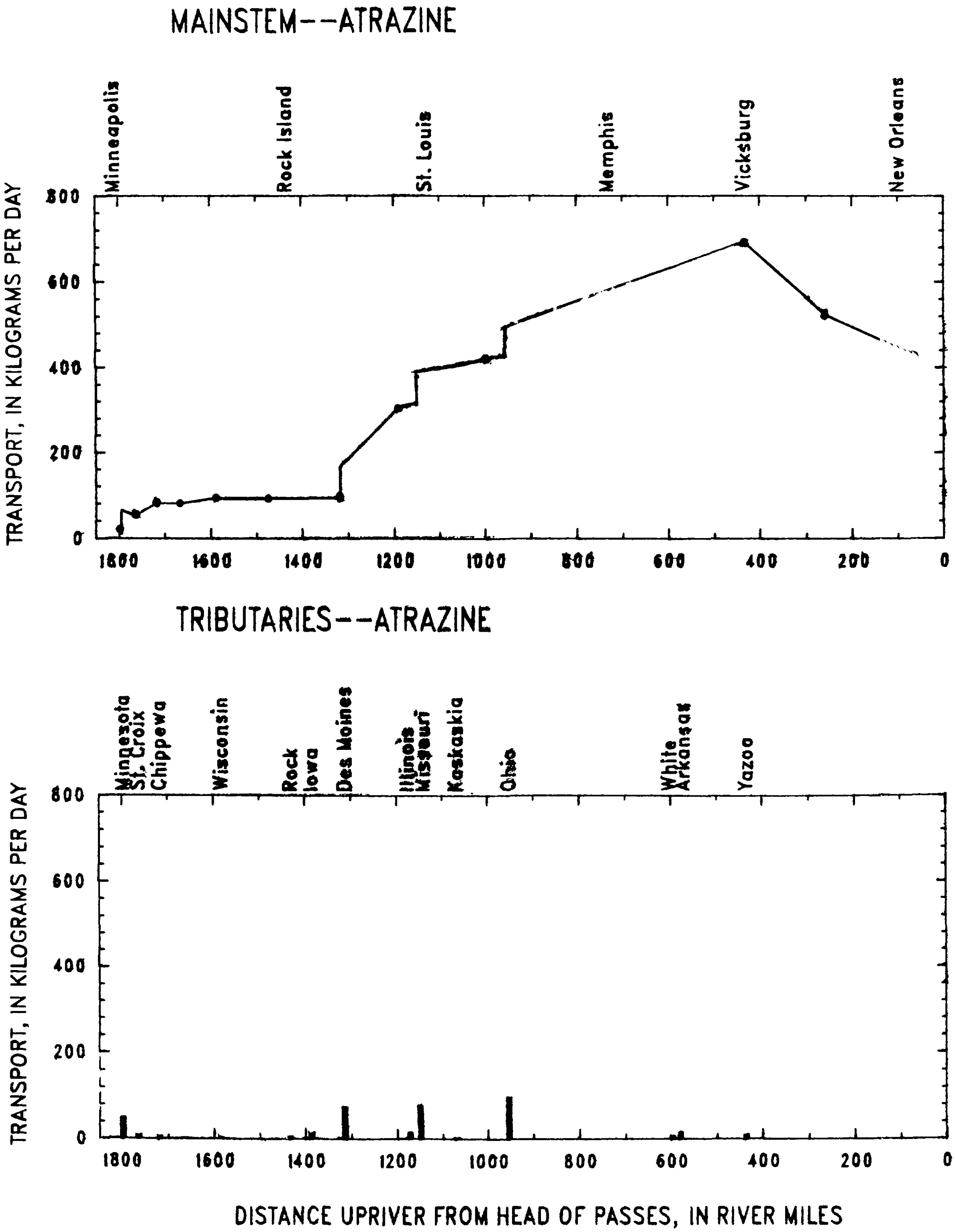


Figure 57.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

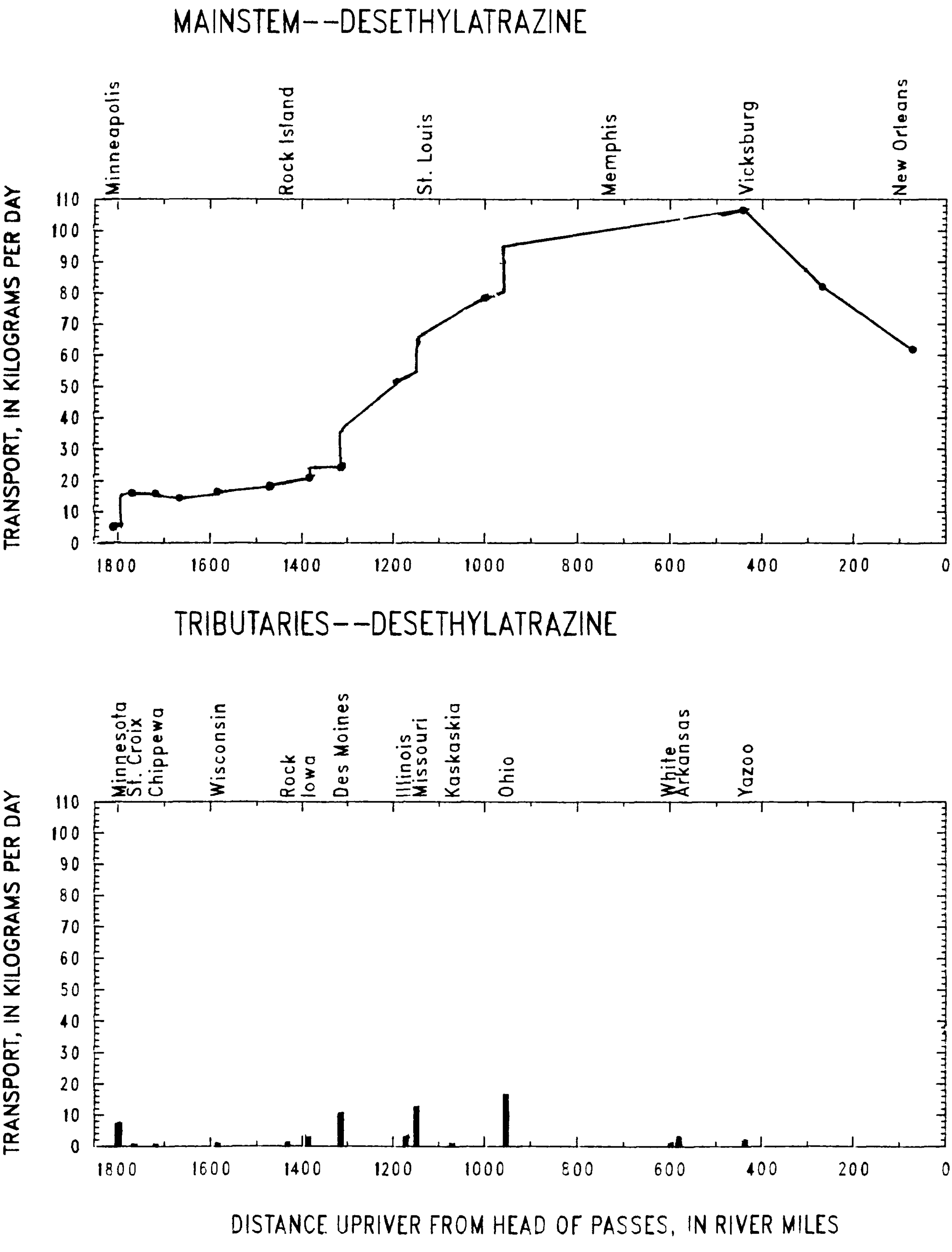


Figure 58.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

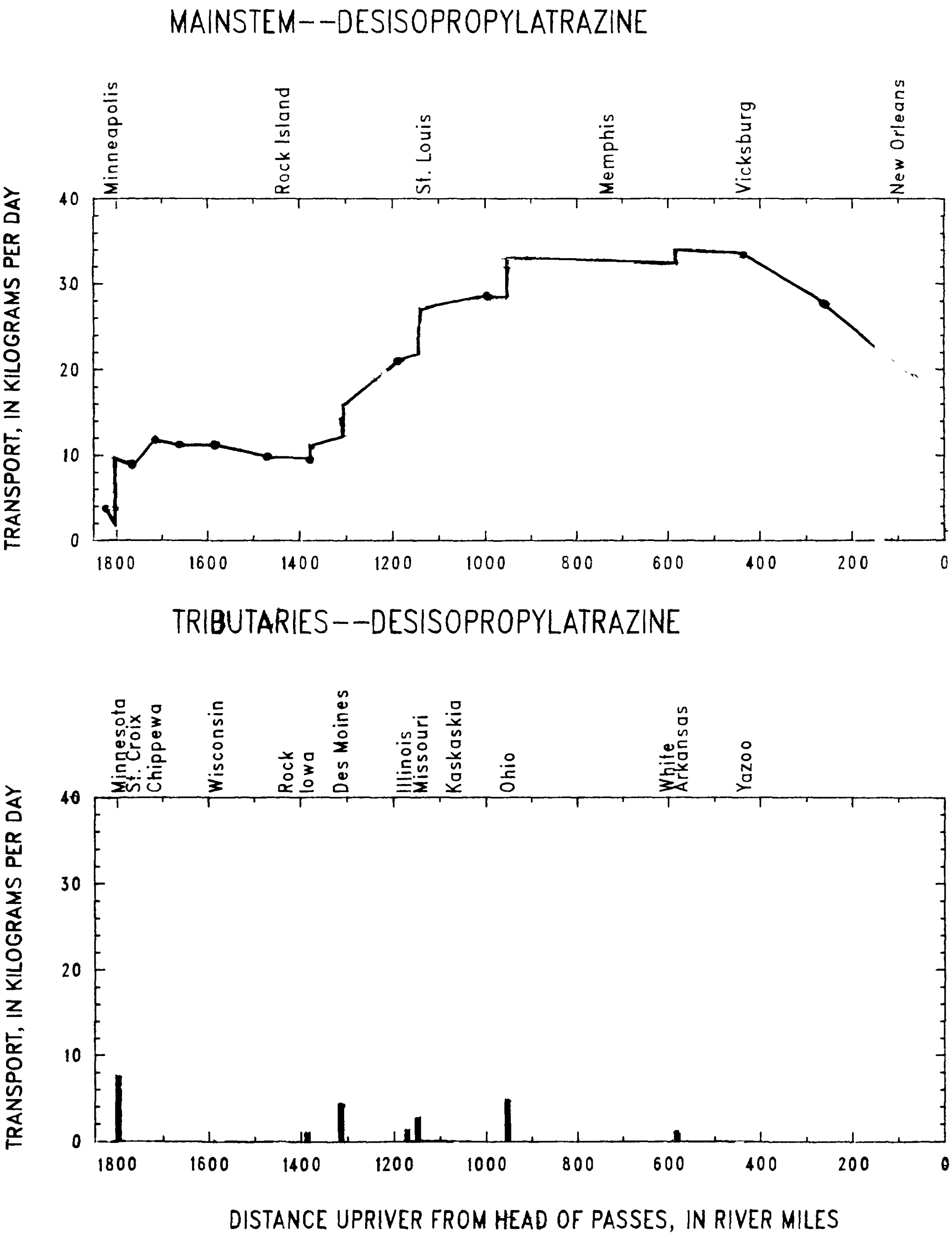


Figure 59.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

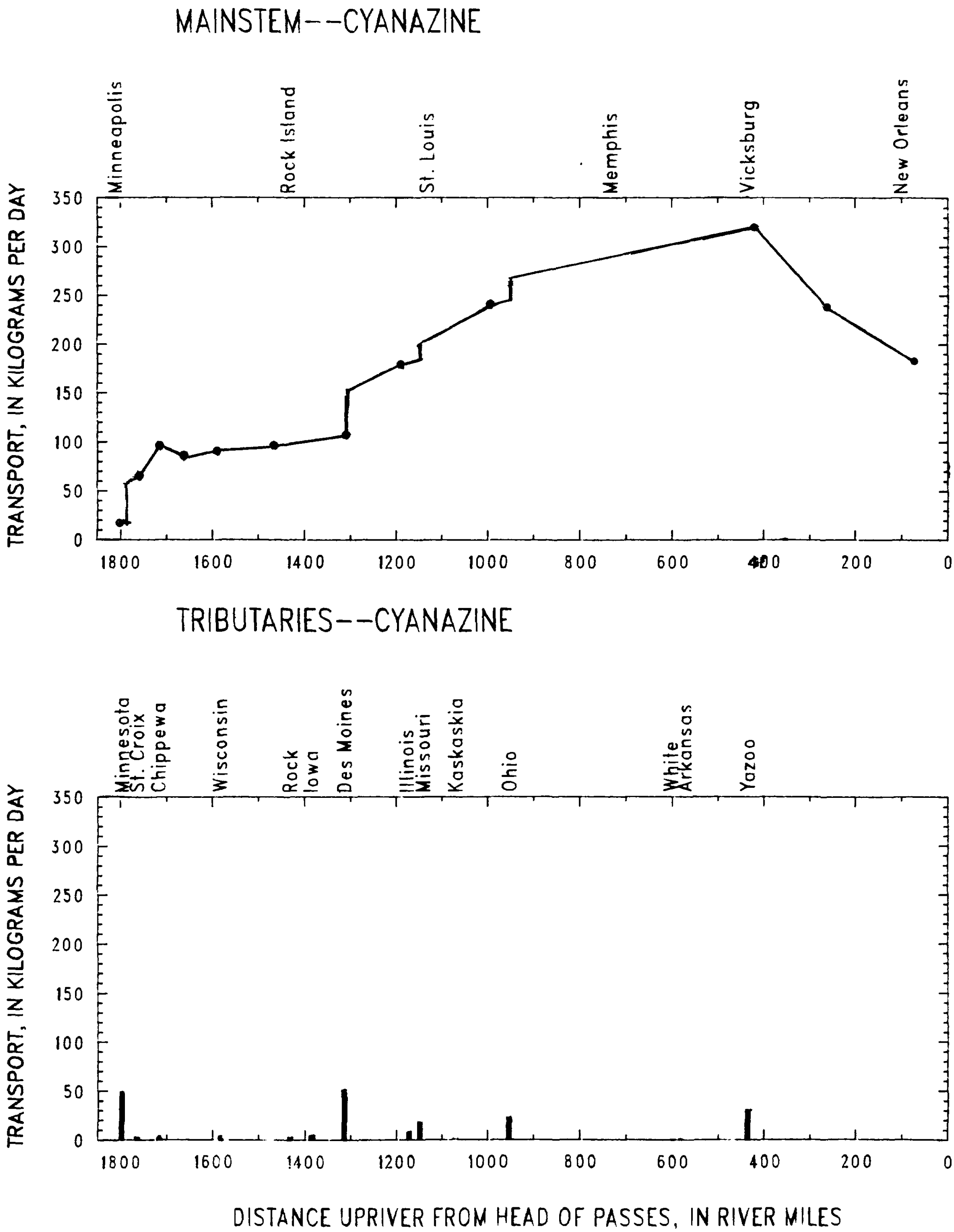


Figure 60.--Transport of cyanazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

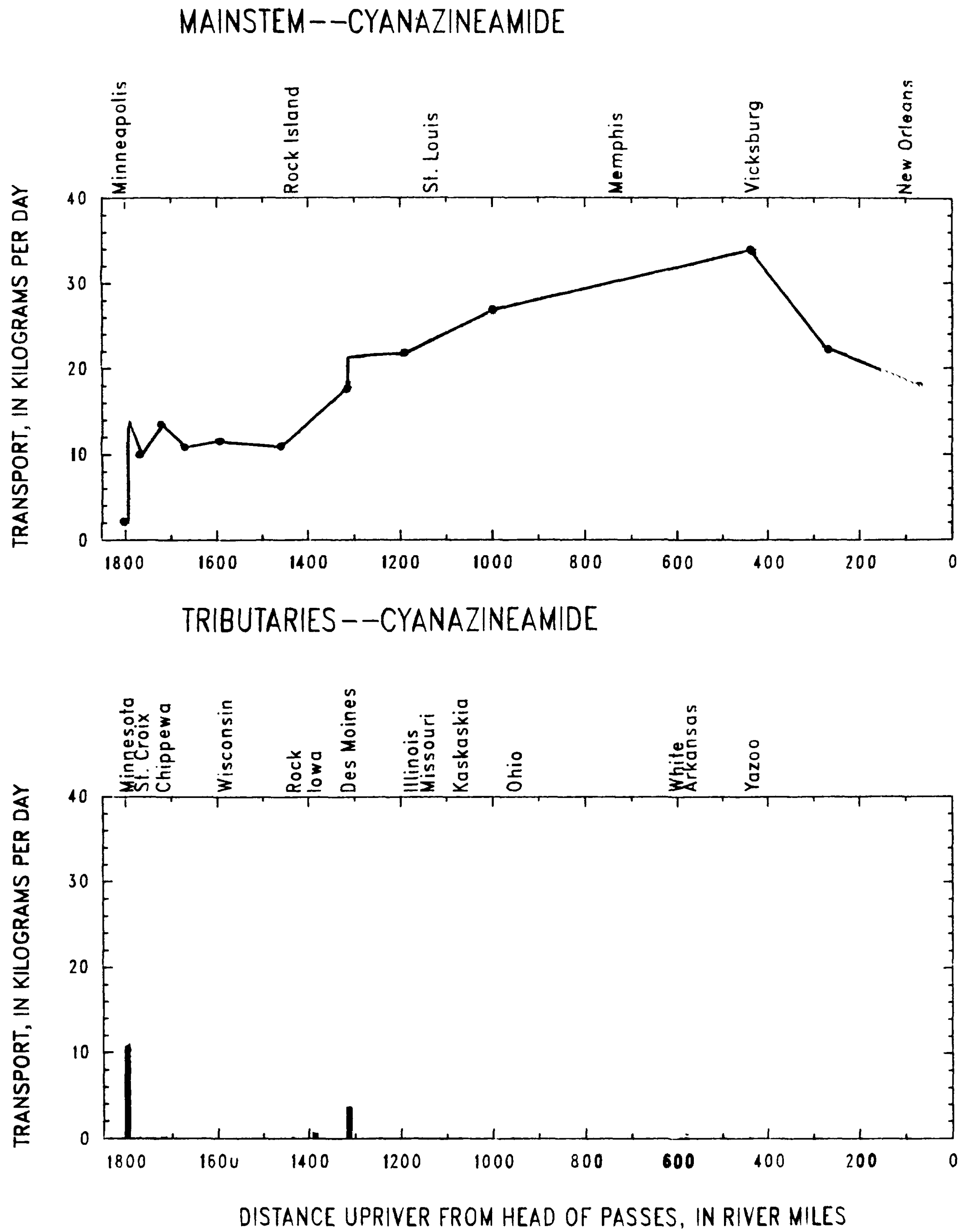


Figure 61.--Transport of cyanazineamide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

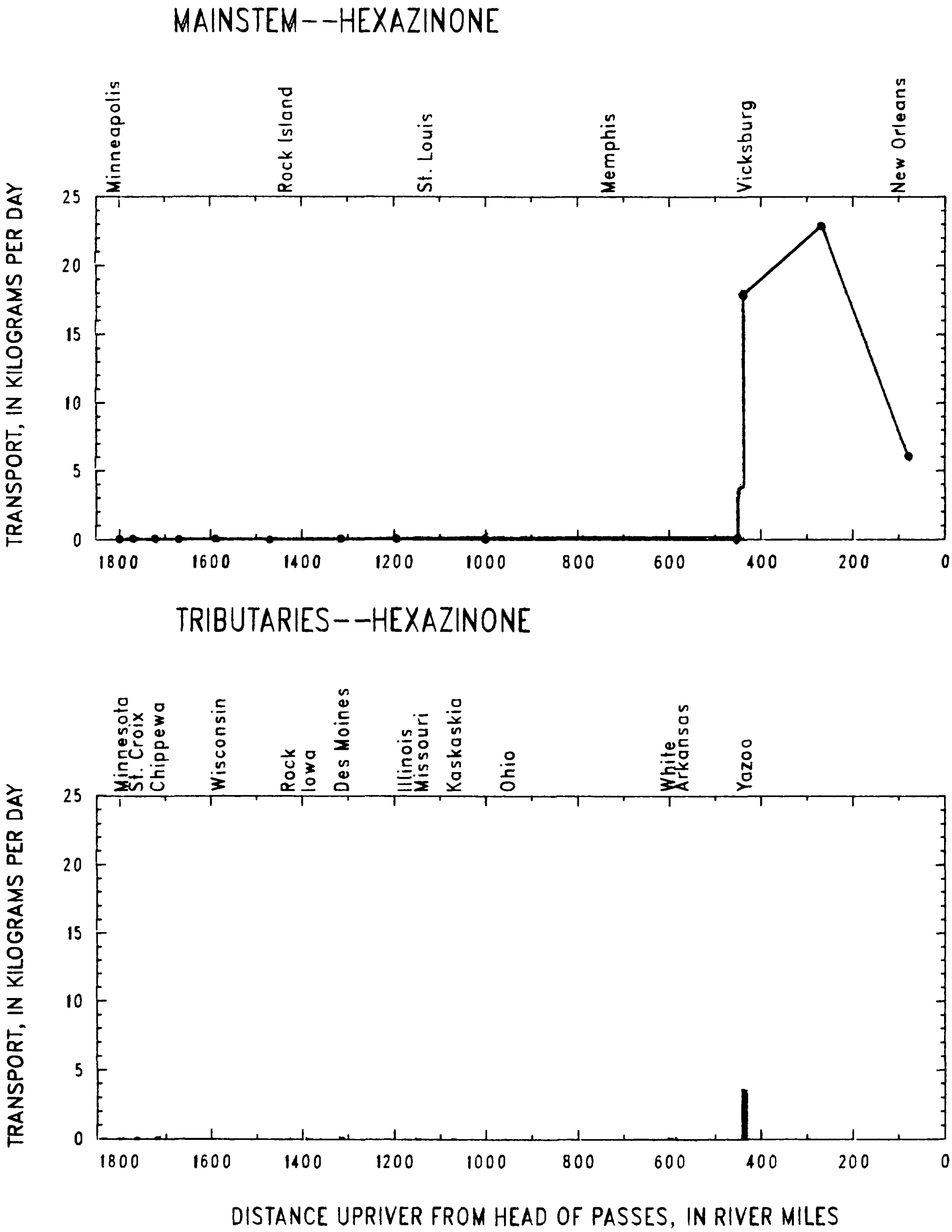


Figure 62.--Transport of hexazinone in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

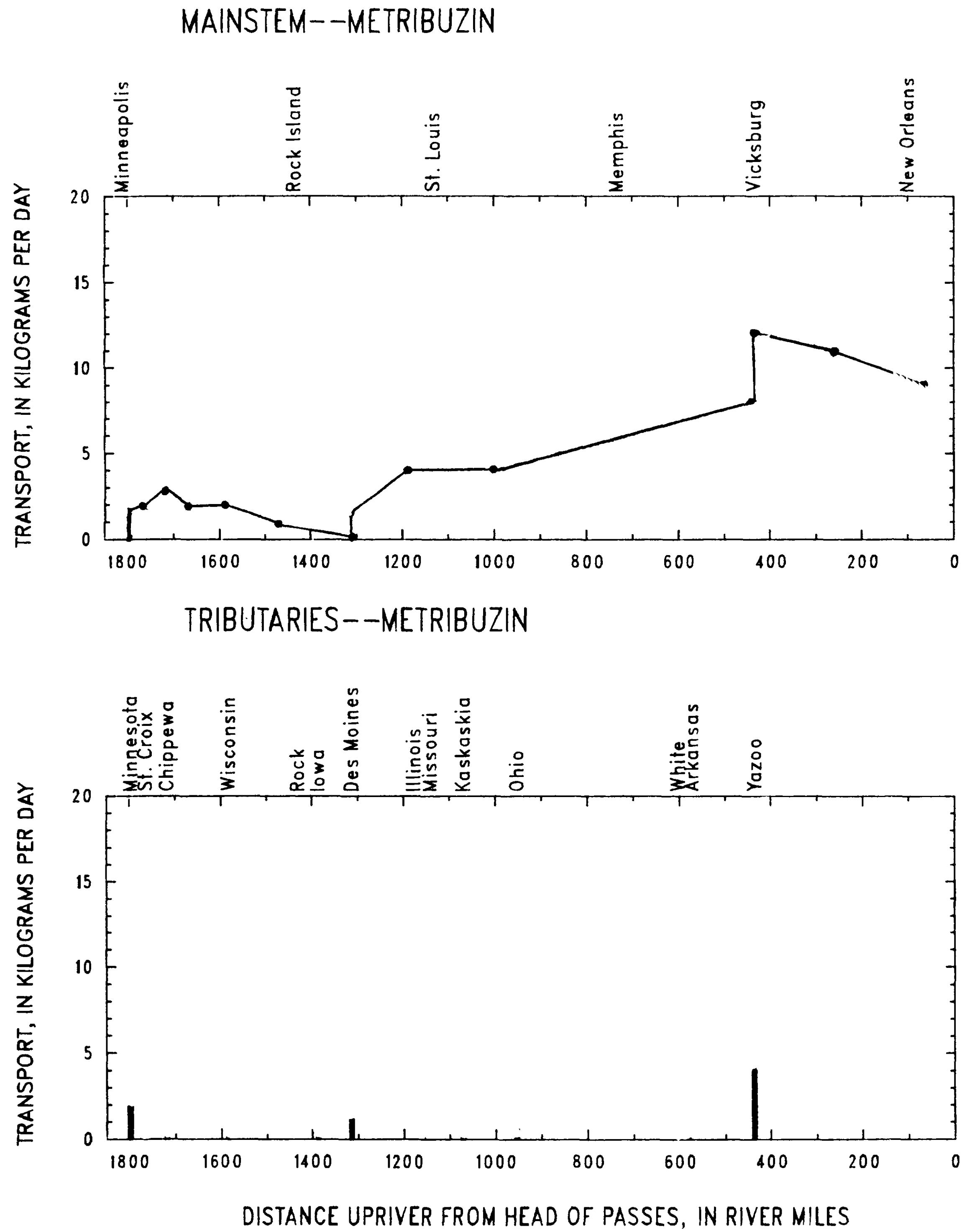


Figure 63.--Transport of metribuzin in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

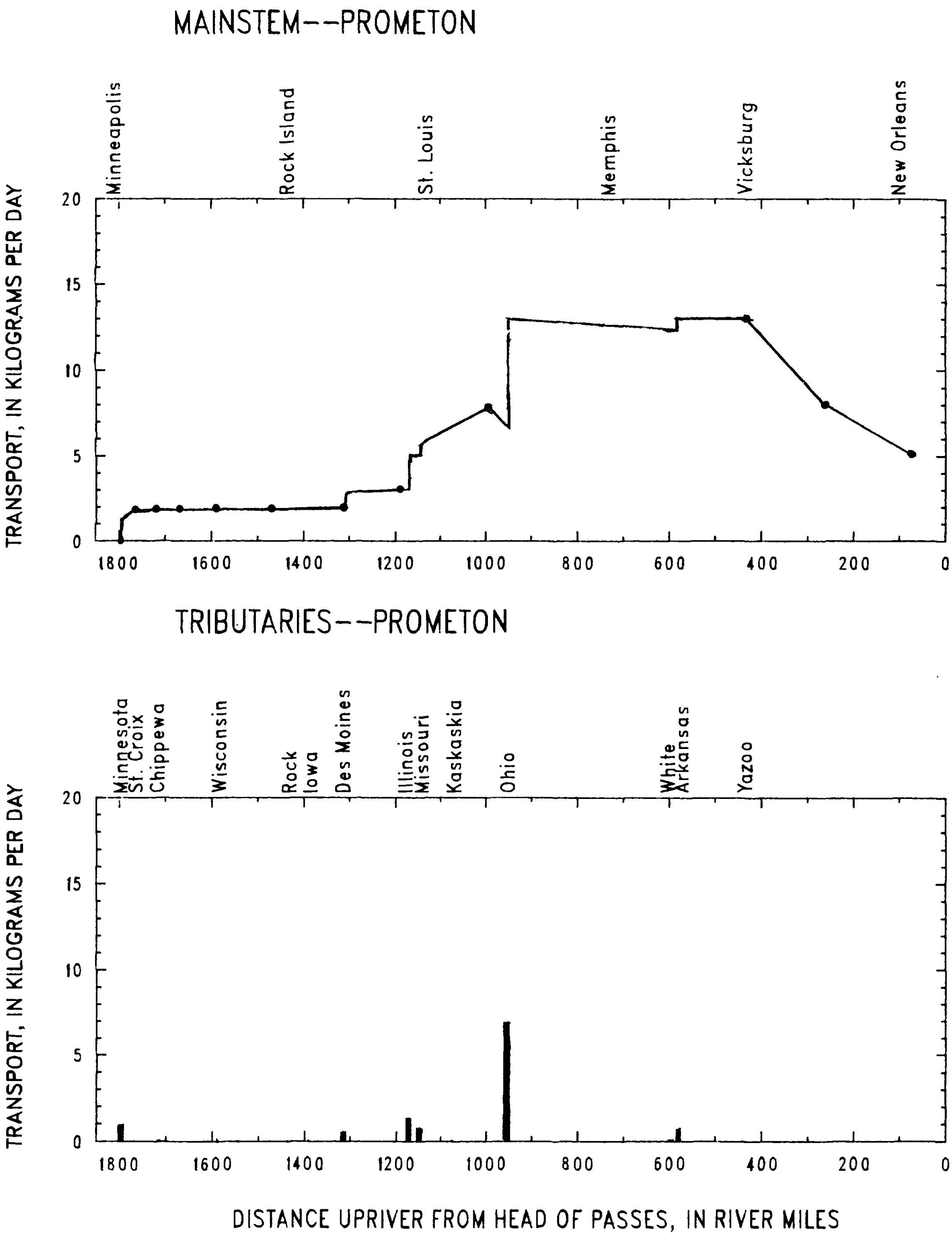


Figure 64.--Transport of prometon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

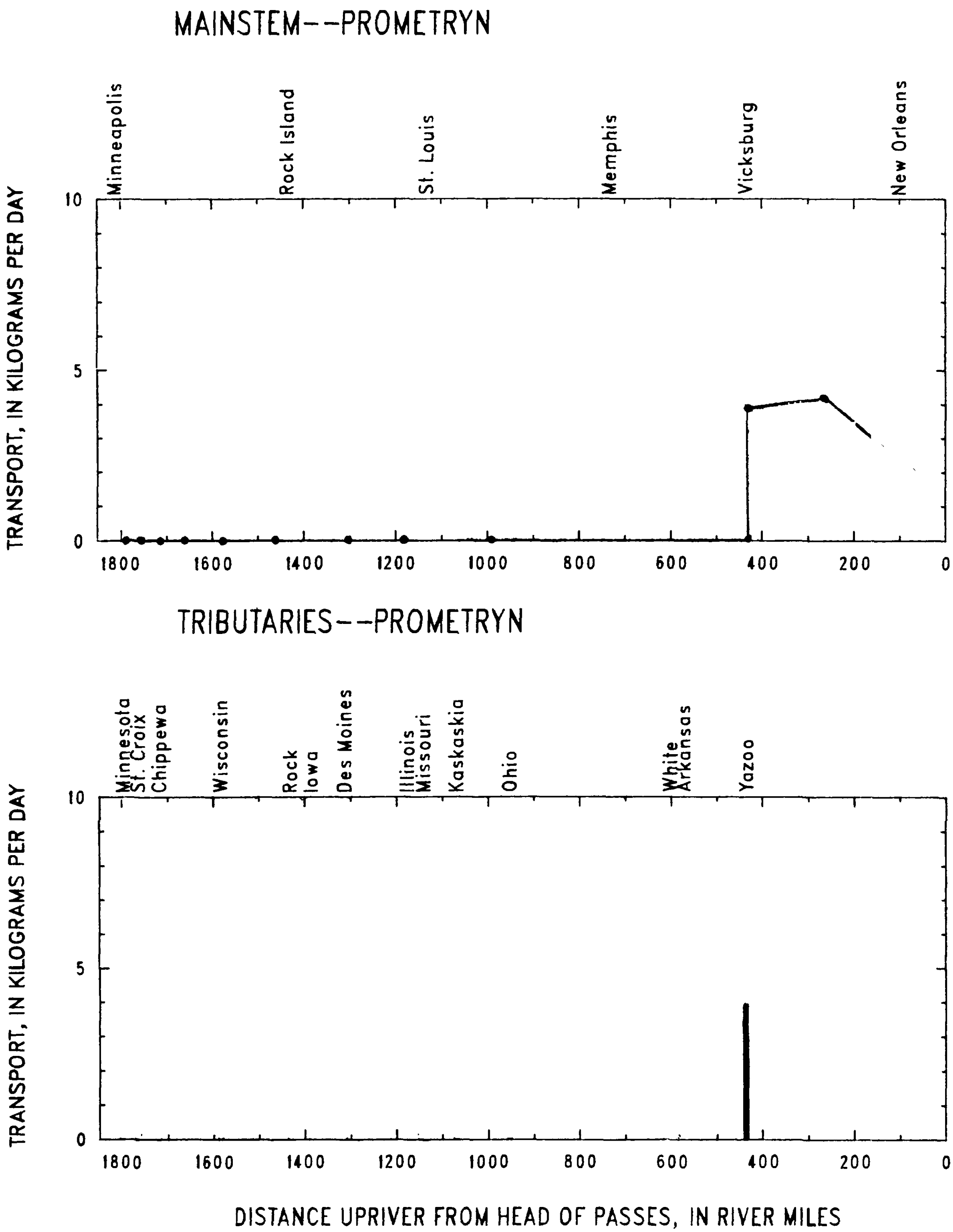


Figure 65.--Transport of prometryn in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

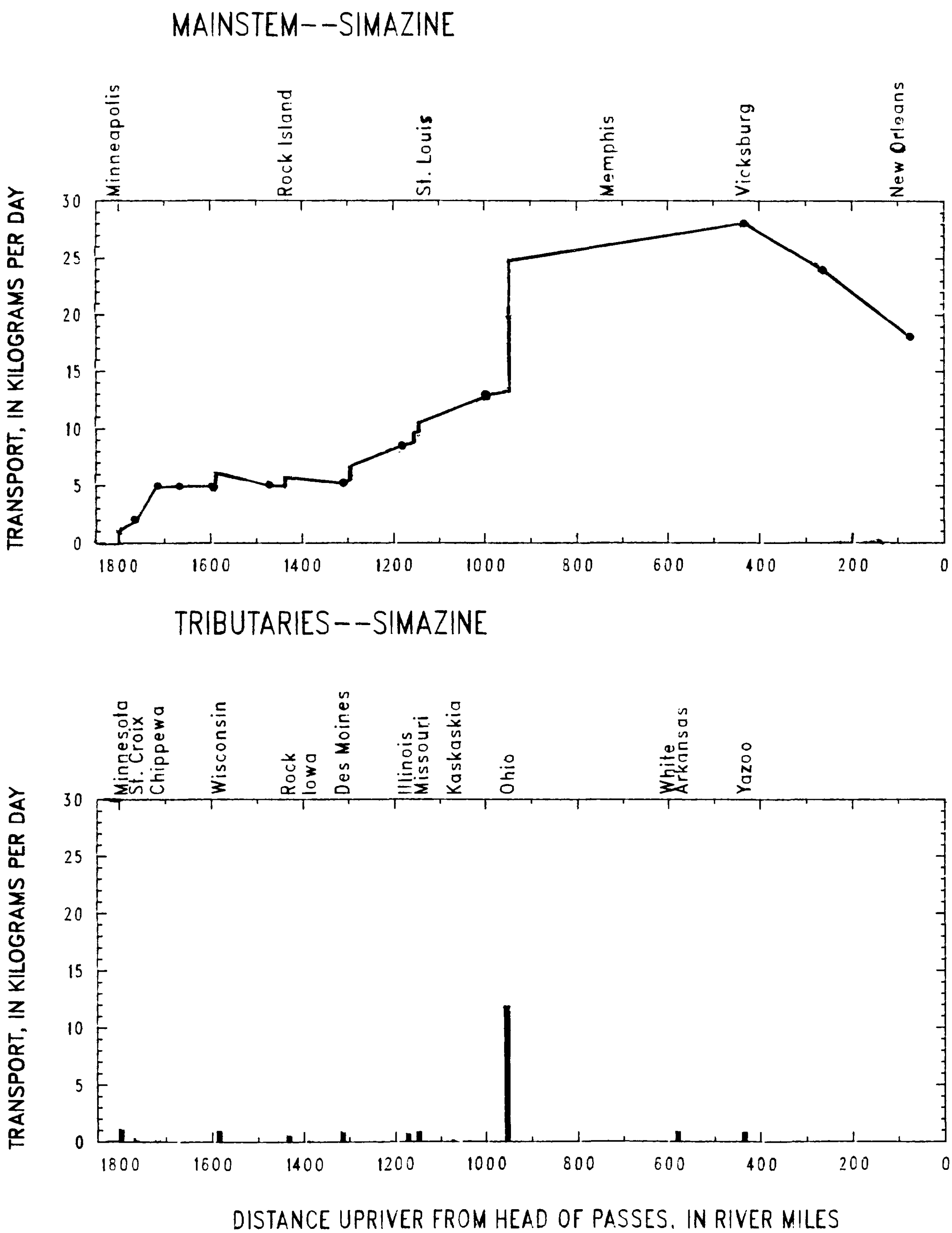


Figure 66.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

Table 17.--Concentrations of chloroacetanilide herbicides and their transformation products in the Mississippi River and some of its tributaries for July–August 1991 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of chloroacetanilide herbicides, in ng/L			
			Alachlor	2-chloro-2′,6′-diethylacetanilide	2-hydroxy-2′,6′-diethylacetanilide	Metolachlor
7–05	Mississippi R. above St. Anthony Falls, Minn.	470	110	ND	85	120
7–06	Minnesota R. at Mile 3.5, Minn.[2]	600	440	8	53	700
			480	7	48	710
7–08	Mississippi R. at Hastings, Minn.	980	250	ND	31	420
7–08	St. Croix R. at Mile 0.5, Wis.	260	24	ND	69	63
7–10	Mississippi R. near Pepin, Wis.[2]	1,350	310	6	27	490
			320	6	38	480
7–10	Chippewa R. at Mile 1.7, Wis.	160	13	ND	35	28
7–12	Mississippi R. at Trempealeau, Wis.	1,440	240	ND	ND	390
7–15	Mississippi R. below Lock and Dam 9, Wis.	1,590	190	ND	ND	350
7–15	Wisconsin R. at Mile ~1.0, Wis.	145	25	ND	ND	24
7–18	Mississippi R. at Clinton, Iowa	1,850	140	ND	47	280
7–20	Rock R. at Mile ~1.0, Ill.	68	13	ND	49	67
7–20	Iowa R. at Mile ~1.0, Iowa	200	110	ND	19	520
7–21	Mississippi R. at Keokuk, Iowa	2,050	250	ND	24	320
7–22	Des Moines R. at Mile ~1.0, Iowa	623	430	7	10	1,900
7–24	Mississippi R. near Winfield, Mo.	2,730	290	5	18	760
7–25	Illinois R. at Hardin, Ill	260	10	ND	ND	93
7–27	Missouri R. at St. Charles, Mo.	1,100	12	ND	ND	140
7–28	Kaskaskia R. at Mile 1.5, Ill.	7	560	35	42	1,500
7–29	Mississippi R. at Thebes, Ill.	4,390	190	ND	20	520
7–30	Ohio R. at Olmsted, Ill.[2]	2,410	20	ND	30	100
			29	ND	30	120
8–01	White R. at Mile 1.2, Ark.	374	ND	ND	ND	55
8–01	Arkansas R. at Mile 0.0, Ark.	480	8	ND	17	35
8–02	Yazoo R. at Mile ~3.0, Miss.	640	19	ND	ND	180
8–03	Mississippi R. below Vicksburg, Miss.[2]	8,750	92	ND	ND	350
			95	ND	ND	ND
8–05	Mississippi R. near St. Francisville, La.	6,190	120	ND	ND	360
8–07	Mississippi R. below Belle Chasse, La.	4,340	170	6	ND	380

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.

[2]Duplicate samples collected.

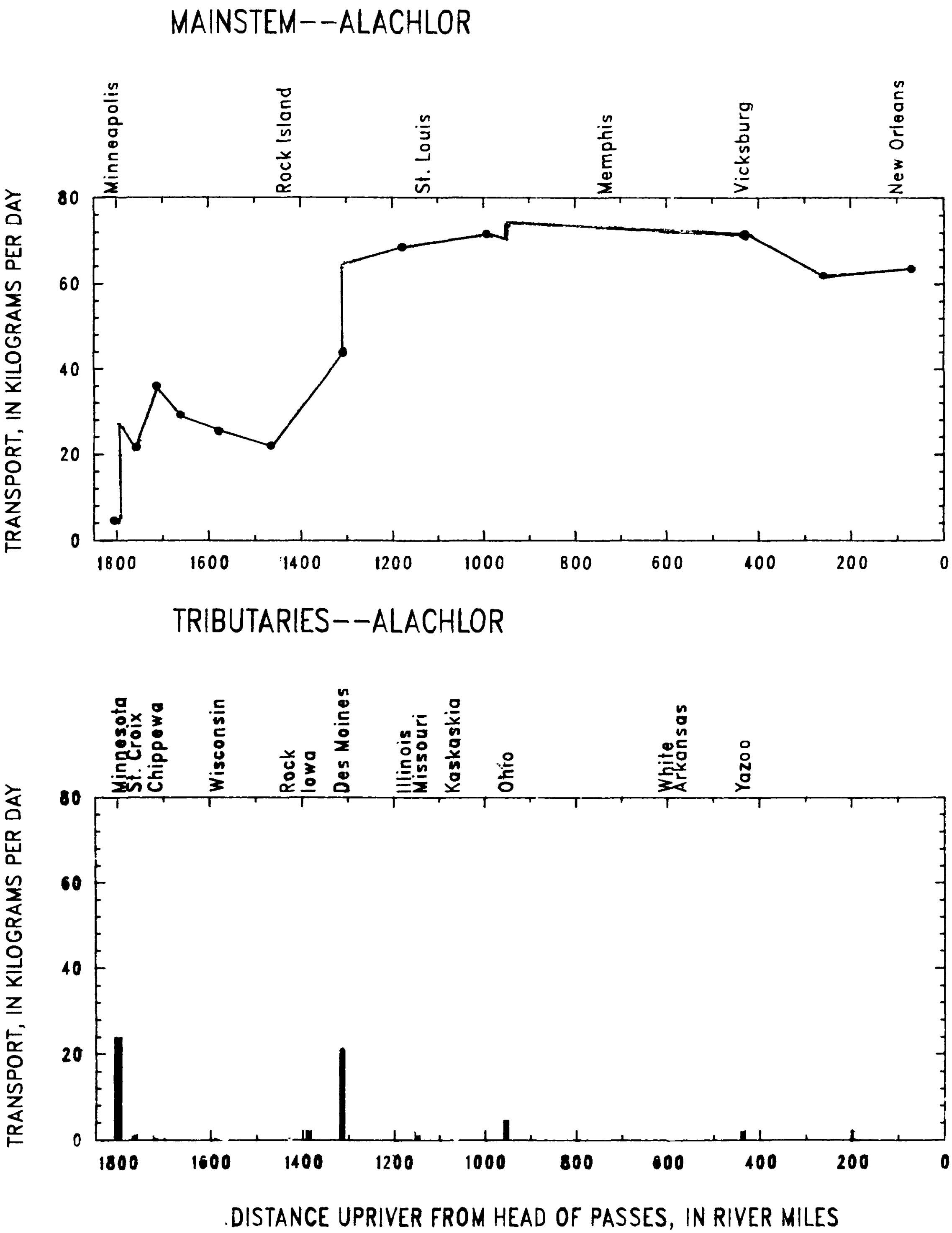


Figure 67.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

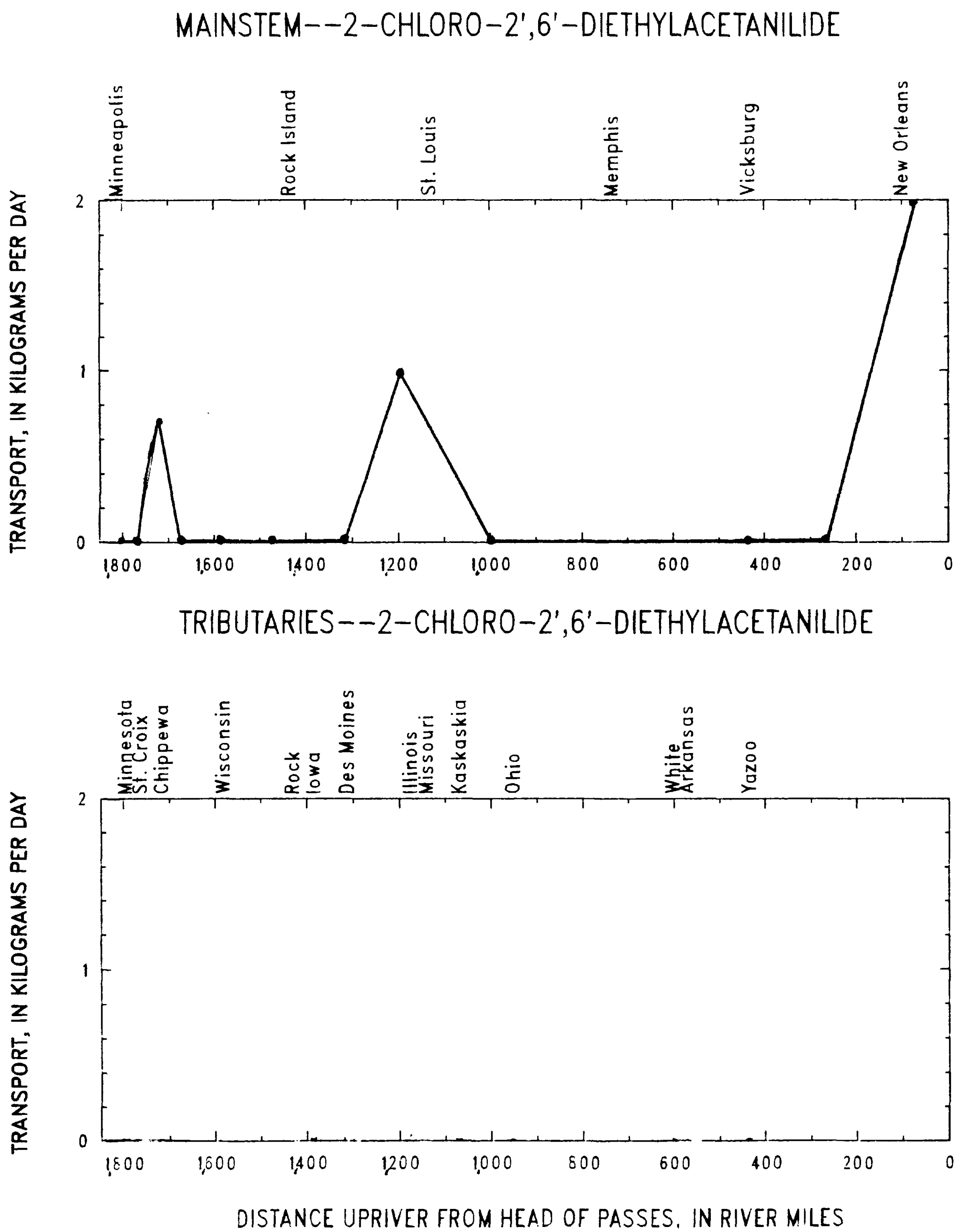


Figure 68.--Transport of 2-chloro-2',6'-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

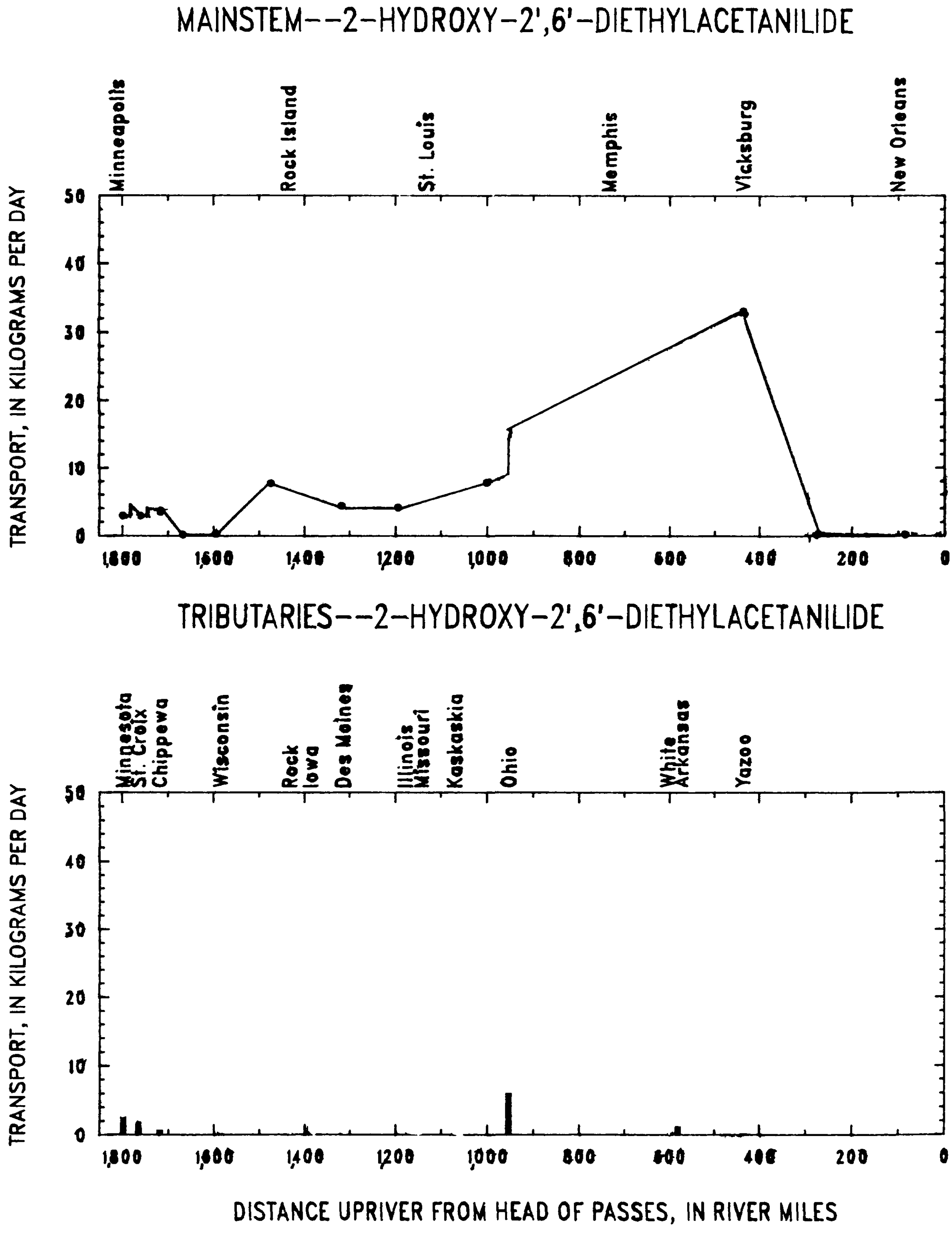


Figure 69.--Transport of 2-hydroxy-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

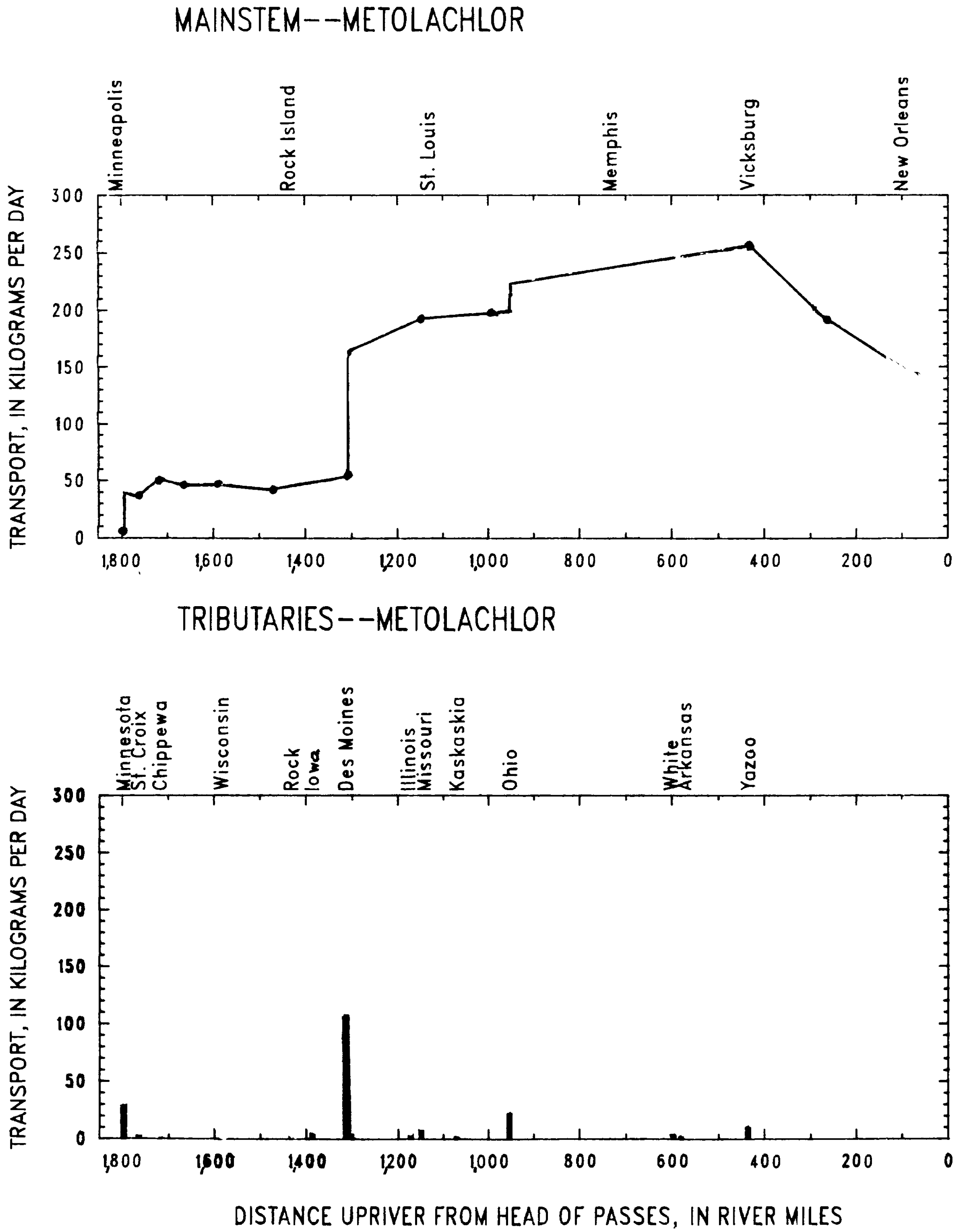


Figure 70.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

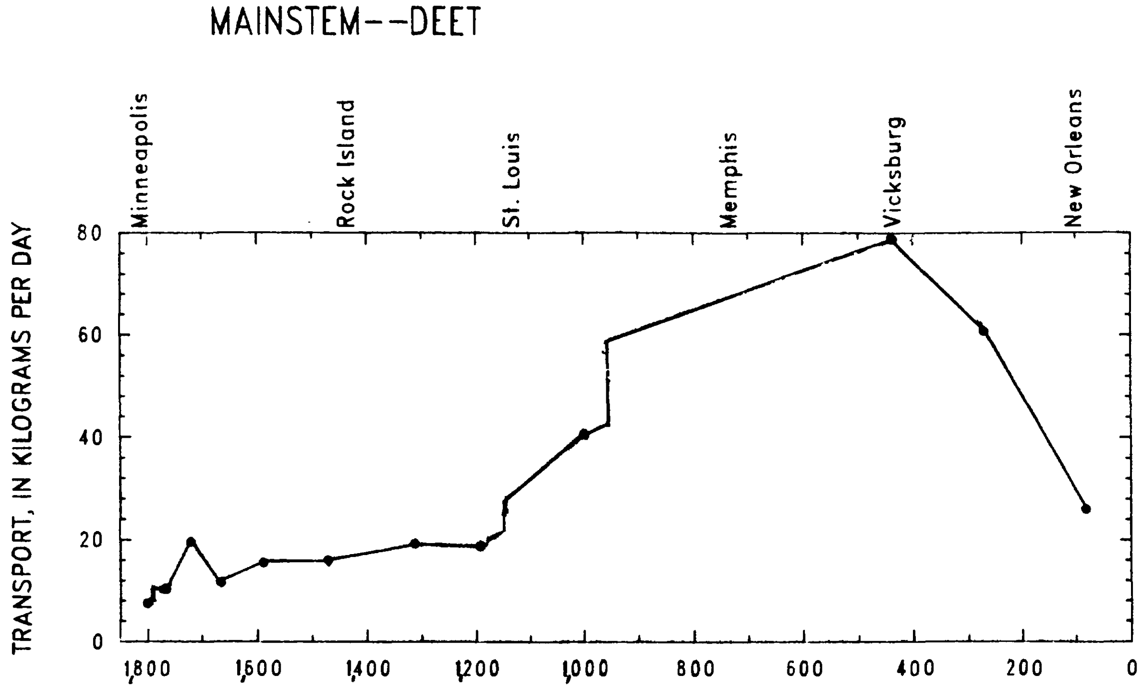
Table 18.--Concentrations of miscellaneous pesticides and their transformation products in the Mississippi River and some of its tributaries for July-August 1991 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of miscellaneous pesticides and their transformation products, in ng/L							
			Deet	Diazinon	Fluometuron	Molinate	4-keto-molinate	Norflurazon	Desmethyl-norflurazon	Thiobencarb
7–05	Mississippi R. above St. Anthony Falls, Minn.	470	200	ND	ND	ND	ND	ND	ND	ND
7–06	Minnesota R. at Mile 3.5, Minn.[2]	600	81	ND	ND	ND	ND	ND	ND	ND
			90	ND	ND	ND	ND	ND	ND	ND
7–08	Mississippi R. at Hastings, Minn.	980	120	ND	ND	ND	ND	ND	ND	ND
7–08	St. Croix R. at Mile 0.5, Wis.	260	ND	ND	ND	ND	ND	ND	ND	ND
7–10	Mississippi R. near Pepin, Wis.[2]	1,350	170	ND	ND	ND	ND	ND	ND	ND
			170	ND	ND	ND	ND	ND	ND	ND
7–10	Chippewa R. at Mile 1.7, Wis.	160	ND	ND	ND	ND	ND	ND	ND	ND
7–12	Mississippi R. at Trempealeau, Wis.	1,440	88	ND	ND	ND	ND	ND	ND	ND
7–15	Mississippi R. below Lock and Dam 9, Wis.	1,590	110	ND	ND	ND	ND	ND	ND	ND
7–15	Wisconsin R. at Mile ~1.0, Wis.	145	28	ND	ND	ND	ND	ND	ND	ND
7–18	Mississippi R. at Clinton, Iowa	1,850	92	ND	ND	ND	ND	ND	ND	ND
7–20	Rock R. at Mile ~1.0, Ill.	68	39	ND	ND	ND	ND	ND	ND	ND
7–20	Iowa R. at Mile ~1.0, Iowa	200	ND	ND	ND	ND	ND	ND	ND	ND
7–21	Mississippi R. at Keokuk, Iowa	2,050	100	ND	ND	ND	ND	ND	ND	ND
7–22	Des Moines R. at Mile ~1.0, Iowa	623	ND	ND	ND	ND	ND	ND	ND	ND
7–24	Mississippi R. near Winfield, Mo.	2,730	76	ND	ND	ND	ND	ND	ND	ND
7–25	Illinois R. at Hardin, Ill.	260	38	ND	ND	ND	ND	ND	ND	ND
7–27	Missouri R. at St. Charles, Mo.	1,100	64	ND	ND	ND	ND	ND	ND	ND
7–28	Kaskaskia R. at Mile 1.5, Ill.	7	12	ND	ND	ND	ND	ND	ND	ND
7–29	Mississippi R. at Thebes, Ill.	4,390	110	10	ND	ND	ND	ND	ND	ND
7–30	Ohio R. at Olmsted, Ill.[2]	2,410	72	ND	ND	ND	ND	ND	ND	ND
			79	ND	ND	ND	ND	ND	ND	ND
8–01	White R. at Mile 1.2, Ark.	374	5	ND	19	240	291	ND	ND	ND
8–01	Arkansas R. at Mile 0.0, Ark.	480	17	ND	9	ND	120	ND	ND	ND
8–02	Yazoo R. at Mile ~3.0, Miss.	640	7	ND	410	2,600	1,600	300	120	62
8–03	Mississippi R. below Vicksburg, Miss.[2]	8,750	100	ND	93	360	200	51	ND	ND
			110	ND	89	430	200	38	ND	ND
8–05	Mississippi R. near St. Francisville, La.	6,190	110	8	75	360	210	30	14	ND
8–07	Mississippi R. below Belle Chasse, La.	4,340	69	ND	75	130	90	27	ND	ND

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.

[2]Duplicate samples collected.



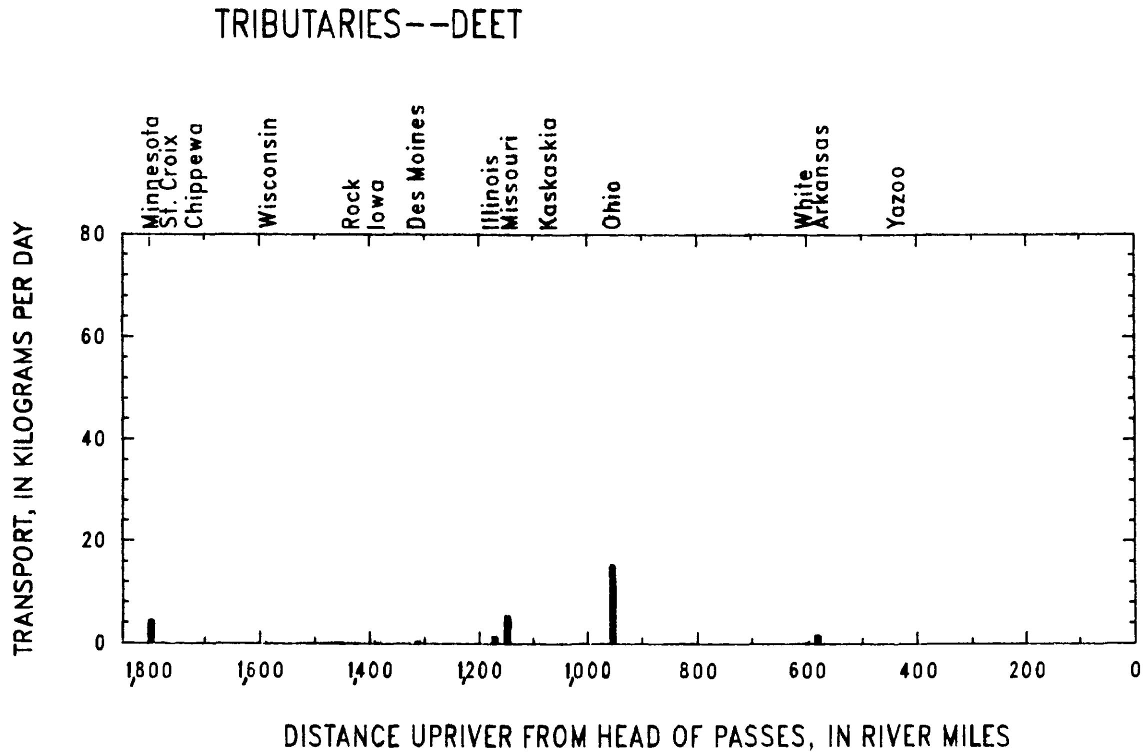


Figure 71.--Transport of deet in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

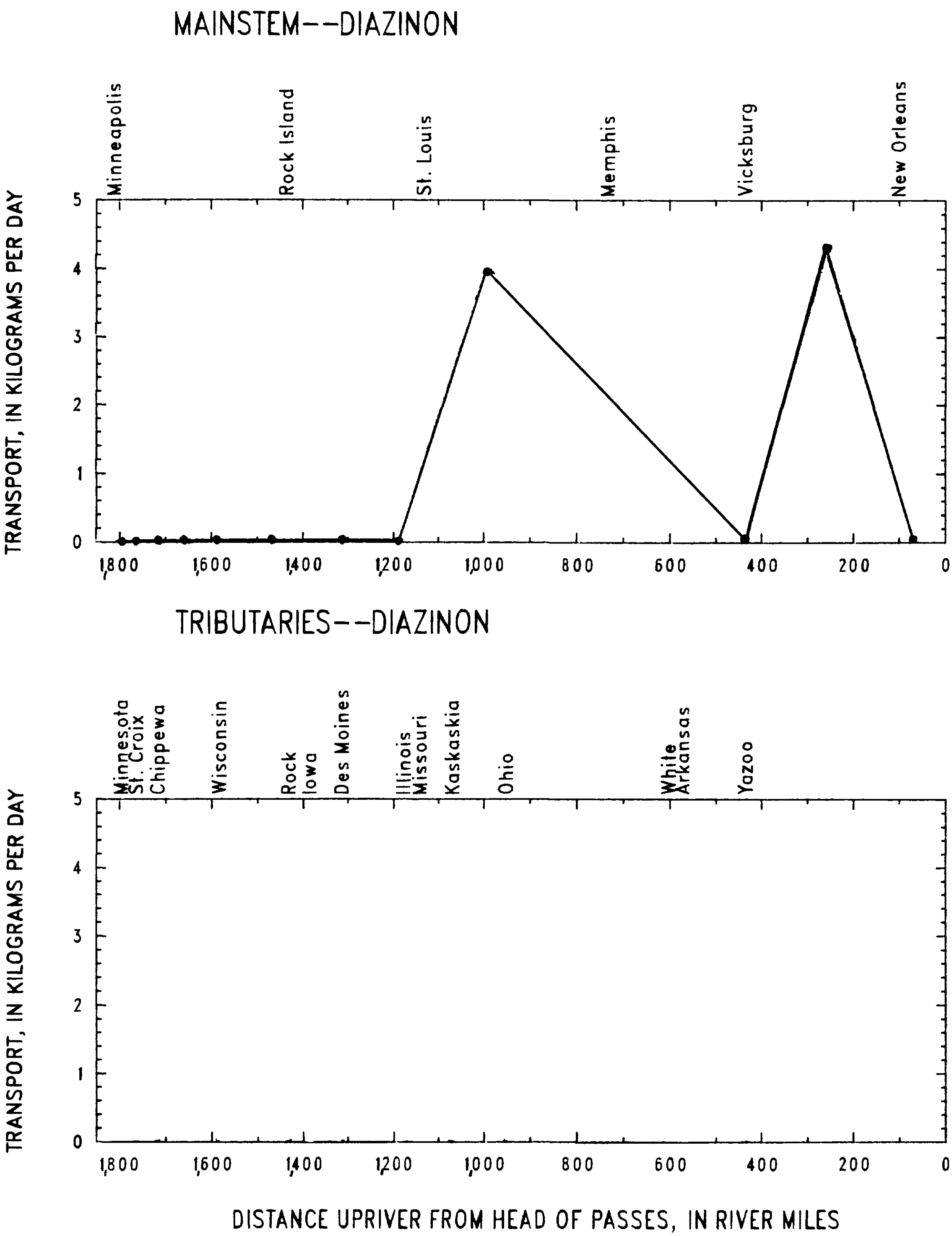


Figure 72.--Transport of diazinon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

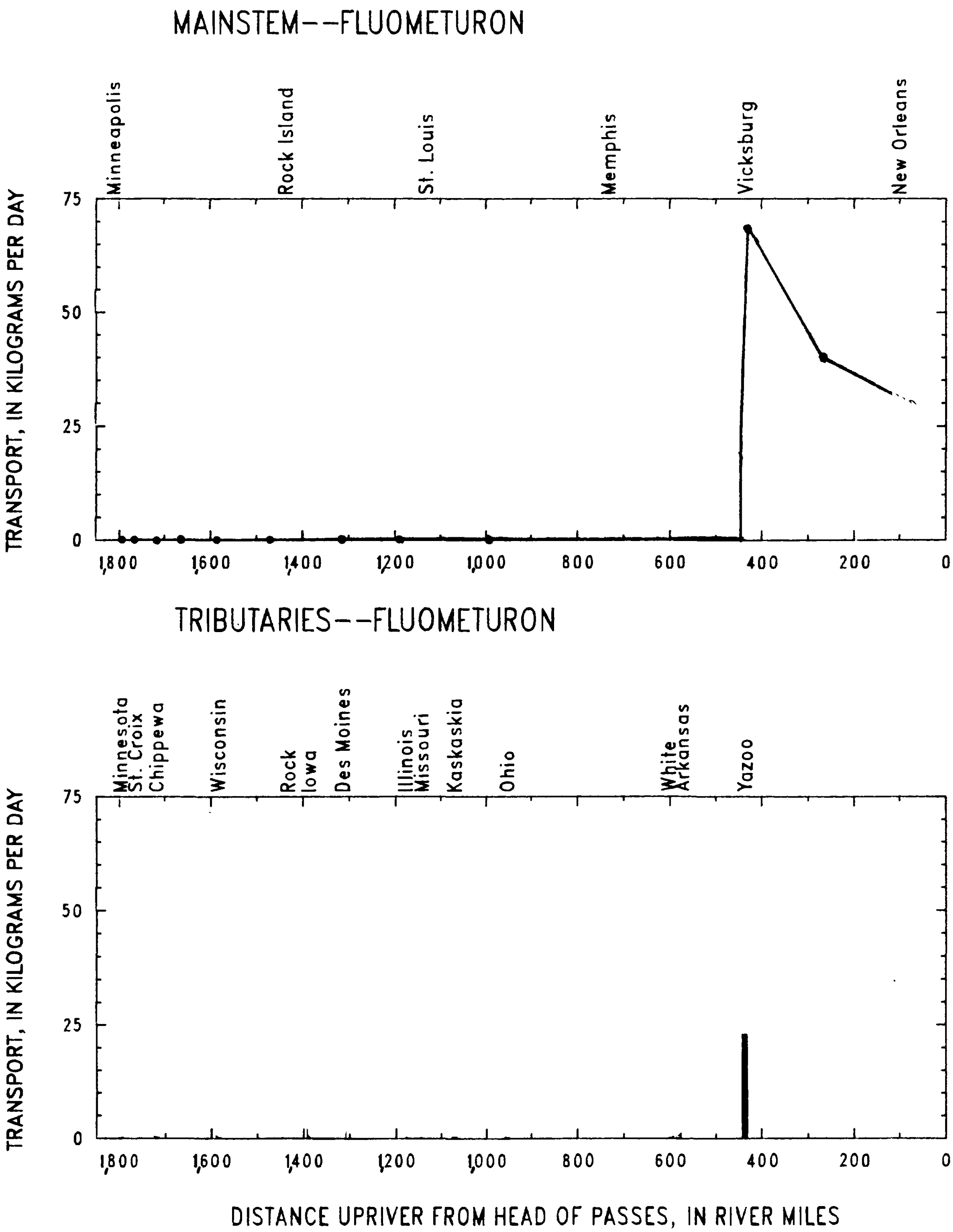


Figure 73.--Transport of fluometuron in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

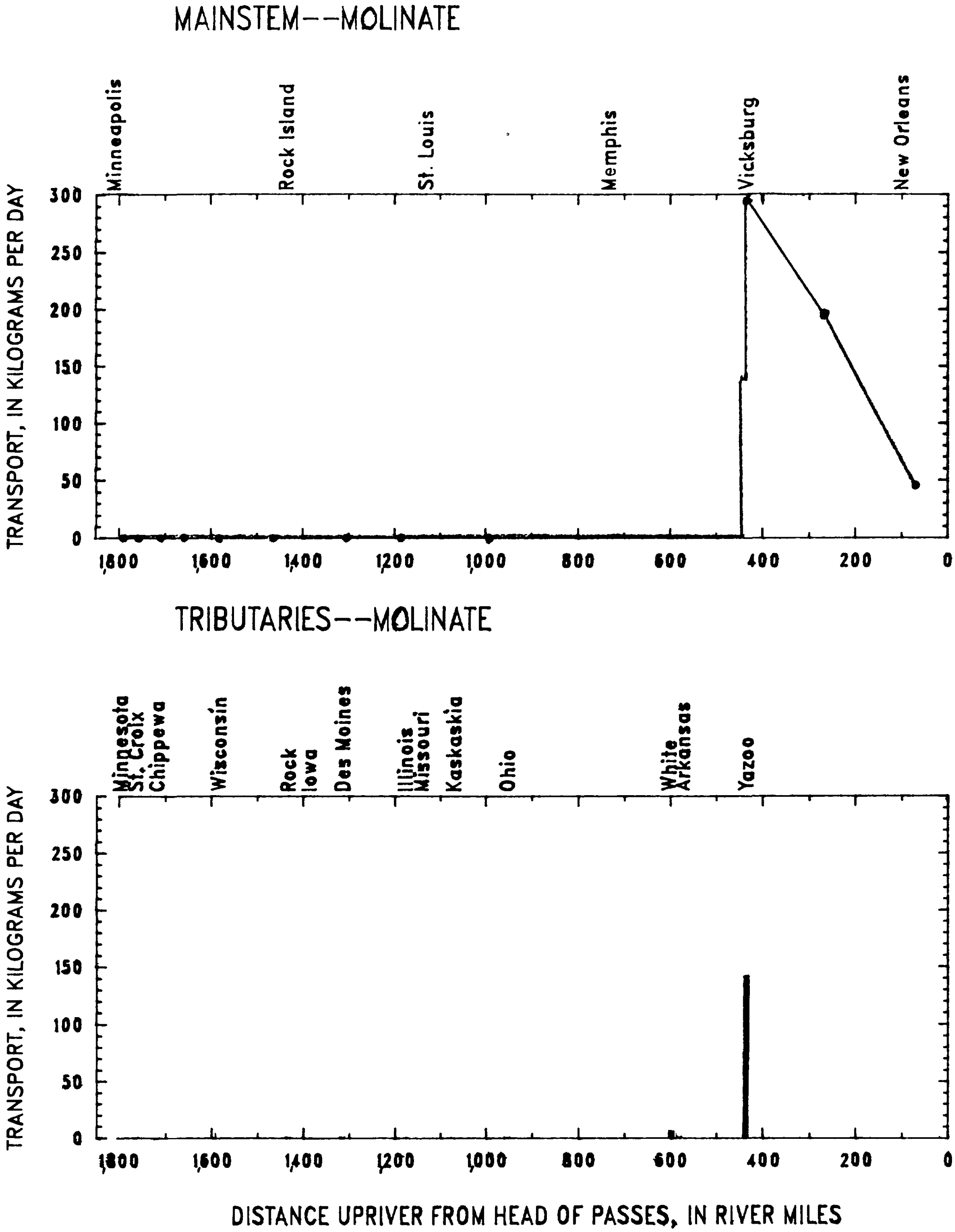


Figure 74.--Transport of molinate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

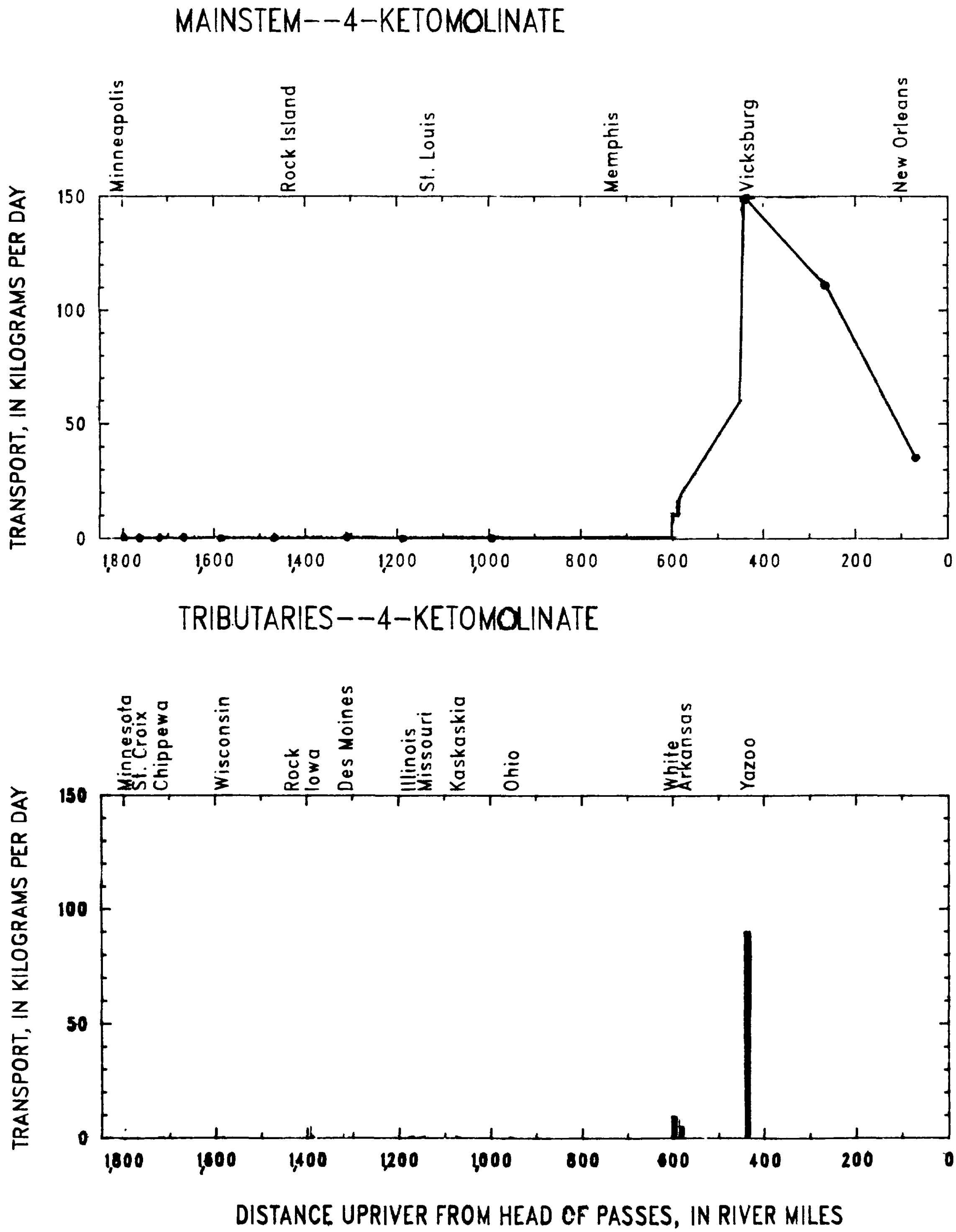


Figure 75.--Transport of 4-ketomolinate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

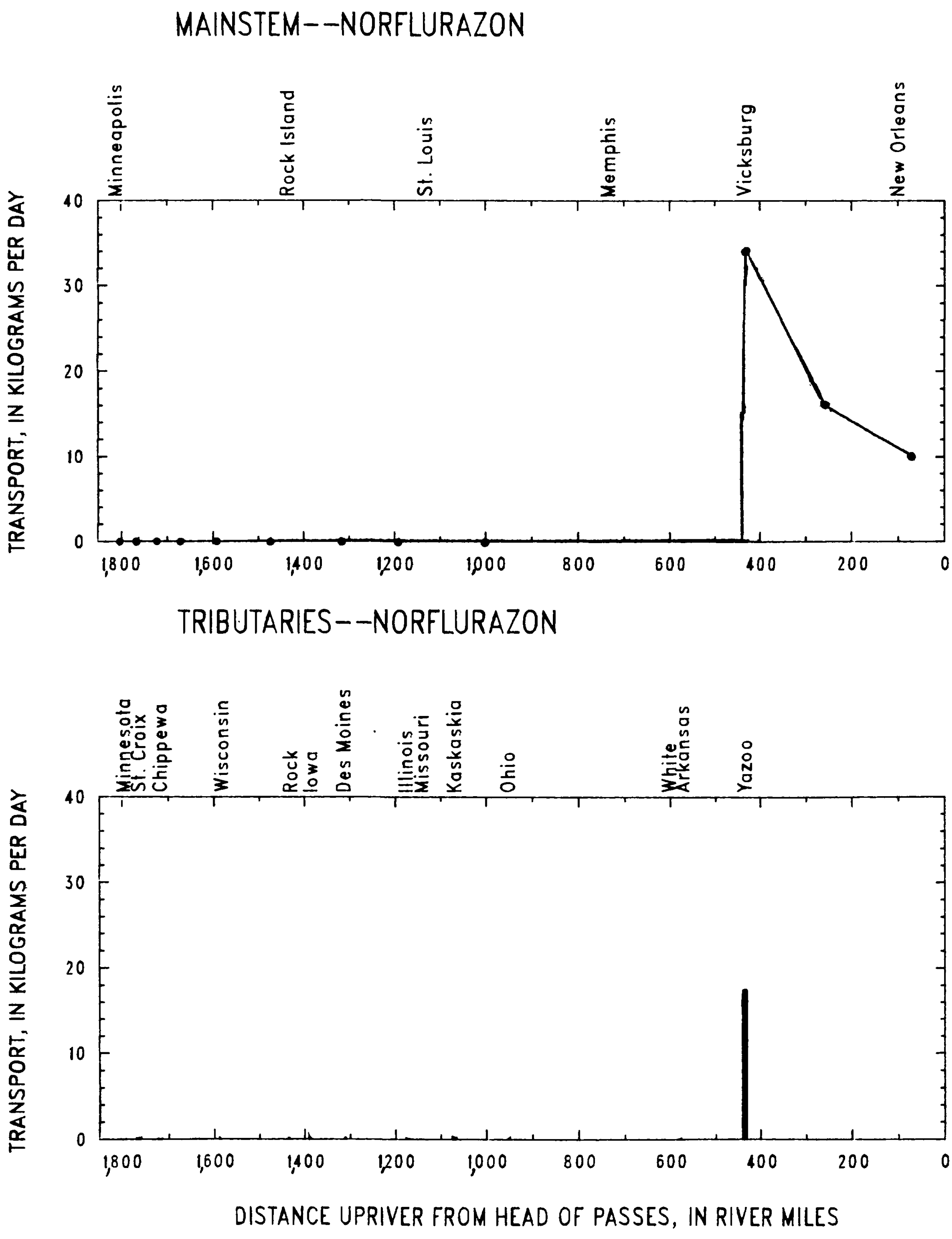


Figure 76.--Transport of norflurazon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

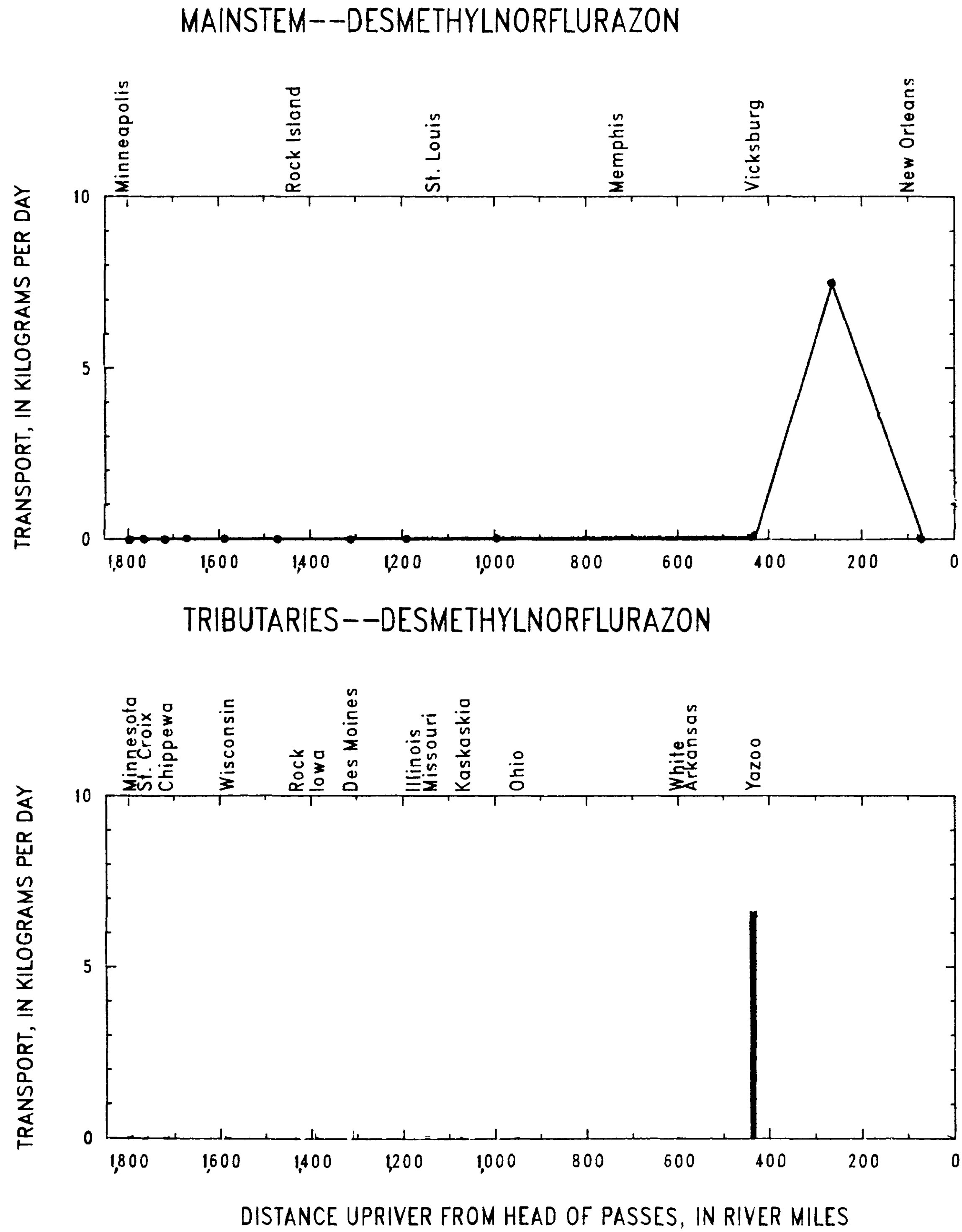


Figure 77.--Transport of desmethylnorflurazon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

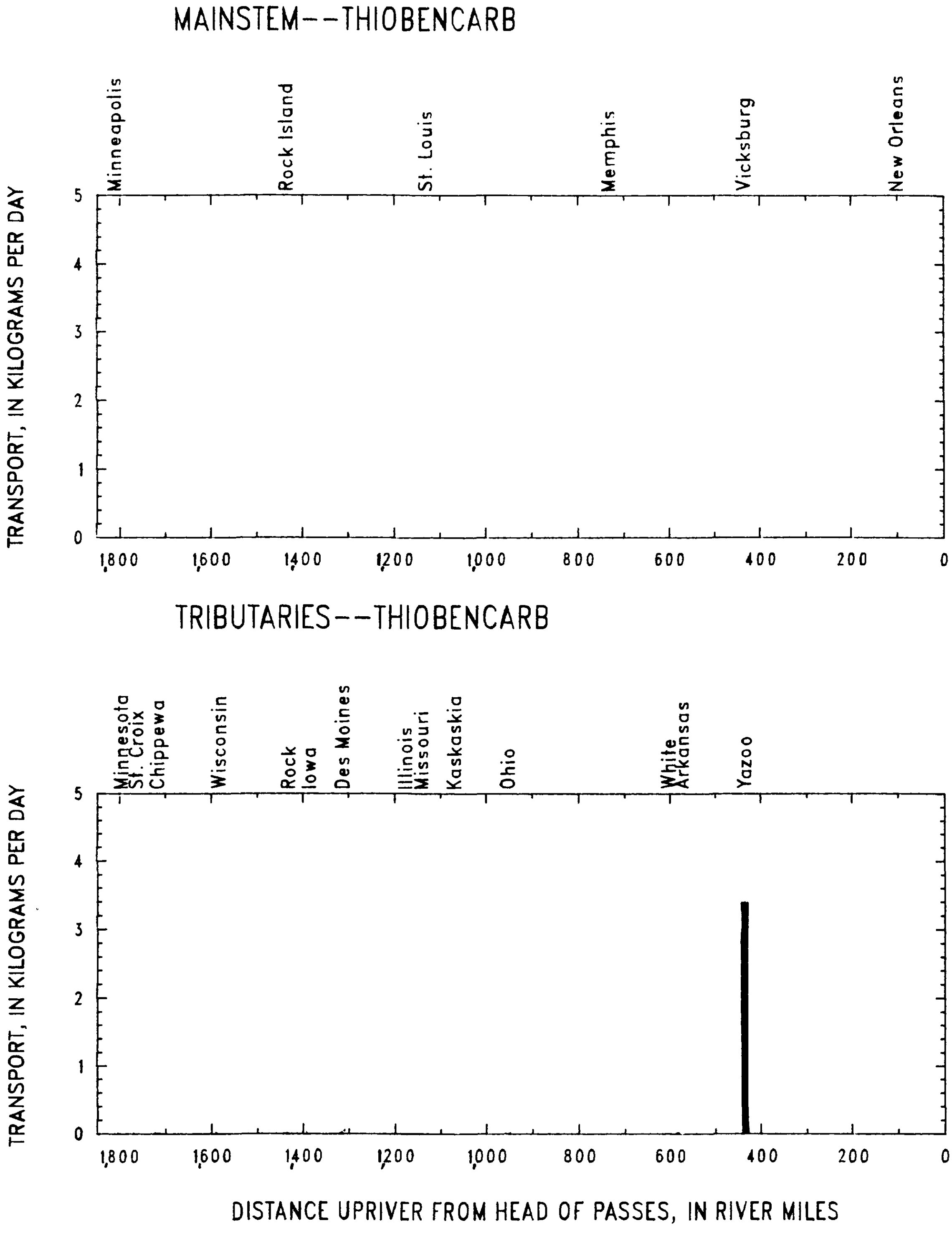


Figure 78.--Transport of thiobencarb in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

Table 19.—Concentrations of miscellaneous organic contaminants in the Mississippi River and some of its tributaries for July–August 1991 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of miscellaneous organic contaminants, in ng/L: 2,6-diethylaniline	Caffeine	1,3,5-trimethyl-2,4,6-triazinetrione	Tris-2-chloroethylphosphate	Tris-2-chloropropylphosphate isomer A	Tris-2-chloropropylphosphate isomer B
7–05	Mississippi R. above St. Anthony Falls, Minn.	470	ND	35	ND	8	ND	ND
7–06	Minnesota R. at Mile 3.5, Minn.[2]	600	ND	20	ND	17	11	6
			ND	23	ND	18	9	6
7–08	Mississippi R. at Hastings, Minn.	980	ND	24	ND	17	15	10
7–08	St. Croix R. at Mile 0.5, Wis.	260	ND	13	ND	ND	ND	ND
7–10	Mississippi R. near Pepin, Wis.[2]	1,350	ND	31	ND	14	13	11
			ND	28	ND	14	12	10
7–10	Chippewa R. at Mile 1.7, Wis.	160	ND	18	ND	ND	ND	ND
7–12	Mississippi R. at Trempealeau, Wis.	1,440	ND	26	ND	13	11	9
7–15	Mississippi R. below Lock and Dam 9, Wis.	1,590	ND	23	ND	11	8	11
7–15	Wisconsin R. at Mile ~1.0, Wis.	145	ND	8	ND	ND	ND	ND
7–18	Mississippi R. at Clinton, Iowa	1,850	ND	18	ND	11	7	8
7–20	Rock R. at Mile ~1.0, Ill.	68	ND	47	ND	15	18	26
7–20	Iowa R. at Mile ~1.0, Iowa	200	ND	29	ND	5	7	12
7–21	Mississippi R. at Keokuk, Iowa	2,050	61	21	ND	7	7	9
7–22	Des Moines R. at Mile ~1.0, Iowa	623	ND	9	ND	ND	ND	ND
7–24	Mississippi R. near Winfield, Mo.	2,730	17	17	ND	5	6	9
7–25	Illinois R. at Hardin, Ill.	260	ND	78	ND	280	470	280
7–27	Missouri R. at St. Charles, Mo.	1,100	ND	29	ND	6	8	7
7–28	Kaskaskia R. at Mile 1.5, Ill.	7	ND	15	ND	ND	ND	ND
7–29	Mississippi R. at Thebes, Ill.	4,390	ND	28	ND	20	31	22
7–30	Ohio R. at Olmsted, Ill.[2]	2,410	ND	32	123	4	13	18
			ND	36	124	11	9	8
8–01	White R. at Mile 1.2, Ark.	374	ND	11	ND	ND	8	12
8–01	Arkansas R. at Mile 0.0, Ark.	480	ND	22	ND	5	13	8
8–02	Yazoo R. at Mile ~3.0, Miss.	640	ND	24	ND	ND	ND	ND
8–03	Mississippi R. below Vicksburg, Miss.[2]	8,750	ND	15	28	11	21	19
			ND	13	35	ND	20	19
8–05	Mississippi R. near St. Francisville, La.	6,190	ND	20	36	6	14	9
8–07	Mississippi R. below Belle Chasse, La.	4,340	ND	440	39	6	21	19

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.

[2]Duplicate samples collected.

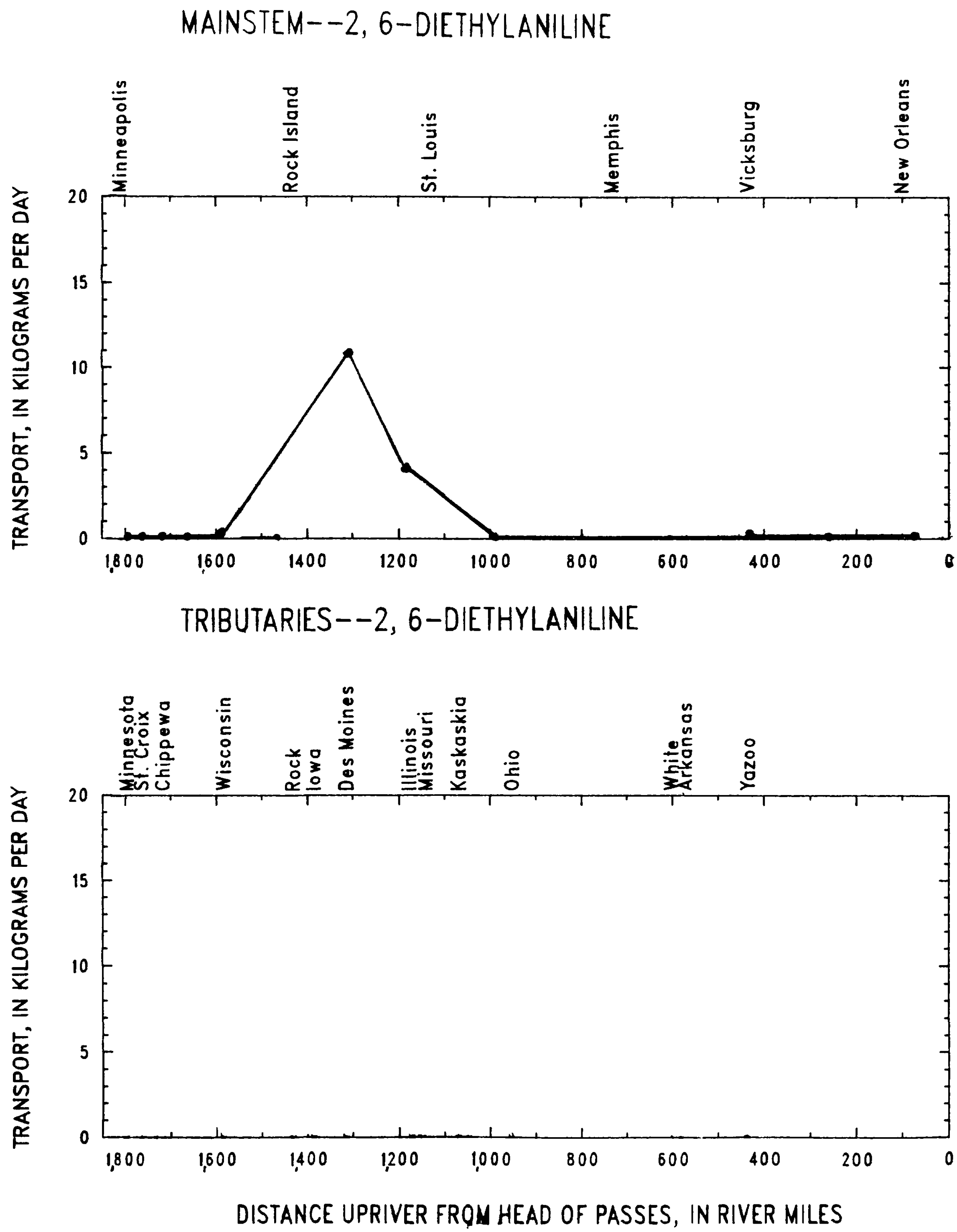


Figure 79.--Transport of 2,6-diethylaniline in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

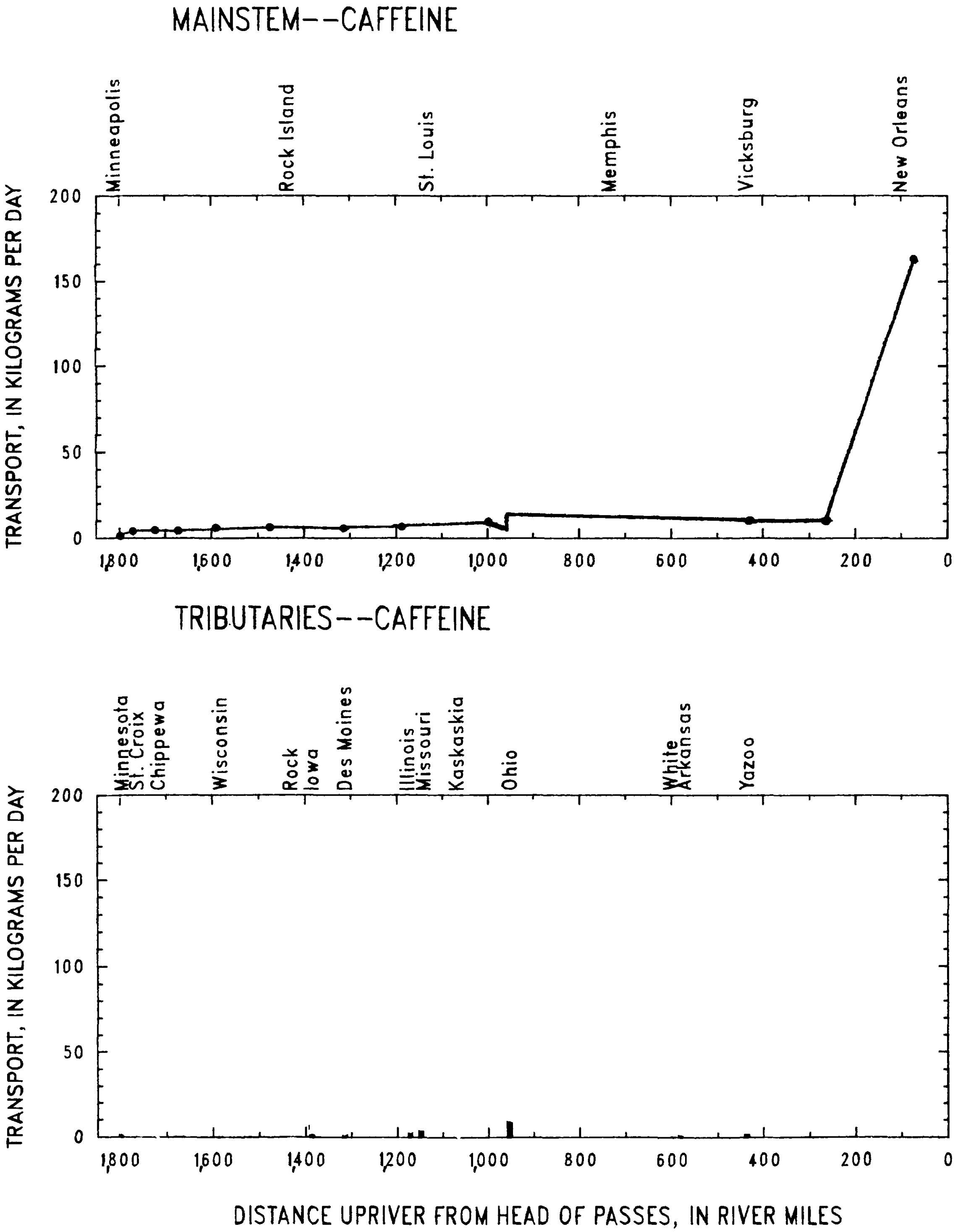


Figure 80.--Transport of caffeine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

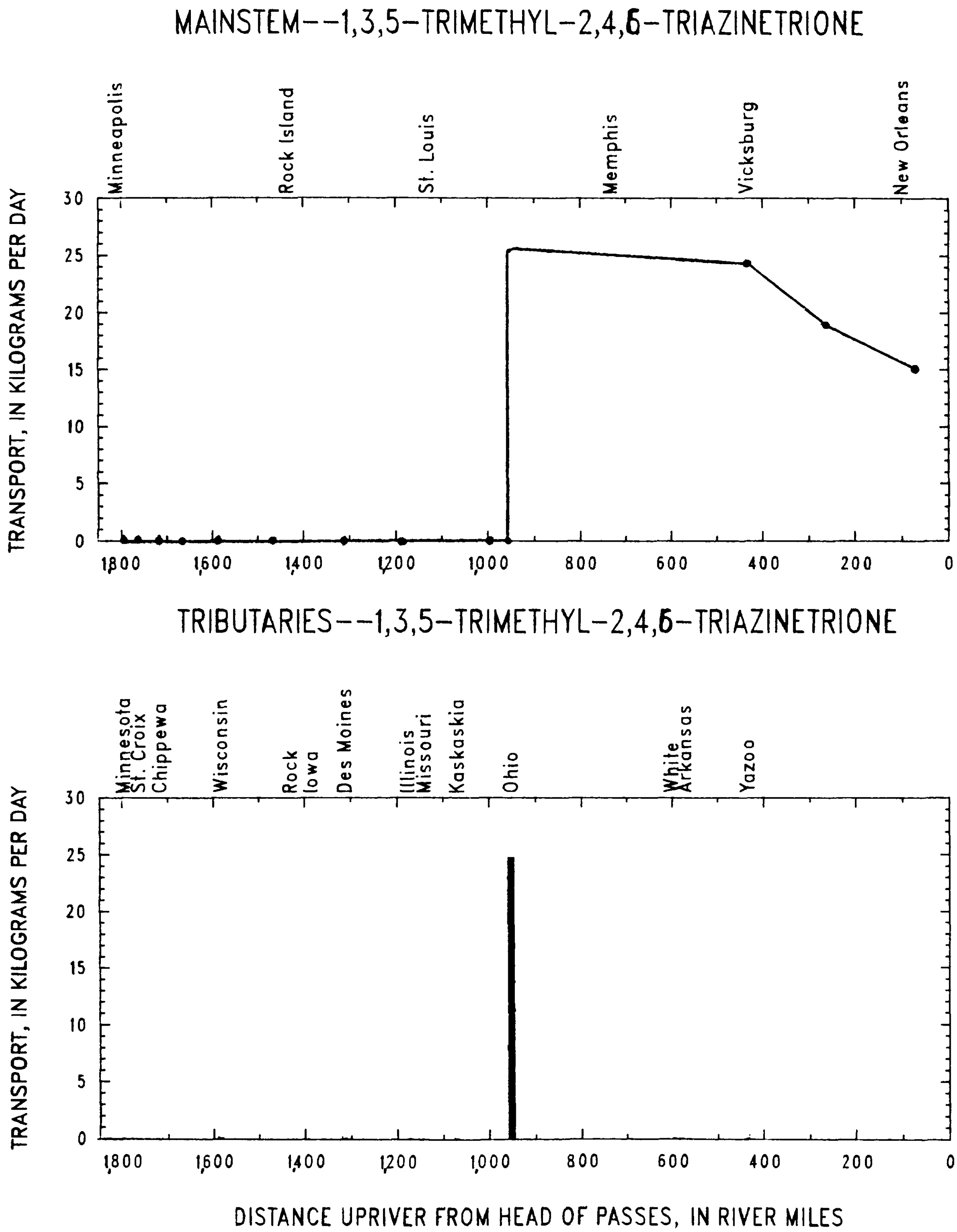


Figure 81.--Transport of 1,3,5-trimethyl-2,4,6-triazinetrione in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

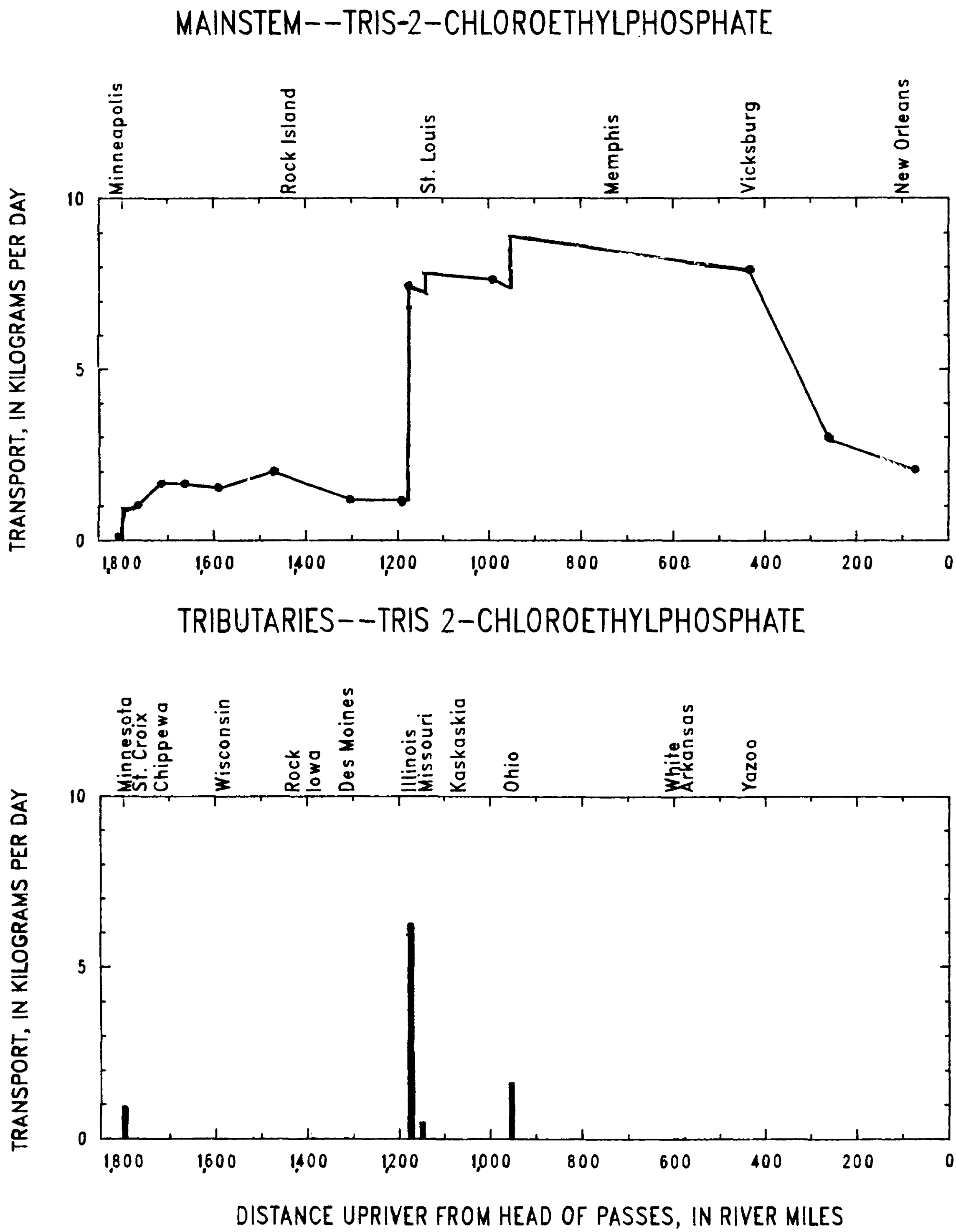


Figure 82.--Transport of tris-2-chloroethylphosphate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

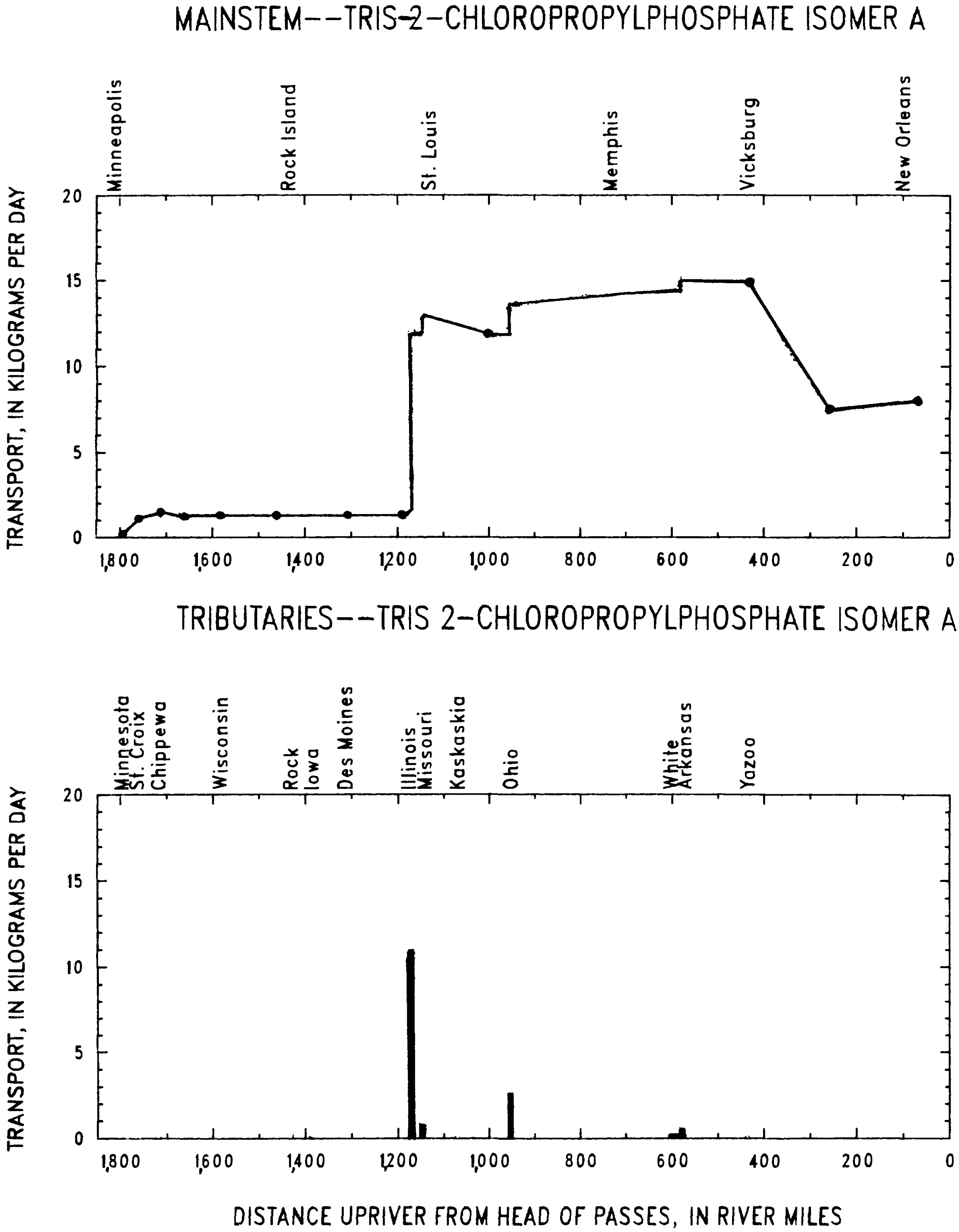


Figure 83.--Transport of tris-2-chloropropylphosphate isomer A in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

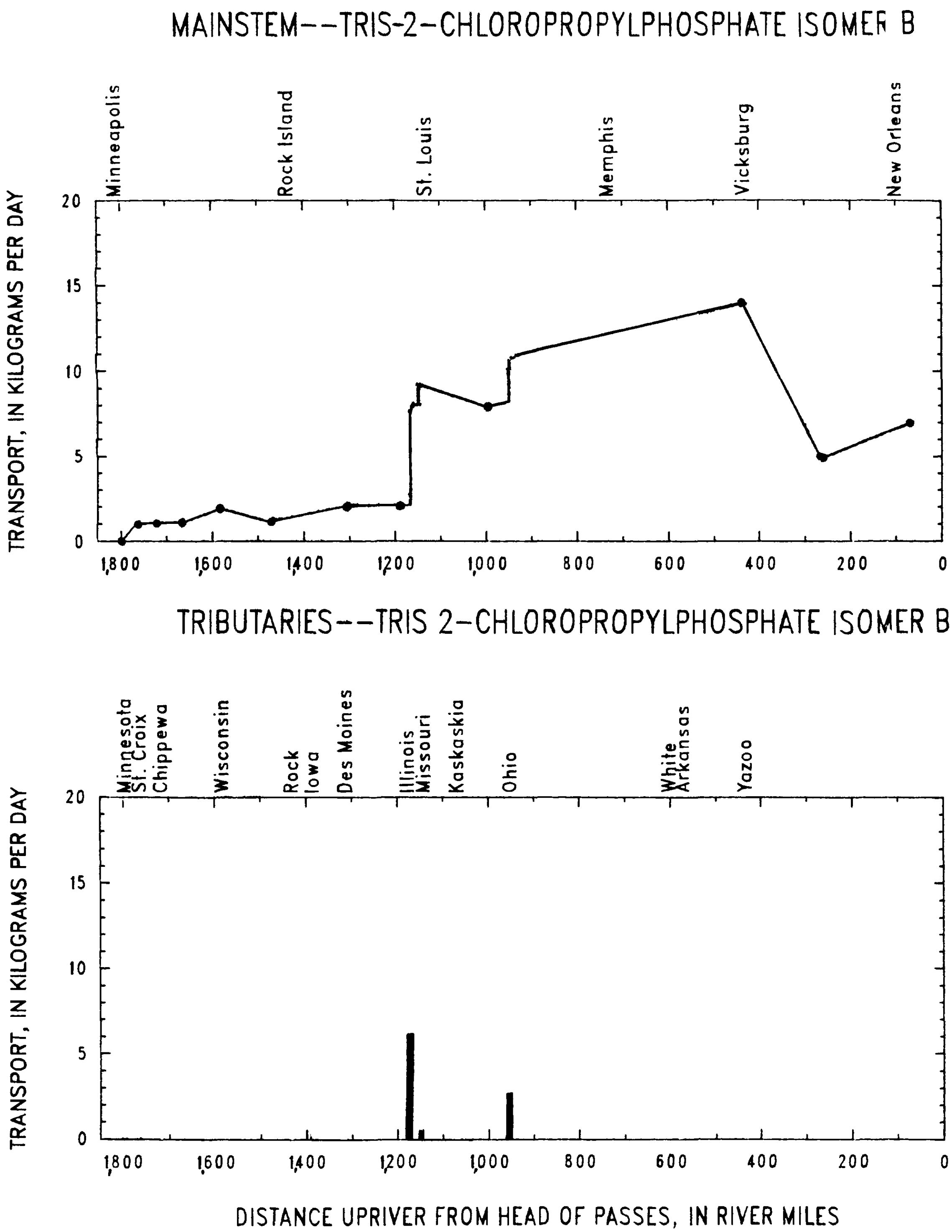


Figure 84.--Transport of tris-2-chloropropylphosphate isomer B in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between July 5 and August 7, 1991.

Table 20.--Concentrations of triazine herbicides and their transformation products in the Mississippi River and some of its tributaries for October–November 1991

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of triazine herbicides, in ng/L										
			Ametryn	Atrazine	Desethylatrazine	Desisopropylatrazine	Cyanazine	Cyanazine-amide	Hexazinone	Metribuzin	Prometon	Prometryn	Simazine
10–07	Mississippi R. above St. Anthony Falls, Minn.	220	ND	150	86	ND	170	73	ND	ND	10	ND	18
10–08	Minnesota R. at Mile 3.5, Minn.	130	ND	77	42	ND	47	ND	ND	ND	15	ND	11
10–10	Mississippi R. at Hastings, Minn.[2]	350	ND	140	82	ND	150	70	ND	ND	15	ND	23
			ND	120	68	ND	120	43	ND	ND	14	ND	21
10–10	St. Croix R. at Mile 0.5, Wis.	95	ND	39	23	ND	ND	ND	ND	ND	ND	ND	9
10–13	Mississippi R. near Pepin, Wis.	510	ND	130	75	ND	110	39	ND	ND	16	ND	18
10–12	Chippewa R. at Mile 1.7, Wis.	161	ND	34	29	16	ND	ND	ND	ND	ND	ND	10
10–15	Mississippi R. at Trempealeau, Wis.	660	ND	110	65	ND	69	27	ND	ND	13	ND	14
10–18	Mississippi R. below Lock and Dam 9, Wis.	690	ND	110	68	ND	74	28	ND	ND	7	ND	18
10–18	Wisconsin R. at Mile ~1.0, Wis.	161	ND	180	65	ND	35	ND	ND	ND	ND	ND	21
10–22	Mississippi R. at Clinton, Iowa	940	ND	120	73	47	48	ND	ND	ND	9	ND	17
10–24	Rock R. at Mile ~1.0, Ill.	82	6	180	120	ND	117	30	ND	ND	17	ND	23
10–25	Iowa R. at Mile ~1.0, Iowa	74	ND	160	110	ND	31	47	ND	ND	18	ND	10
10–27	Mississippi R. at Keokuk, Iowa	1,410	ND	180	88	ND	78	48	ND	ND	15	ND	18
10–28	Des Moines R. at Mile ~1.0, Iowa	39	ND	320	116	74	290	130	ND	ND	26	ND	14
10–30	Mississippi R. near Winfield, Mo.	1,230	ND	180	86	ND	70	ND	ND	ND	16	ND	15
10–31	Illinois R. at Hardin, Ill.	520	7	110	46	ND	72	ND	ND	ND	92	ND	35
11–03	Missouri R. at St. Charles, Mo.	1,350	ND	170	37	32	32	ND	ND	ND	11	ND	11
11–04	Kaskaskia R. at Mile 1.5, Ill.	10	12	600	230	150	130	ND	ND	21	73	ND	63
11–05	Mississippi R. at Thebes, Ill.[2]	3,870	ND	190	63	ND	65	ND	ND	ND	26	ND	19
			ND	190	61	ND	61		ND	ND	26	ND	20
11–06	Ohio R. at Olmsted, Ill.	2,480	ND	170	49	32	86	ND	ND	ND	28	ND	32
11–08	White R. at Mile 1.2, Ark.	1,220	ND	19	ND	ND	ND	ND	ND	ND	ND	ND	15
11–08	Arkansas R. at Mile 0.0, Ark.	1,620	5	110	33	ND	ND	99	ND	6	17	ND	26
11–10	Yazoo R. at Mile ~3.0, Miss.	540	ND	89	15	ND	130	ND	88	12	ND	22	15

Table 20.--Concentrations of triazine herbicides and their transformation products in the Mississippi River and some of its tributaries for October–November 1991--Continued

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of triazine herbicides, in ng/L										
			Ametryn	Atrazine	Desethylatrazine	Desisopropylatrazine	Cyanazine	Cyanazine-amide	Hexazinone	Metribuzin	Prometon	Prometryn	Simazine
11–09	Mississippi R. below Vicksburg, Miss.[2]	10,700	ND	180	52	55	73	ND	7	6	19	ND	29
			ND	180	52	70	79	ND	9	6	18	ND	30
11–11	Mississippi R. near St. Francisville, La.	8,950	ND	180	48	70	60	44	10	ND	18	ND	32
11–13	Mississippi R. below Belle Chasse, La.	8,840	ND	160	45	50	63	35	8	6	20	6	45

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.
[2]Duplicate samples collected.

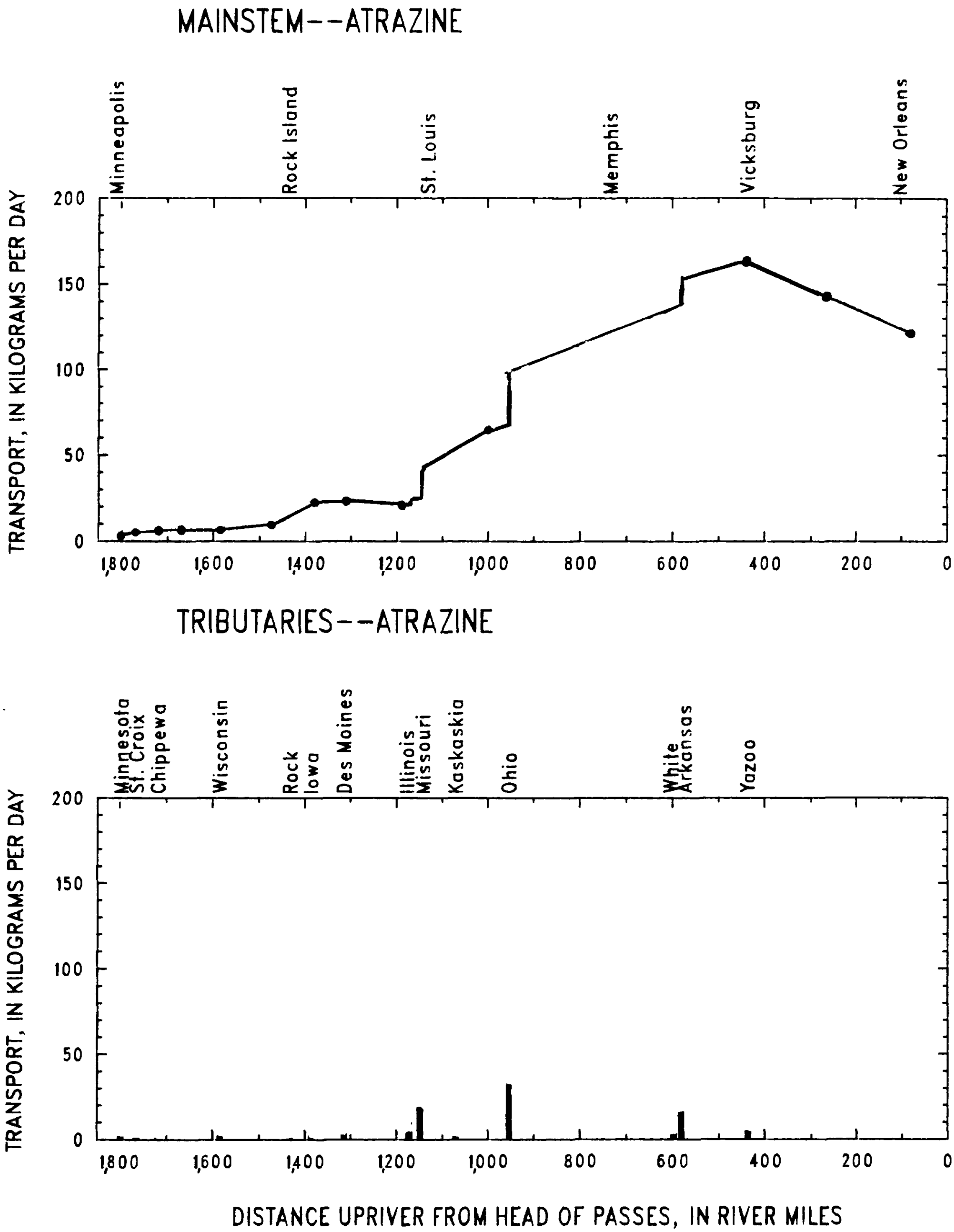


Figure 85.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

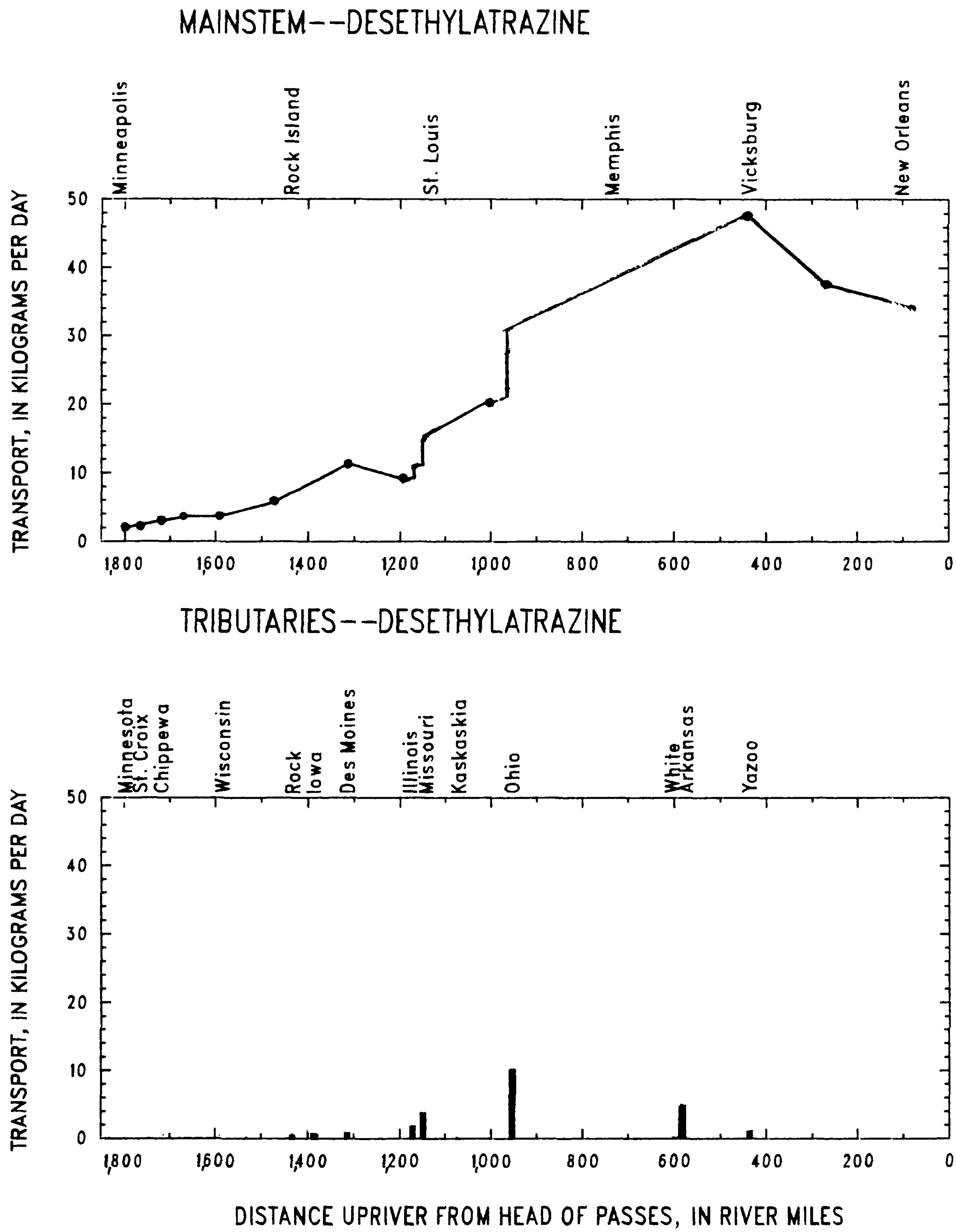


Figure 86.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

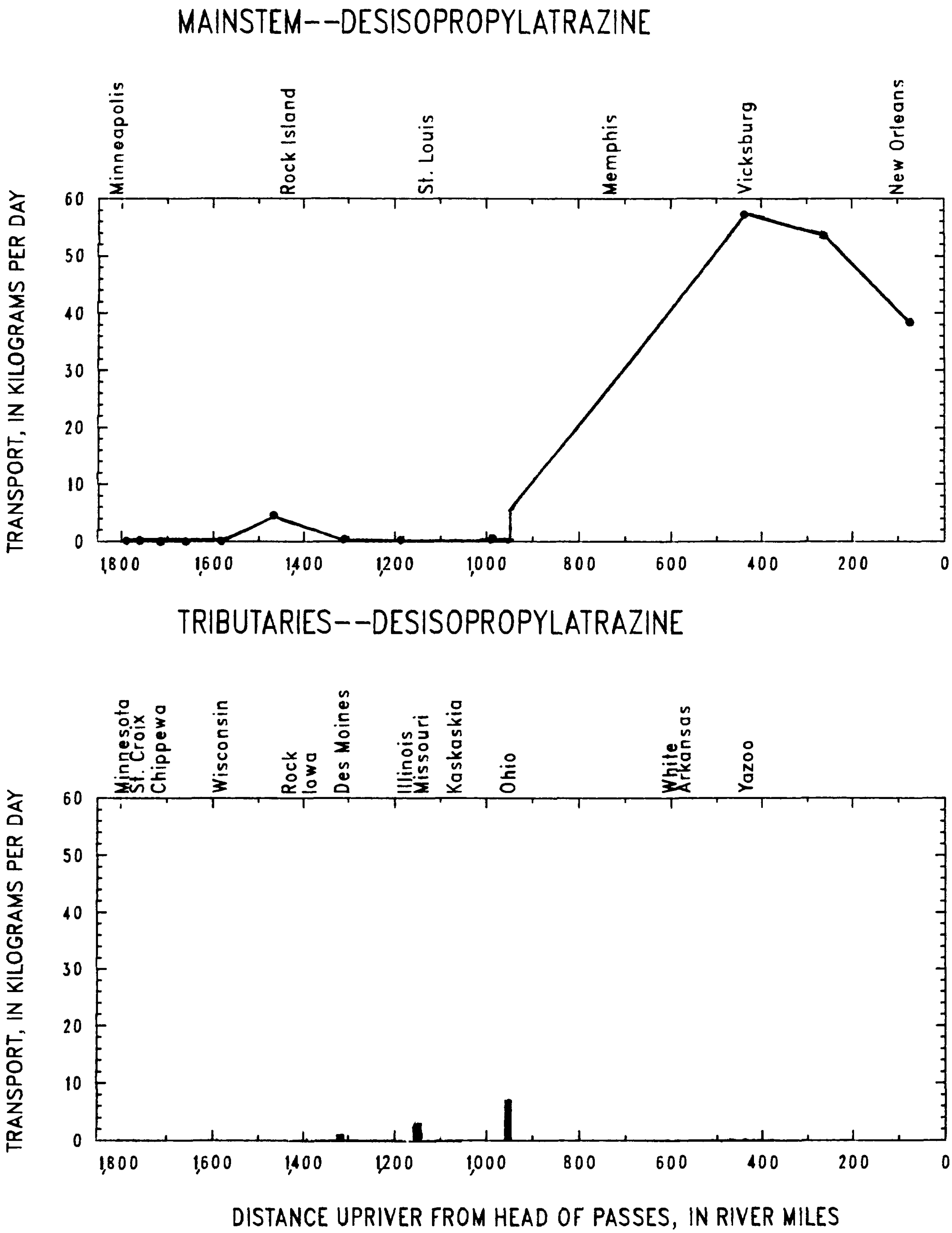


Figure 87.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

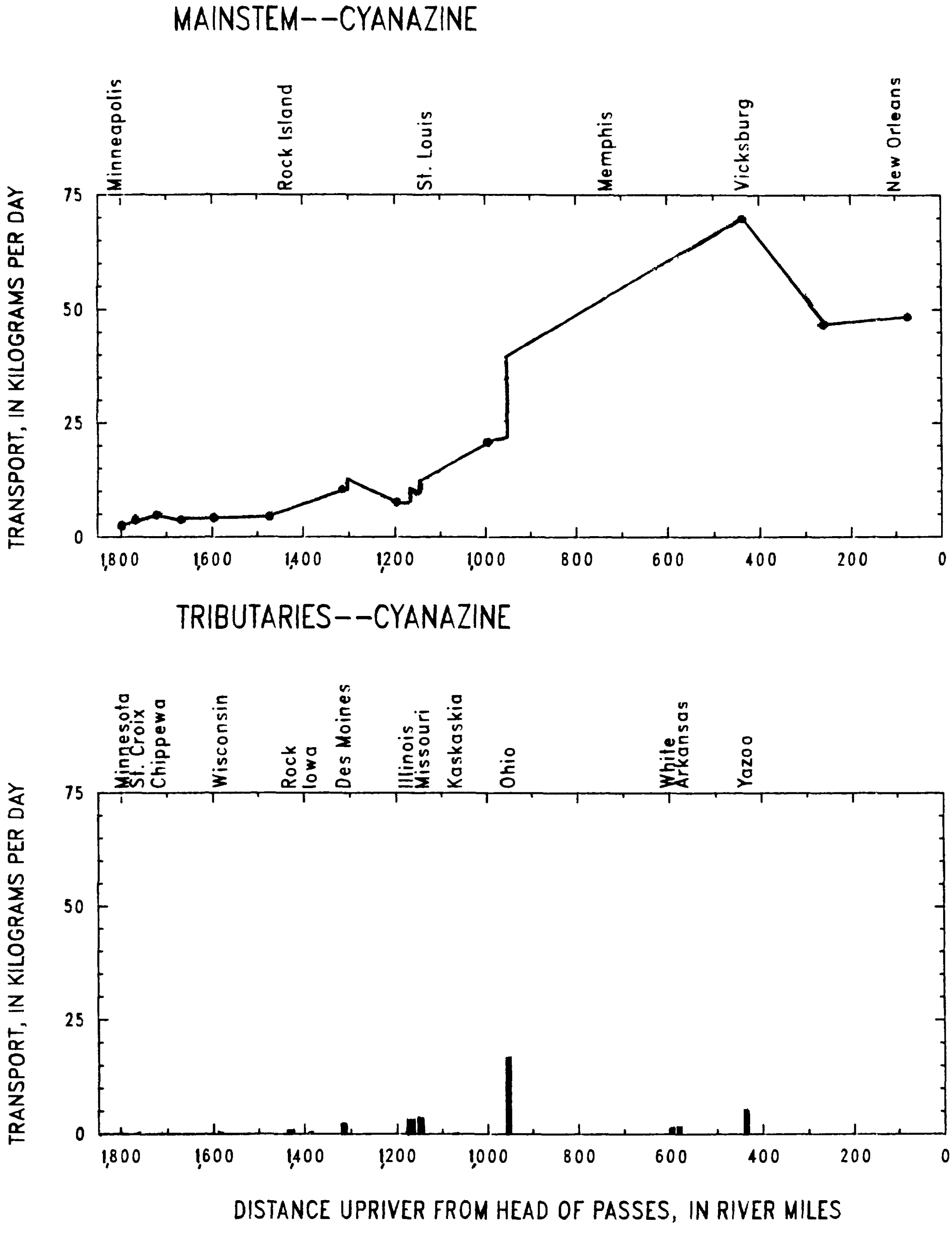


Figure 88.--Transport of cyanazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

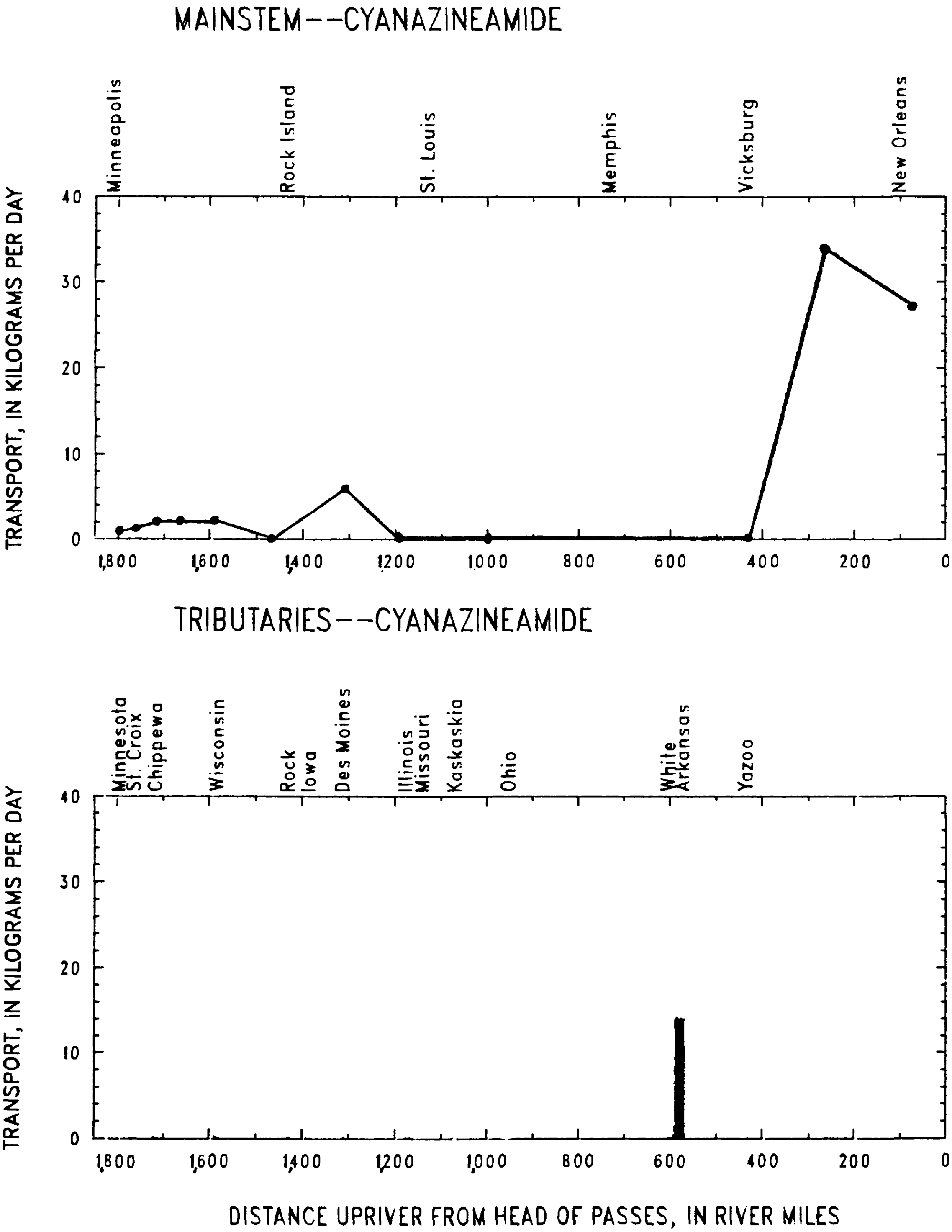


Figure 89.--Transport of cyanazineamide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

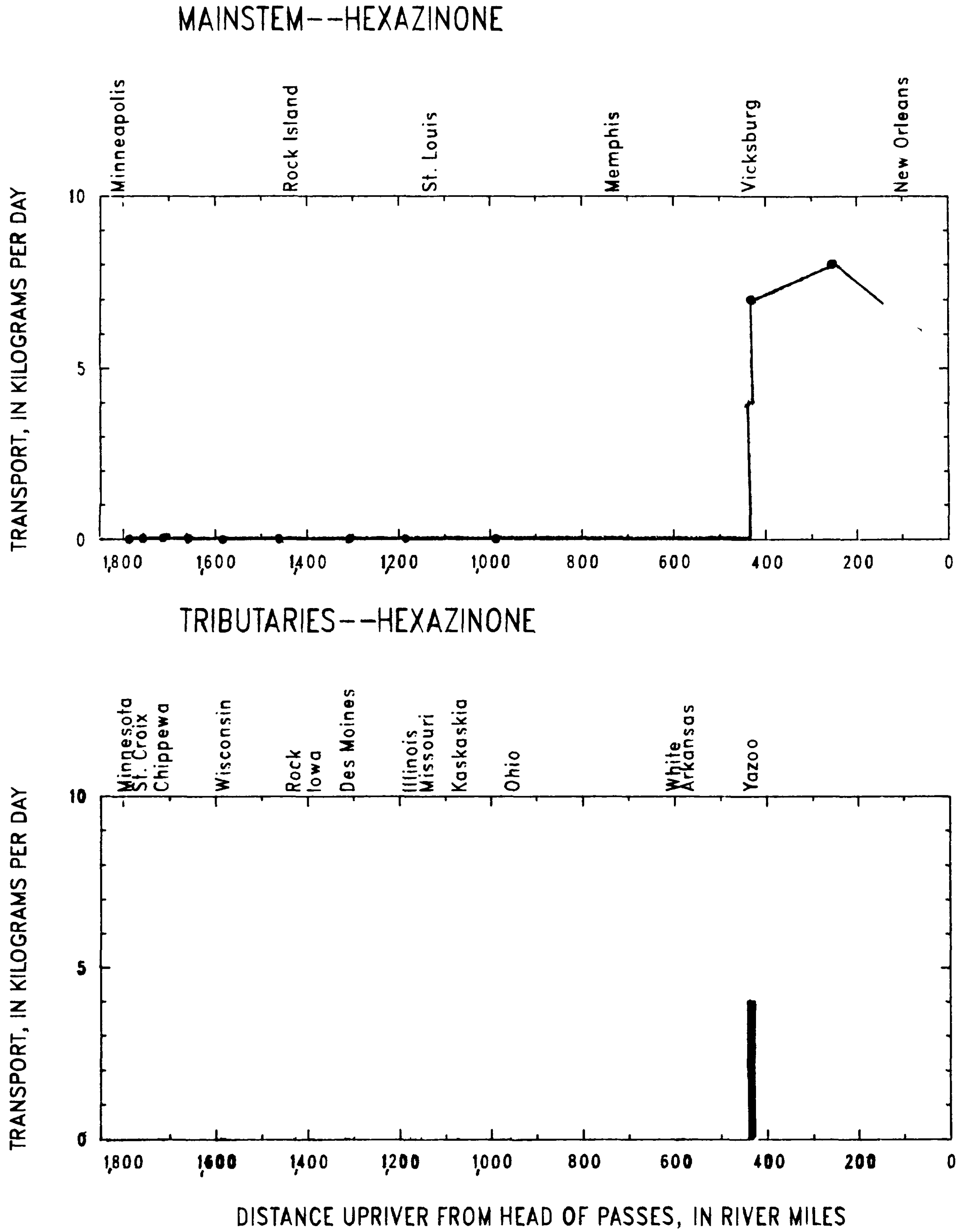


Figure 90.--Transport of hexazinone in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

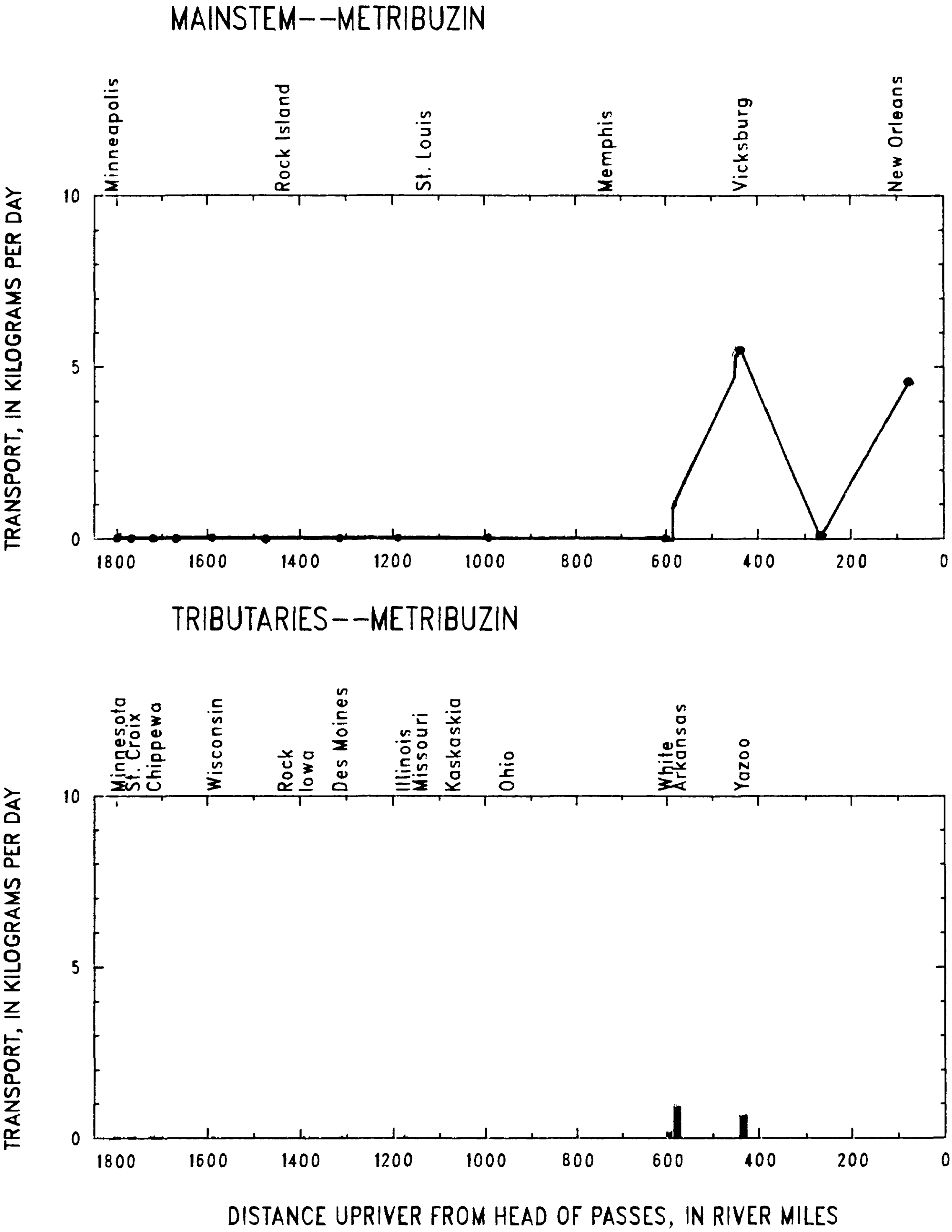


Figure 91.--Transport of metribuzin in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

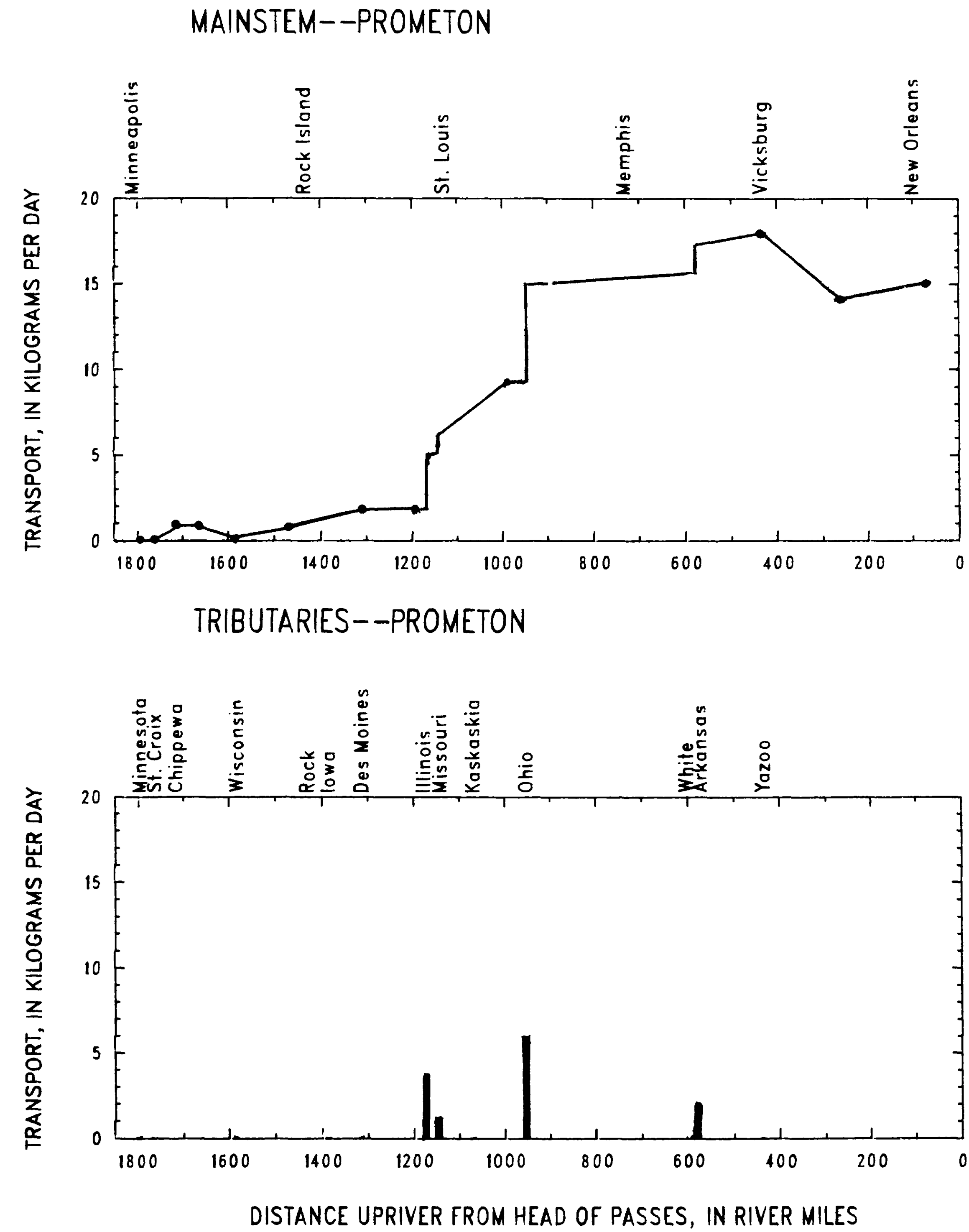


Figure 92.--Transport of prometon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

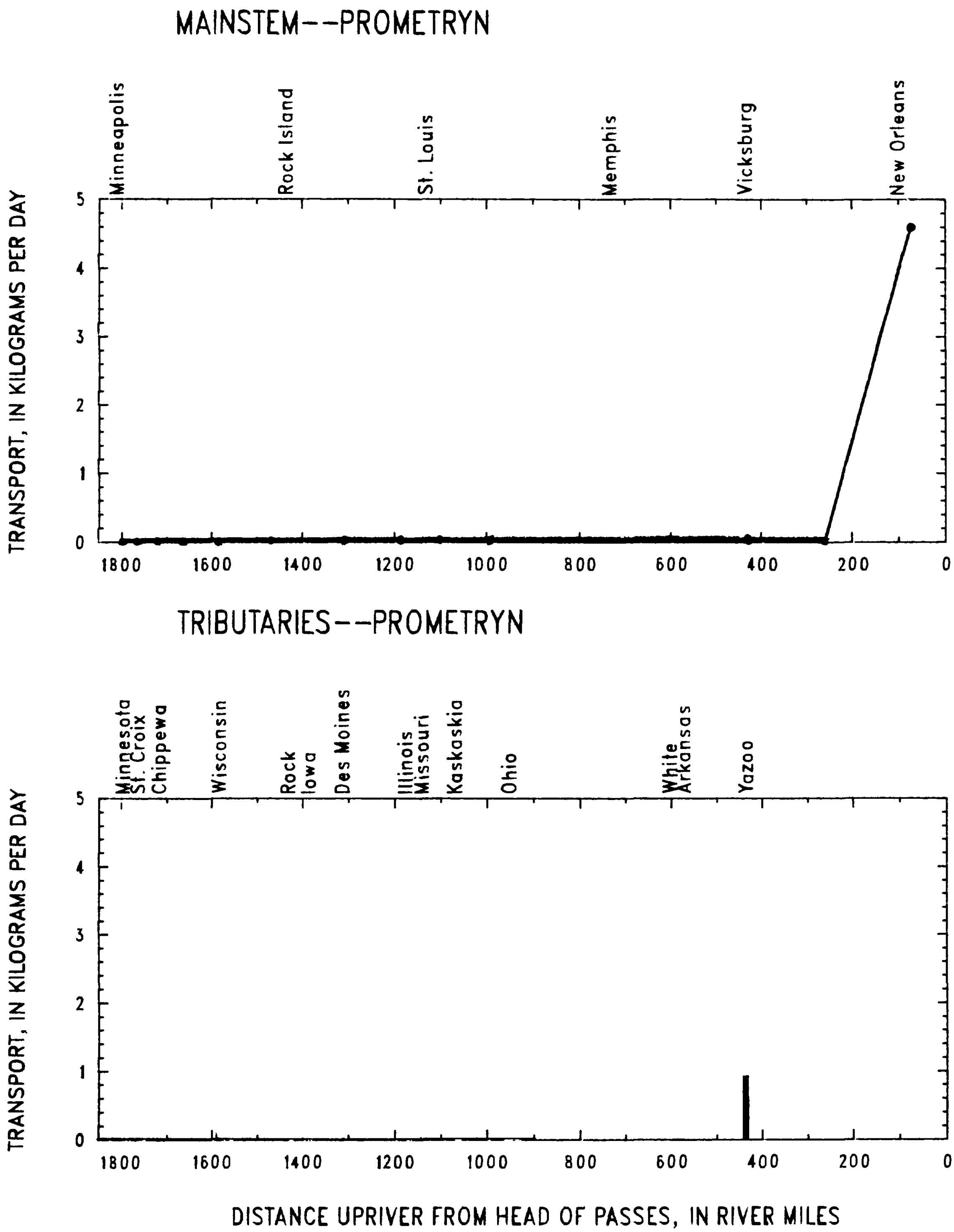


Figure 93.--Transport of prometryn in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

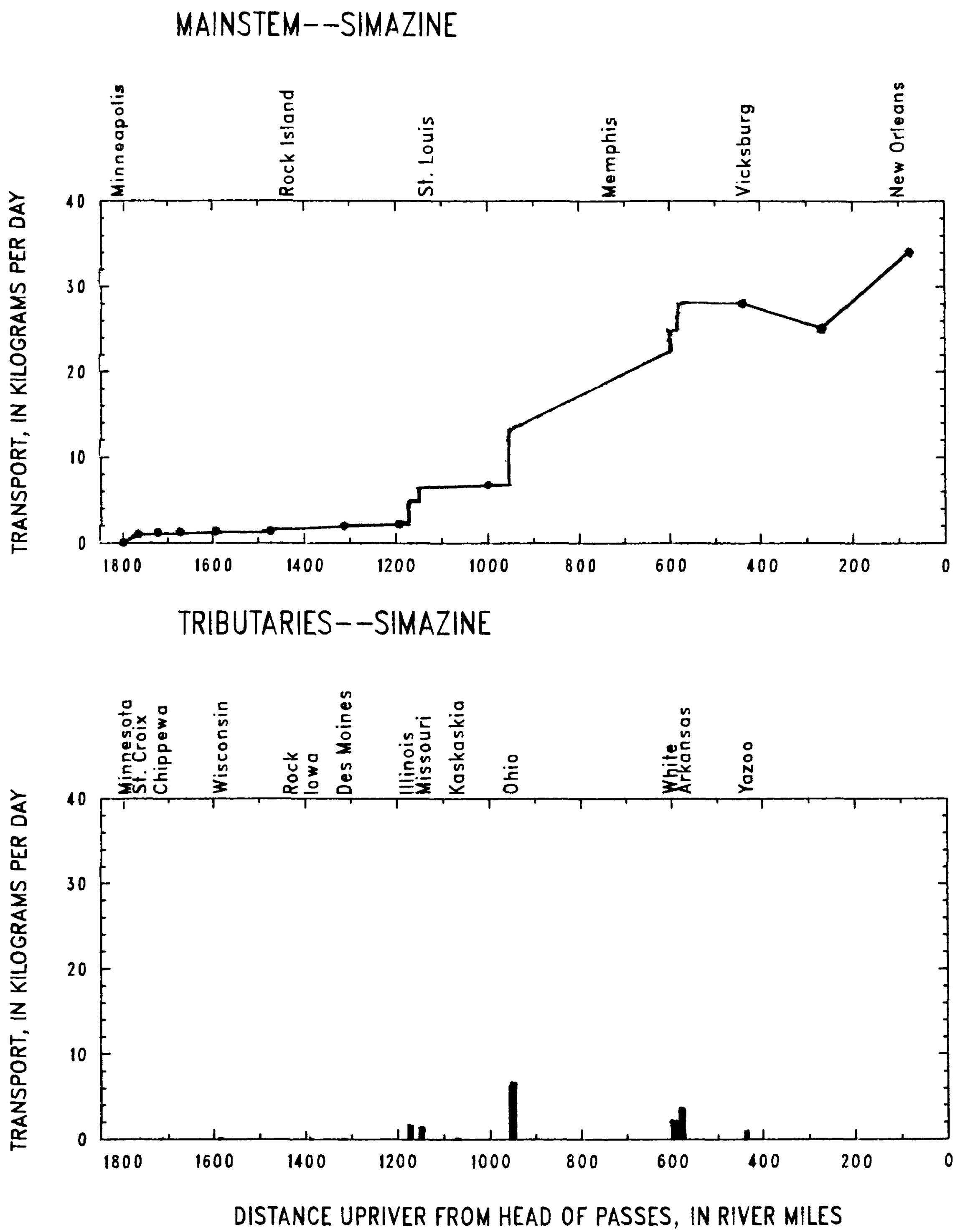


Figure 94.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

Table 21.--Concentrations of chloroacetanilide herbicides and their transformation products in the Mississippi River and some of its tributaries for October–November 1991 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentration of chloroacetanilide herbicides, in ng/L			
			Alachlor	2-chloro-2′,6′-diethylacetanilide	2-hydroxy-2′,6′-diethylacetanilide	Metolachlor
10–07	Mississippi R. above St. Anthony Falls, Minn.	220	5	ND	ND	25
10–08	Minnesota R. at Mile 3.5, Minn.	130	18	ND	ND	58
10–10	Mississippi R. at Hastings, Minn.[2]	350	13	ND	ND	45
			11	ND	ND	38
10–10	St. Croix R. at Mile 0.5, Wis.	95	ND	ND	ND	5
10–13	Mississippi R. near Pepin, Wis.	510	15	ND	ND	66
10–12	Chippewa R. at Mile 1.7, Wis.	161	ND	ND	ND	ND
10–15	Mississippi R. at Trempealeau, Wis.	660	12	ND	ND	50
10–18	Mississippi R. below Lock and Dam 9, Wis.	690	10	ND	ND	43
10–18	Wisconsin R. at Mile ~1.0, Wis.	161	5	ND	ND	6
10–22	Mississippi R. at Clinton, Iowa	940	11	ND	ND	42
10–24	Rock R. at Mile ~1.0, Ill.	82	20	ND	ND	33
10–25	Iowa R. at Mile ~1.0, Iowa	74	8	ND	ND	76
10–27	Mississippi R. at Keokuk, Iowa	1,410	230	ND	ND	55
10–28	Des Moines R. at Mile ~1.0, Iowa	39	ND	ND	ND	110
10–30	Mississippi R. near Winfield, Mo.	1,230	210	ND	ND	64
10–31	Illinois R. at Hardin, Ill	520	23	ND	ND	66
11–03	Missouri R. at St. Charles, Mo.	1,350	17	ND	ND	51
11–04	Kaskaskia R. at Mile 1.5, Ill.	10	100	ND	ND	130
11–05	Mississippi R. at Thebes, Ill.[2]	3,870	92	ND	ND	68
			94	ND	ND	68
11–06	Ohio R. at Olmsted, Ill.	2,480	ND	ND	ND	34
11–08	White R. at Mile 1.2, Ark.	1,210	ND	ND	ND	16
11–08	Arkansas R. at Mile 0.0, Ark.	1,620	ND	ND	ND	13
11–10	Yazoo R. at Mile ~3.0, Miss.	540	ND	ND	ND	61
11–09	Mississippi R. below Vicksburg, Miss.[2]	10,700	28	ND	ND	53
			30	ND	ND	54
11–11	Mississippi R. near St. Francisville, La.	8,950	15	ND	ND	54
11–13	Mississippi R. below Belle Chasse, La.	8,840	10	ND	ND	42

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.

[2]Duplicate samples collected.

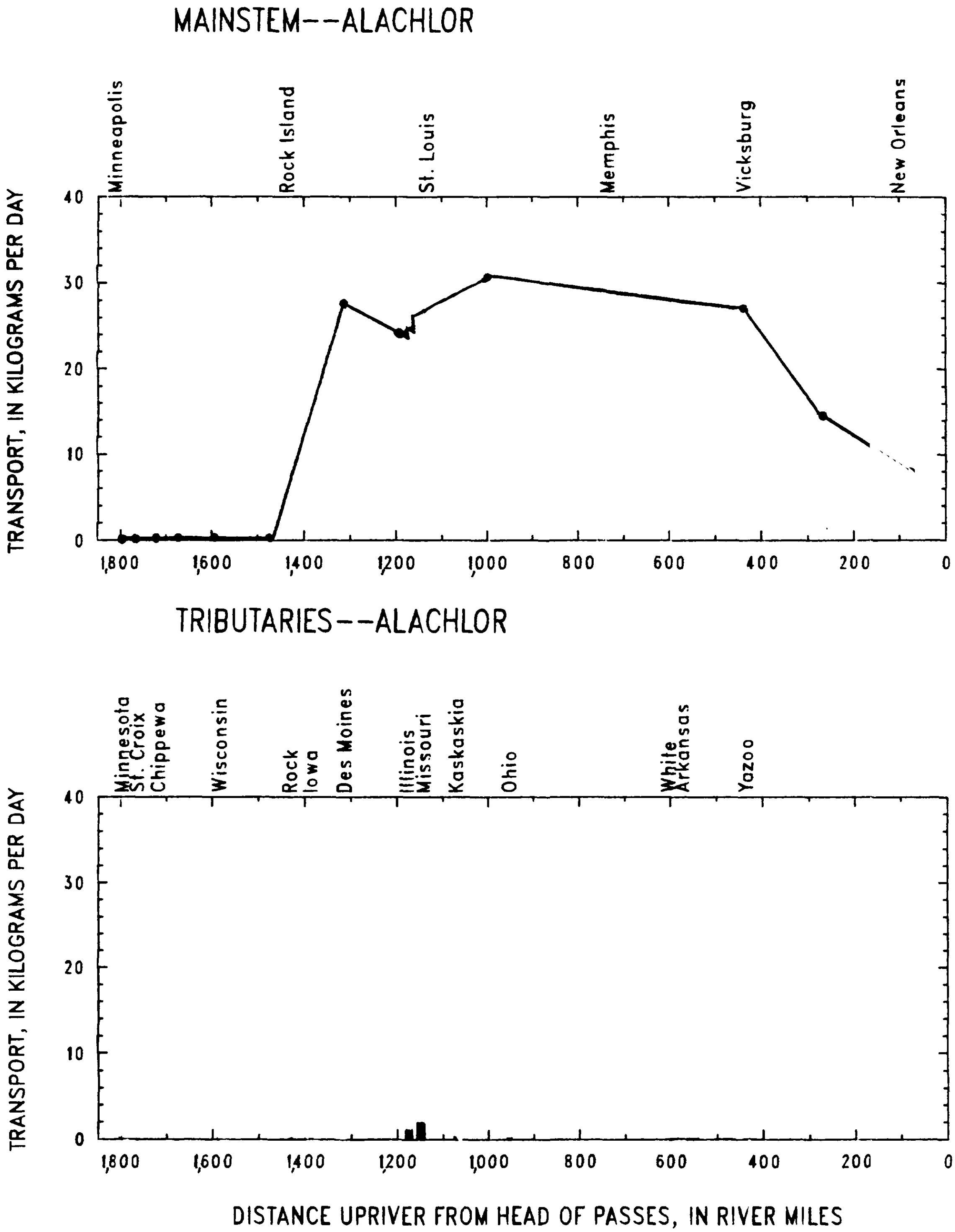


Figure 95.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

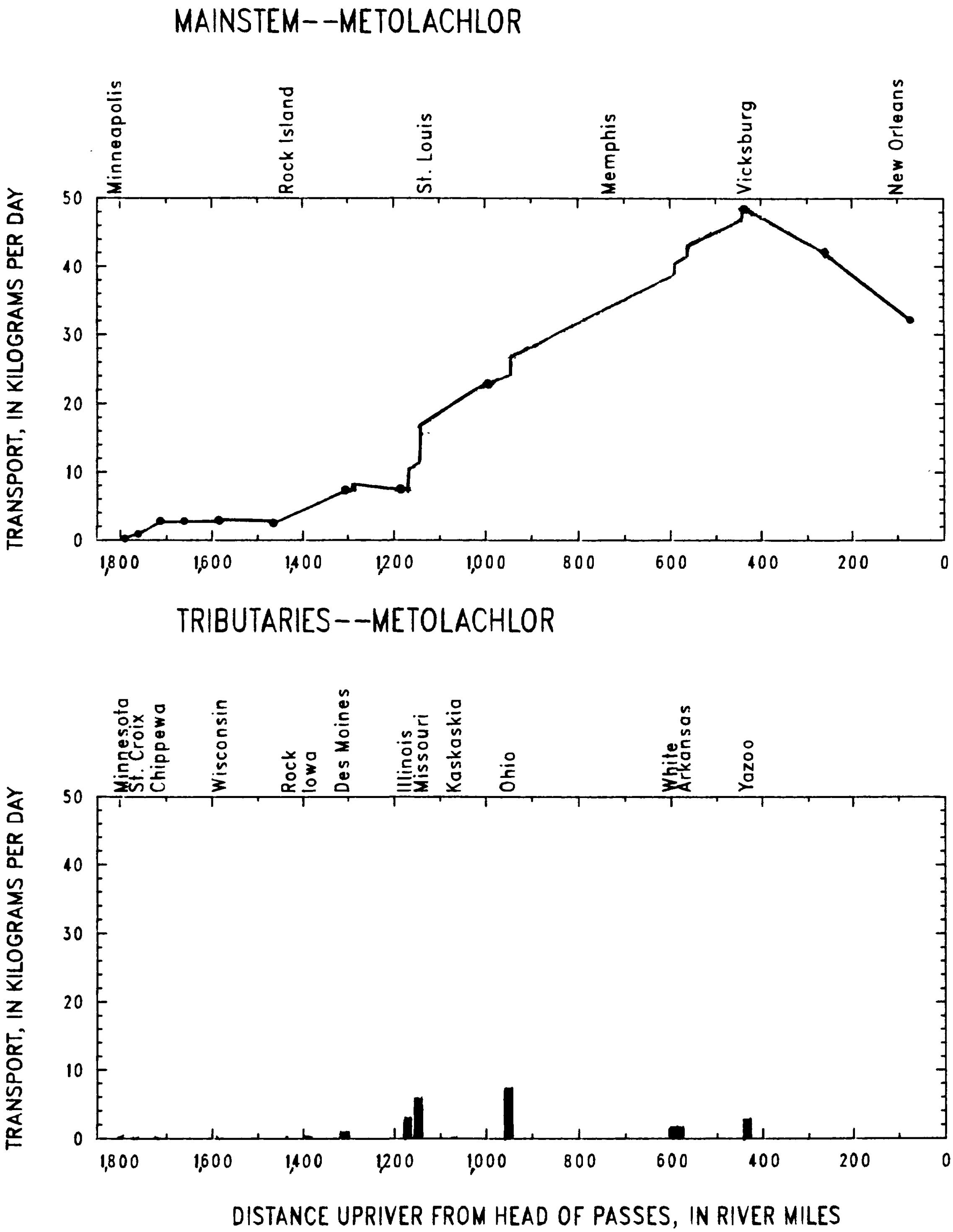


Figure 96.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

Table 22--Concentrations of miscellaneous pesticides and their transformation products in the Mississippi River and some of its tributaries for October–November 1991 cruise

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentrations of miscellaneous pesticides and their transformation products, in ng/L							
			Deet	Diazinon	Fluometuron	Molinate	4-ketomolinate	Norflurazon	Desmethylnorflurazon	Thiobencarb
10–07	Mississippi R. above St. Anthony Falls, Minn.	220	39	ND	ND	ND	ND	ND	ND	ND
10–08	Minnesota R. at Mile 3.5, Minn.	130	50	ND	ND	ND	ND	ND	ND	ND
10–10	Mississippi R. at Hastings, Minn.[2]	350	36	ND	ND	ND	ND	ND	ND	ND
			31	ND	ND	ND	ND	ND	ND	ND
10–10	St. Croix R. at Mile 0.5, Wis.	95	ND	ND	ND	ND	ND	ND	ND	ND
10–13	Mississippi R. near Pepin, Wis.	510	20	ND	ND	ND	ND	ND	ND	ND
10–12	Chippewa R. at Mile 1.7, Wis.	161	ND	ND	ND	ND	ND	ND	ND	ND
10–15	Mississippi R. at Trempealeau, Wis.	660	27	ND	ND	ND	ND	ND	ND	ND
10–18	Mississippi R. below Lock and Dam 9, Wis.	690	28	ND	ND	ND	ND	ND	ND	ND
10–18	Wisconsin R. at Mile ~1.0, Wis.	161	ND	ND	ND	ND	ND	ND	ND	ND
10–22	Mississippi R. at Clinton, Iowa	940	22	ND	ND	ND	ND	ND	ND	ND
10–24	Rock R. at Mile ~1.0, Ill.	82	9	ND	ND	ND	ND	ND	ND	ND
10–25	Iowa R. at Mile ~1.0, Iowa	74	ND	ND	ND	ND	ND	ND	ND	ND
10–27	Mississippi R. at Keokuk, Iowa	1,410	21	ND	ND	ND	ND	ND	ND	ND
10–28	Des Moines R. at Mile ~1.0, Iowa	39	ND	ND	ND	ND	ND	ND	ND	ND
10–30	Mississippi R. near Winfield, Mo.	1,230	24	ND	ND	ND	ND	ND	ND	ND
10–31	Illinois R. at Hardin, Ill.	520	21	83	ND	ND	ND	ND	ND	ND
11–03	Missouri R. at St. Charles, Mo.	1,350	24	ND	ND	ND	ND	ND	ND	ND
11–04	Kaskaskia R. at Mile 1.5, Ill.	10	ND	ND	ND	ND	ND	ND	ND	ND
11–05	Mississippi R. at Thebes, Ill.[2]	3,870	21	16	7	ND	ND	ND	ND	ND
			23	16	7	ND	ND	ND	ND	ND
11–06	Ohio R. at Olmsted, Ill.	2,480	21	ND	ND	ND	ND	ND	ND	ND
11–08	White R. at Mile 1.2, Ark.	1,210	ND	ND	ND	ND	ND	ND	ND	ND
11–08	Arkansas R. at Mile 0.0, Ark.	1,620	ND	ND	ND	6	ND	16	21	ND
11–10	Yazoo R. at Mile ~3.0, Miss.	540	ND	ND	210	24	67	150	200	ND
11–09	Mississippi R. below Vicksburg, Miss.[2]	10,700	21	7	31	ND	ND	26	14	ND
			21	6	34	ND	ND	23	12	ND
11–11	Mississippi R. near St. Francisville, La.	8,950	22	6	36	ND	6	26	17	ND
11–13	Mississippi R. below Belle Chasse, La.	8,840	15	5	39	ND	6	38	39	ND

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.
[2]Duplicate samples collected.

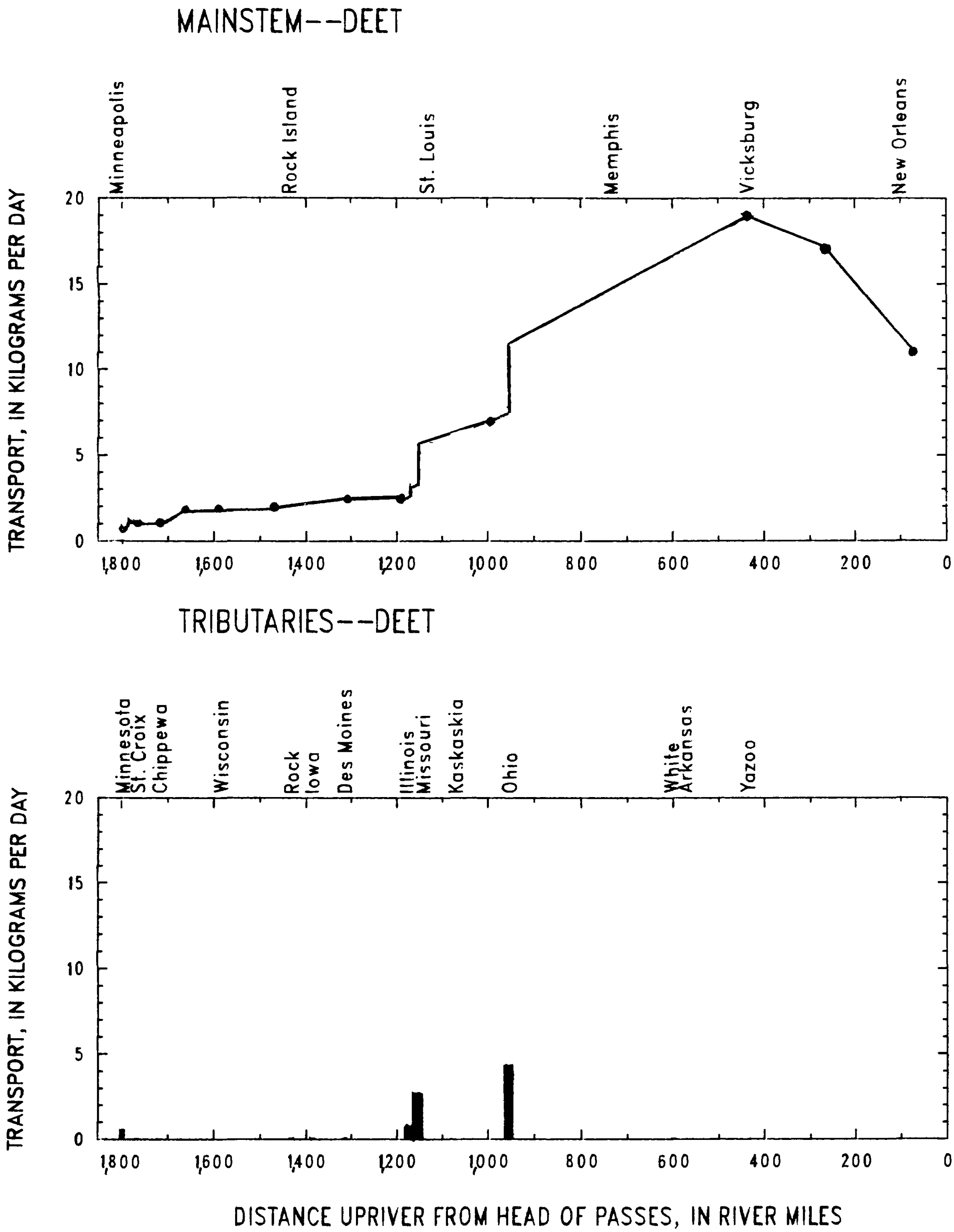


Figure 97.--Transport of deet in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

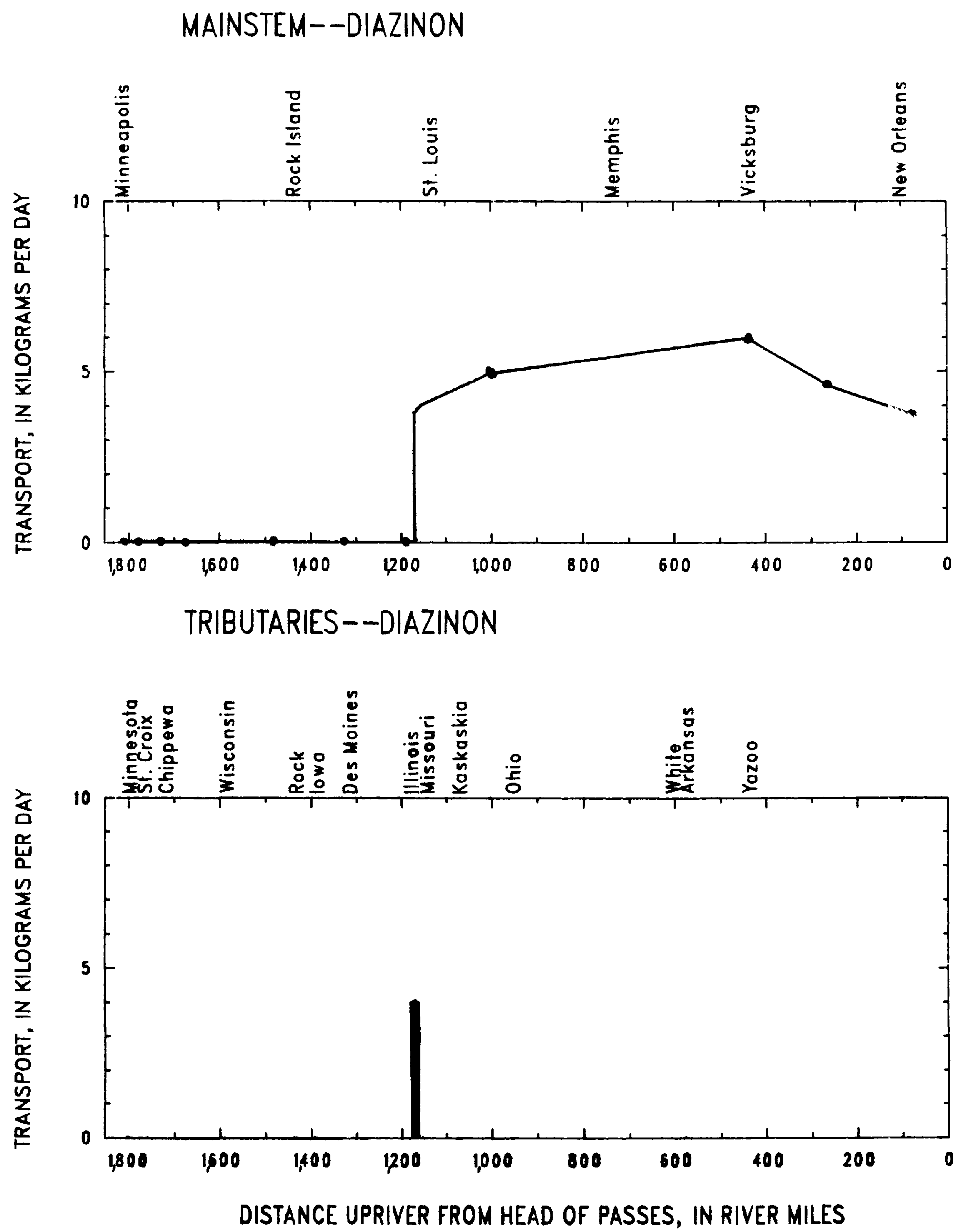


Figure 98.--Transport of diazinon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

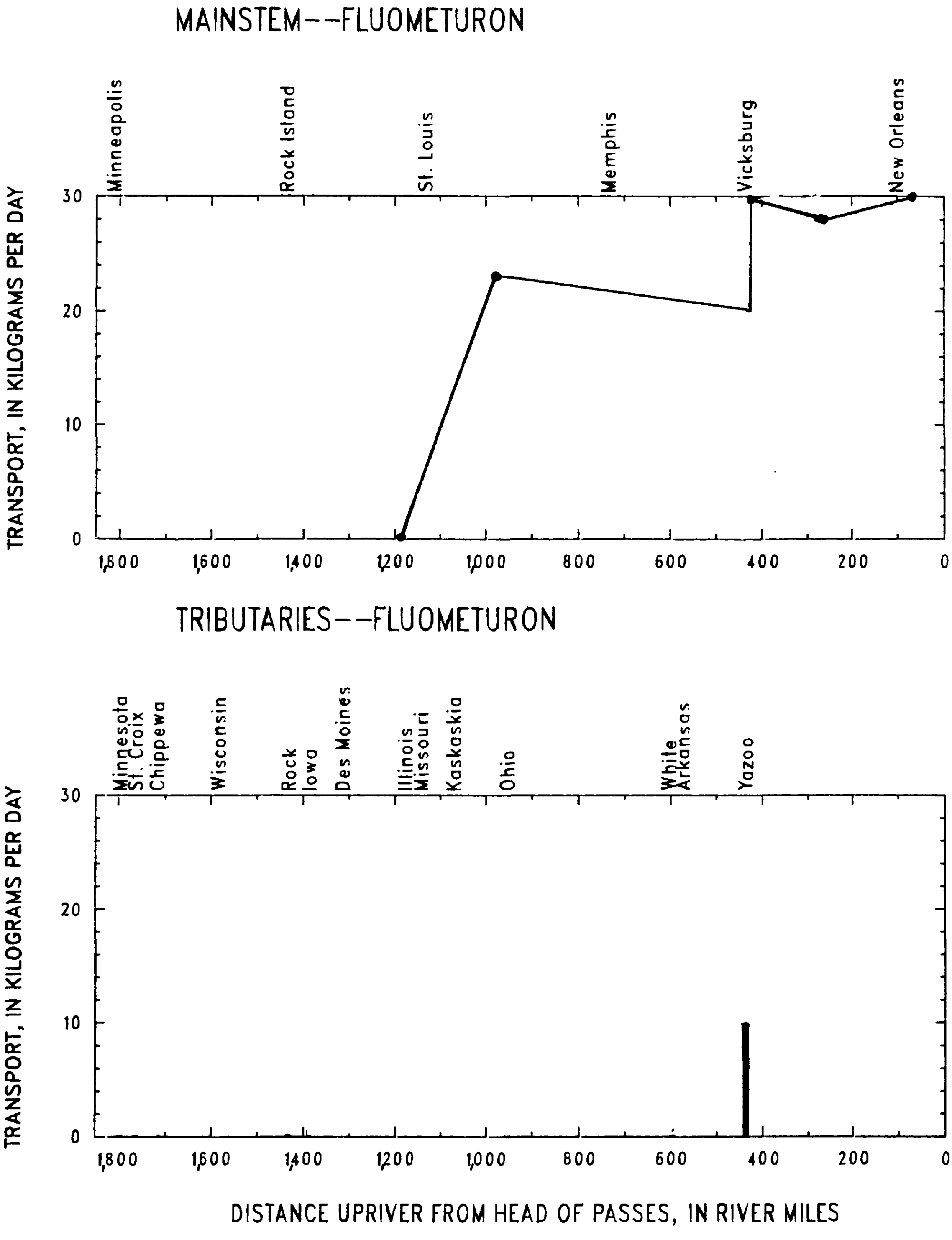


Figure 99.--Transport of fluometuron in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

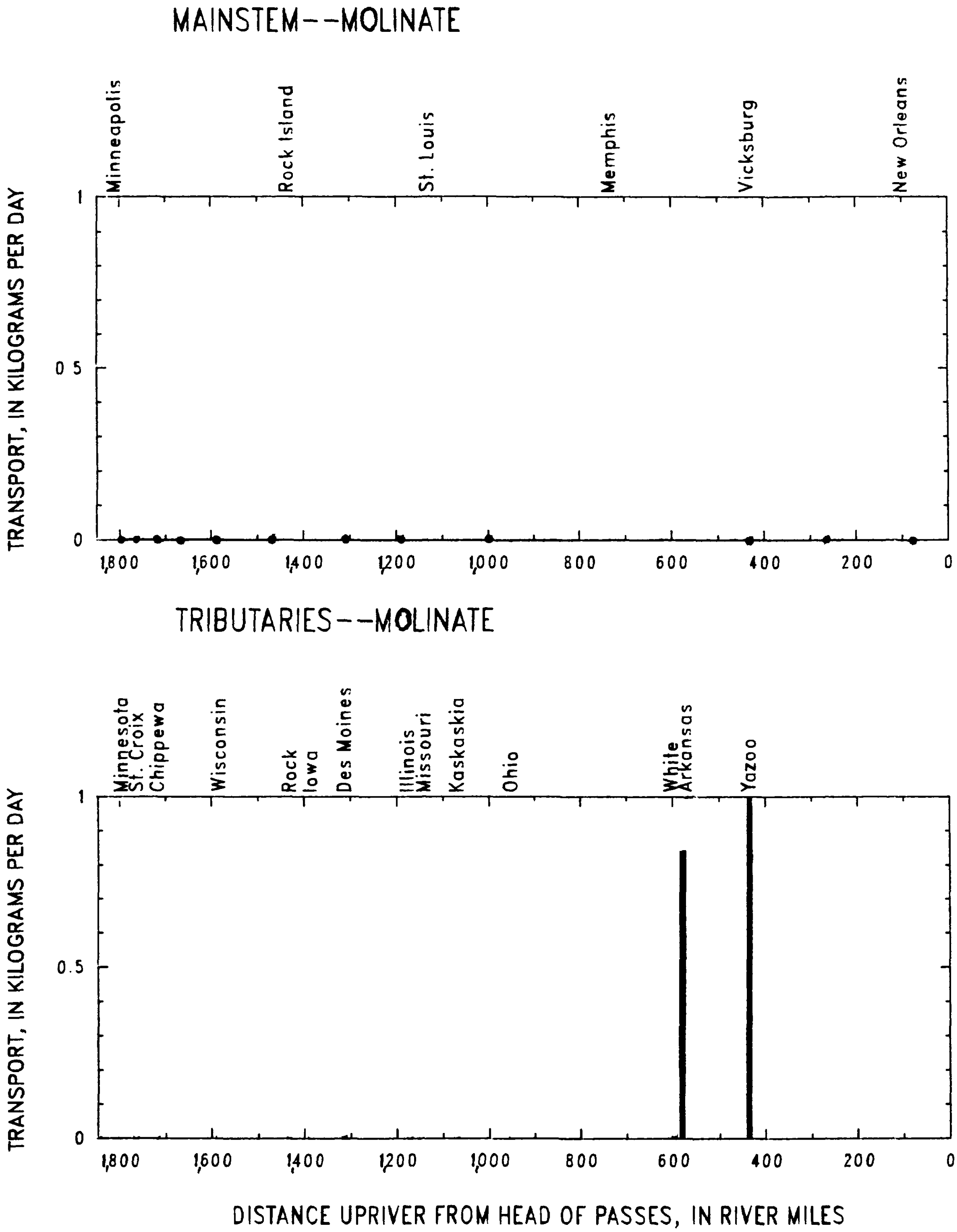


Figure 100.--Transport of molinate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

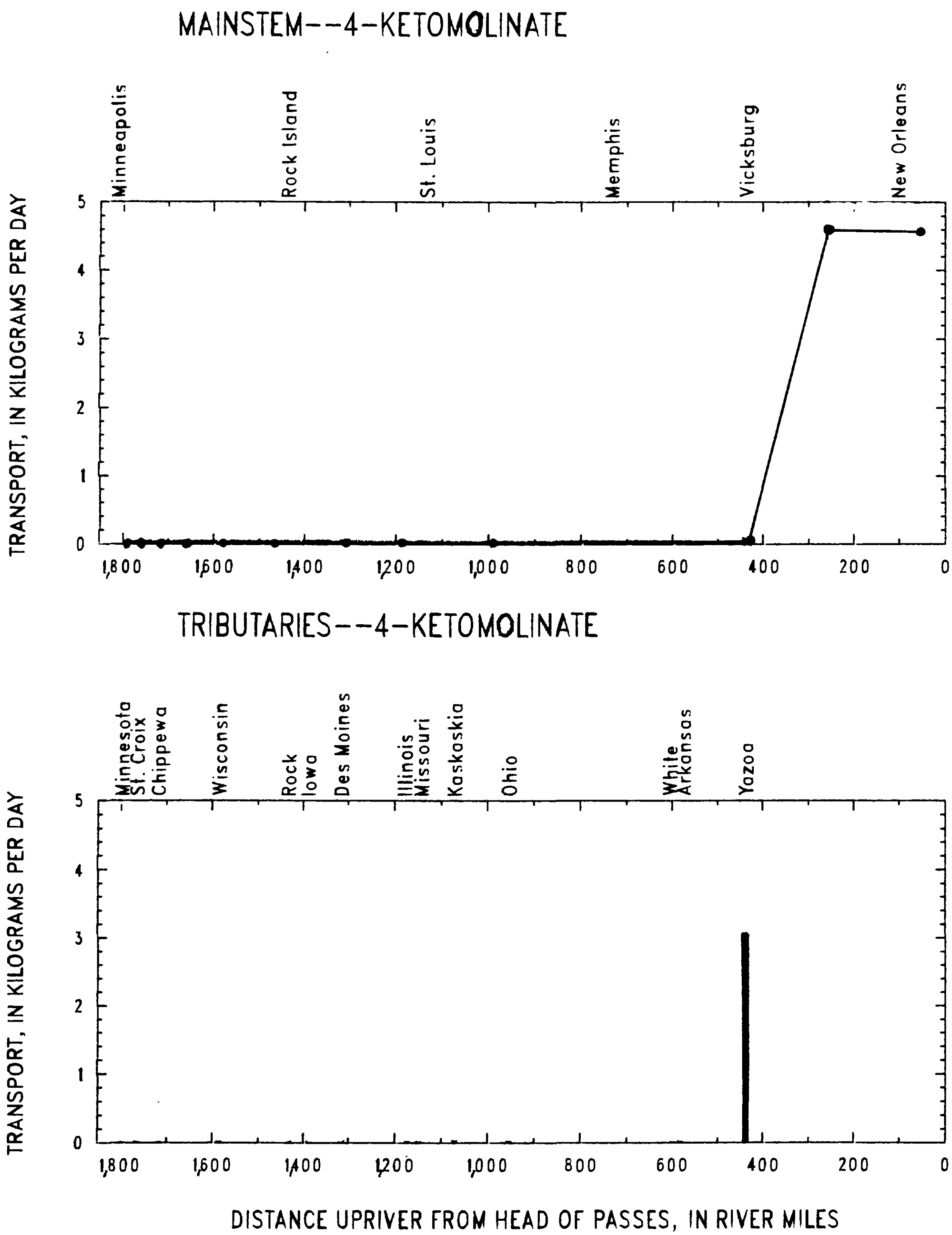


Figure 101.--Transport of 4-ketomolinate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

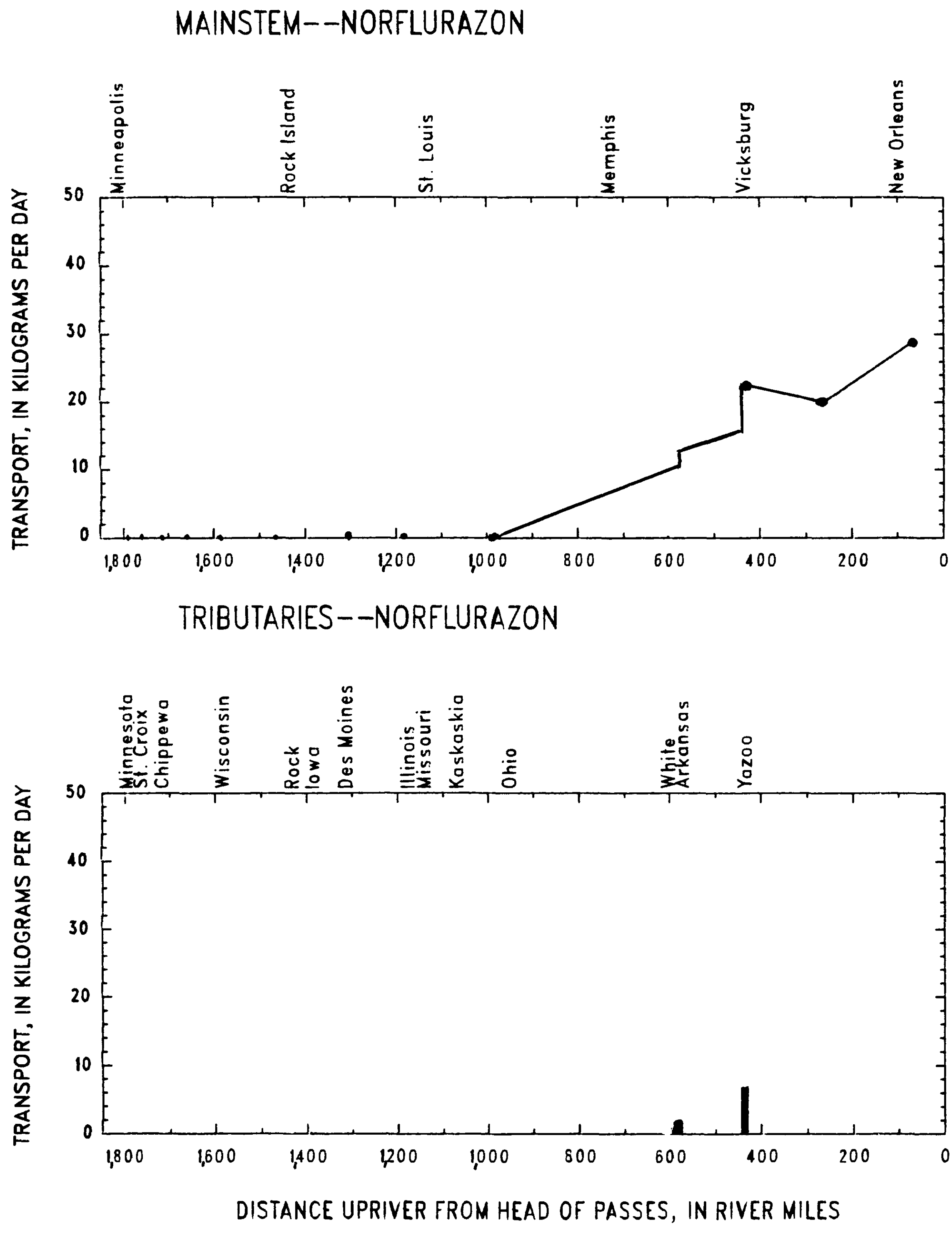


Figure 102.--Transport of norflurazon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

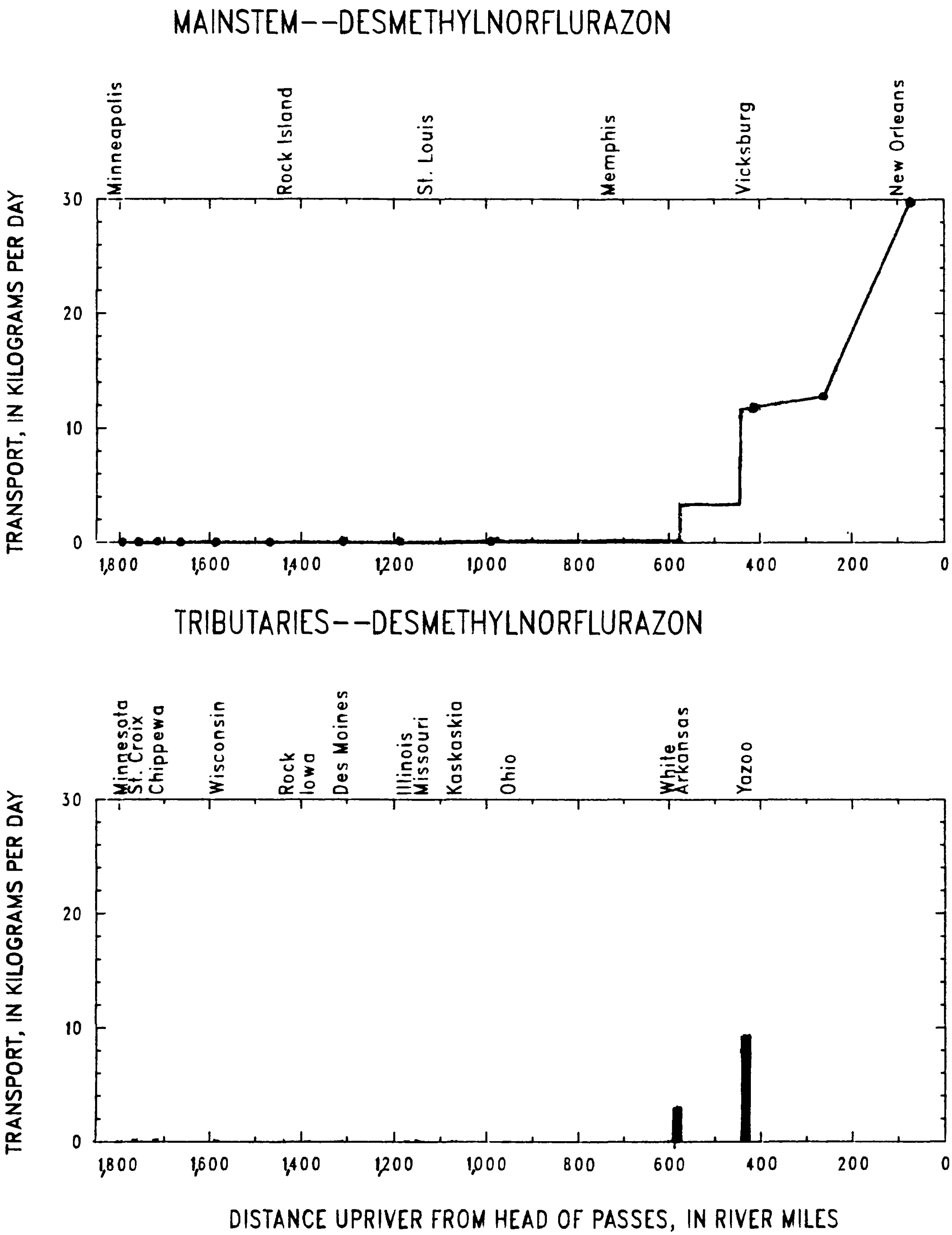


Figure 103.--Transport of desmethylnorflurazon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

Table 23.–Concentrations of miscellaneous organic contaminants in the Mississippi River and some of its tributaries for October–November 1991 cruise

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1991	Site name	Water discharge[1] (m^3/s)	Concentrations of miscellaneous organic contaminants, in ng/L					
			2,6-diethylaniline	Caffeine	1,3,5,-tri-methyl-2,4,6-triazine-trione	Tris-2-chloroethylphosphate	Tris-2-chloropropylphosphate isomer A	Tris-2-chloropropylphosphate isomer B
10–07	Mississippi R. above St. Anthony Falls, Minn.	220	ND	32	ND	ND	ND	ND
10–08	Minnesota R. at Mile 3.5, Minn.	130	ND	6	ND	26	11	ND
10–10	Mississippi R. at Hastings, Minn.[2]	350	ND	27	ND	25	19	ND
			ND	17	ND	18	15	ND
10–10	St. Croix R. at Mile 0.5, Wis.	95	ND	5	ND	ND	ND	ND
10–13	Mississippi R. near Pepin, Wis.	510	ND	14	ND	12	11	ND
10–12	Chippewa R. at Mile 1.7, Wis.	161	ND	62	ND	ND	ND	ND
10–15	Mississippi R. at Trempealeau, Wis.	660	ND	20	ND	12	19	22
10–18	Mississippi R. below Lock and Dam 9, Wis.	690	ND	15	ND	9	14	27
10–18	Wisconsin R. at Mile ~1.0, Wis.	161	ND	6	ND	ND	ND	9
10–22	Mississippi R. at Clinton, Iowa	940	ND	18	ND	7	15	ND
10–24	Rock R. at Mile ~1.0, Ill.	82	ND	24	ND	15	2[illegible]	ND
10–25	Iowa R. at Mile ~1.0, Iowa	74	ND	36	ND	11	12	14
10–27	Mississippi R. at Keokuk, Iowa	1,410	ND	21	ND	11	19	15
10–28	Des Moines R. at Mile ~1.0, Iowa	39	ND	9	ND	10	14	14
10–30	Mississippi R. near Winfield, Mo.	1,230	ND	18	ND	10	21	22
10–31	Illinois R. at Hardin, Ill.	520	ND	100	ND	90	620	300
11–03	Missouri R. at St. Charles, Mo.	1,350	ND	23	ND	ND	24	ND
11–04	Kaskaskia R. at Mile 1.5, Ill.	10	ND	30	ND	11	35	28
11–05	Mississippi R. at Thebes, Ill.[2]	3,870	7	36	ND	22	130	110
			6	32	ND	22	130	100
11–06	Ohio R. at Olmsted, Ill.	2,480	ND	15	119	16	25	18
11–08	White R. at Mile 1.2, Ark.	1,210	ND	ND	ND	ND	ND	ND
11–08	Arkansas R. at Mile 0.0, Ark.	1,620	ND	21	ND	11	ND	ND
11–10	Yazoo R. at Mile ~3.0, Miss.	540	ND	6	ND	ND	ND	ND
11–09	Mississippi R. below Vicksburg, Miss.[2]	10,700	ND	15	36	14	80	81
11–11	Mississippi R. near St. Francisville, La.	8,950	ND	11	22	13	75	71
11–13	Mississippi R. below Belle Chasse, La.	8,840	ND	16	22	16	91	85

[1]Discharges are listed in Moody and Meade (1995) with a discussion of errors.
[2]Duplicate samples collected.

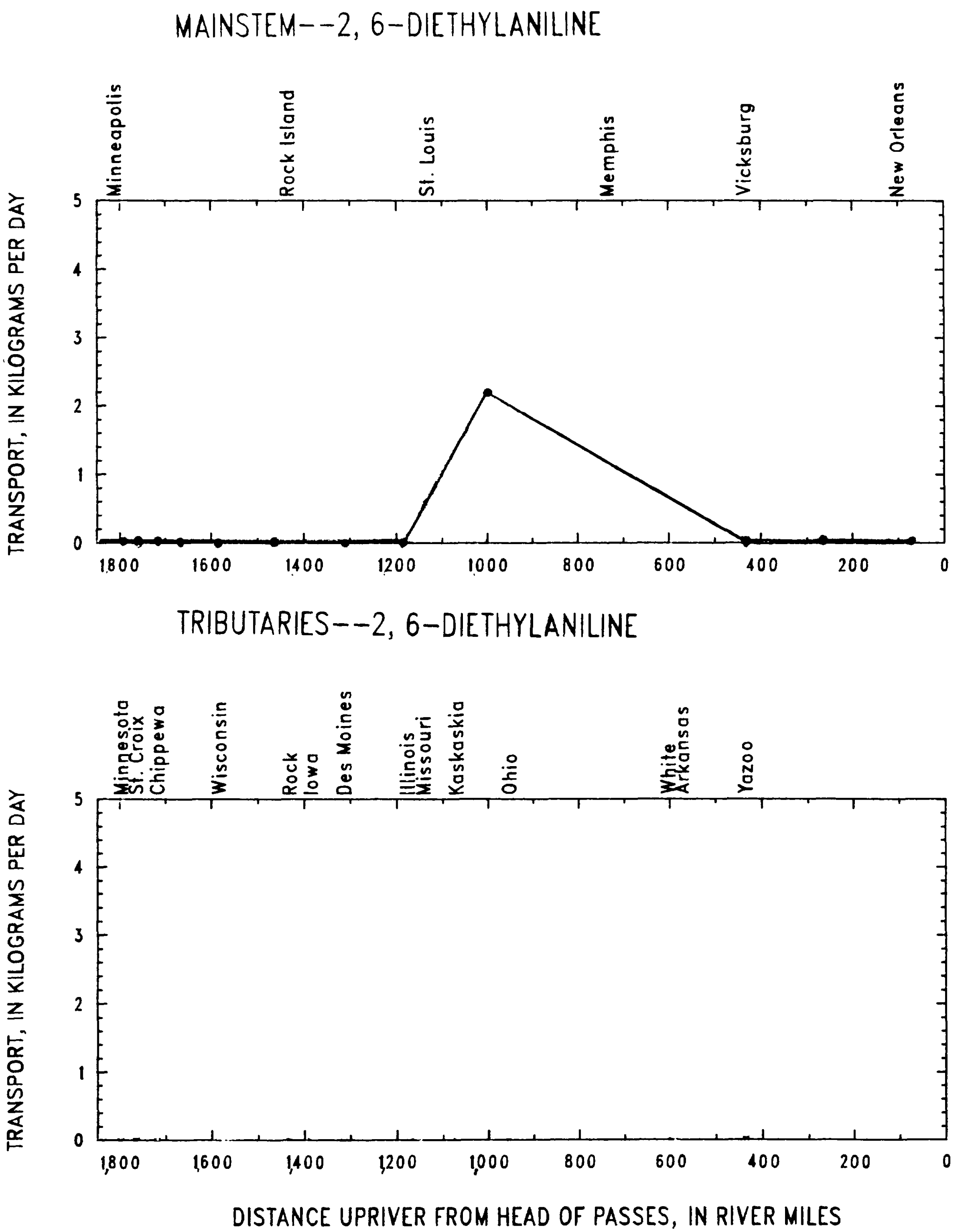


Figure 104.--Transport of 2,6-diethylaniline in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

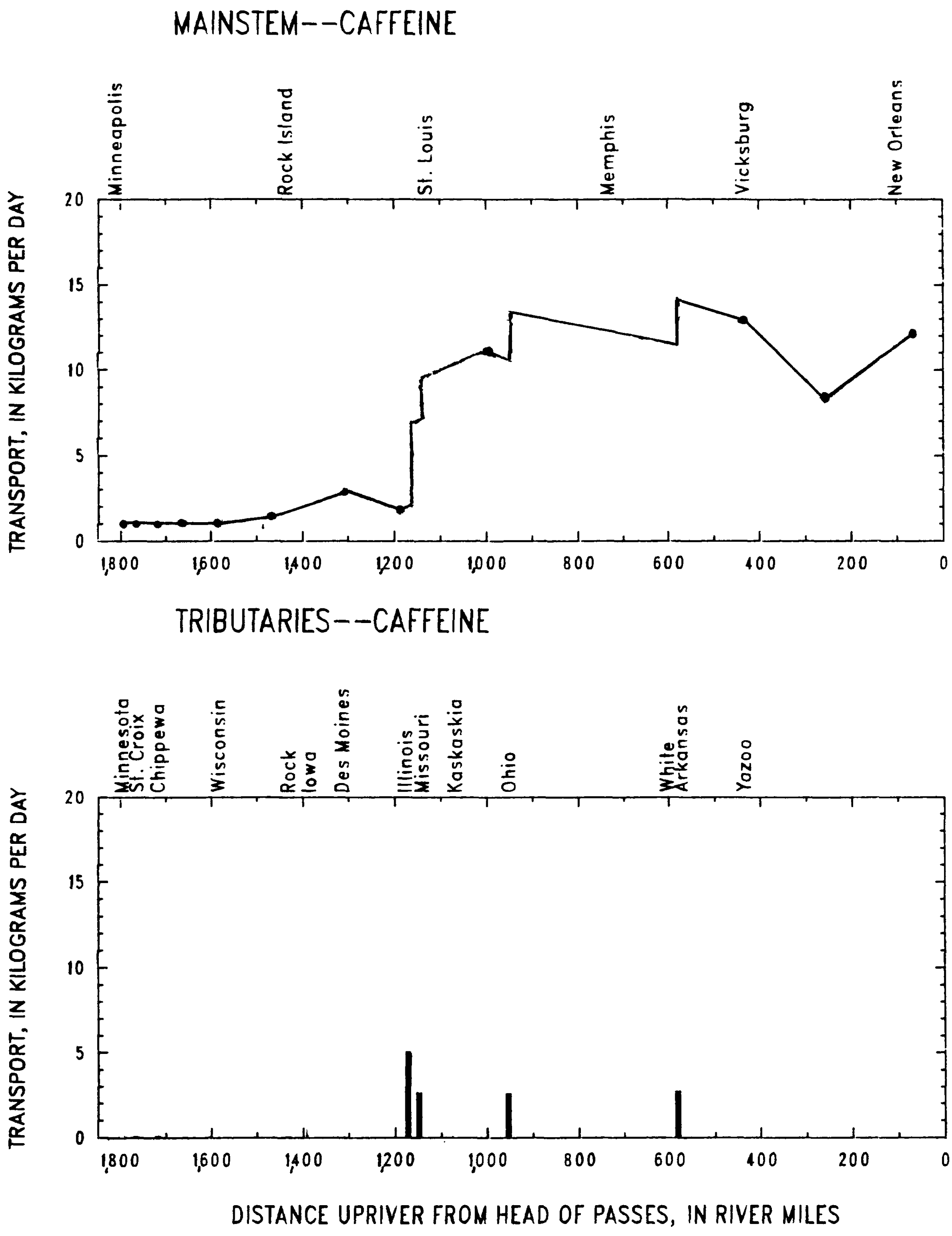


Figure 105.--Transport of caffeine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

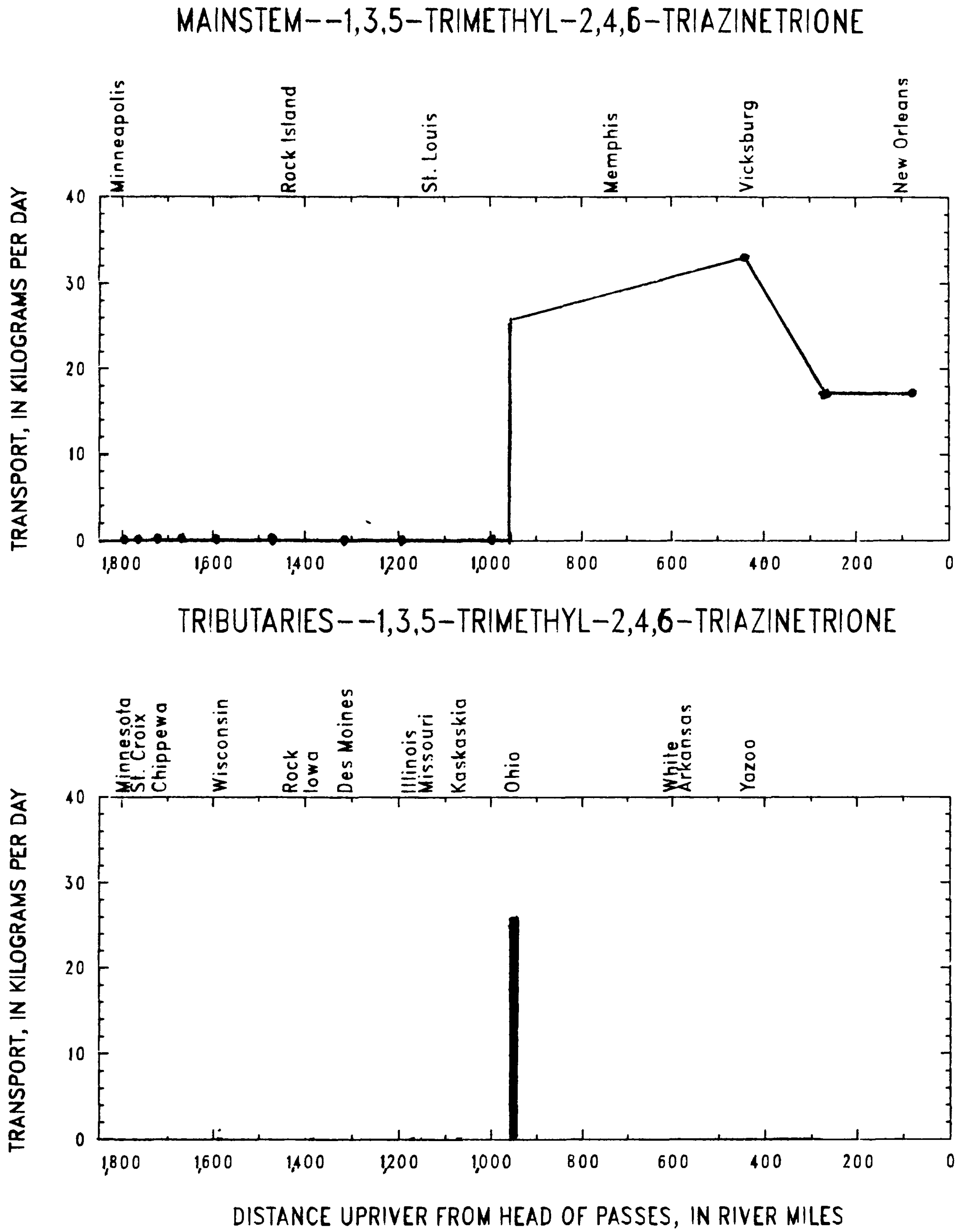


Figure 106.--Transport of 1,3,5-trimethyl-2,4,6-triazinetrione in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

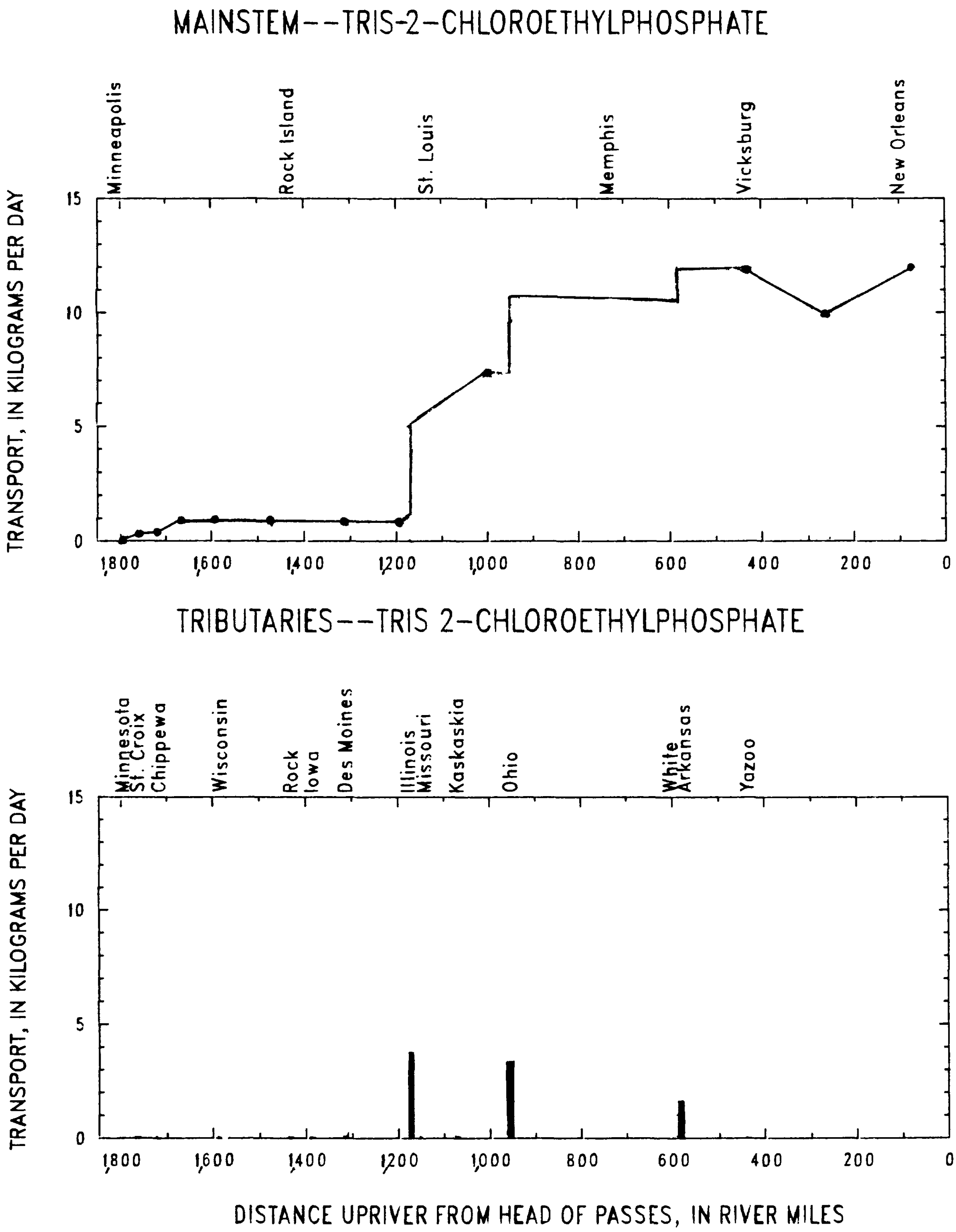


Figure 107.--Transport of tris-2-chloroethylphosphate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

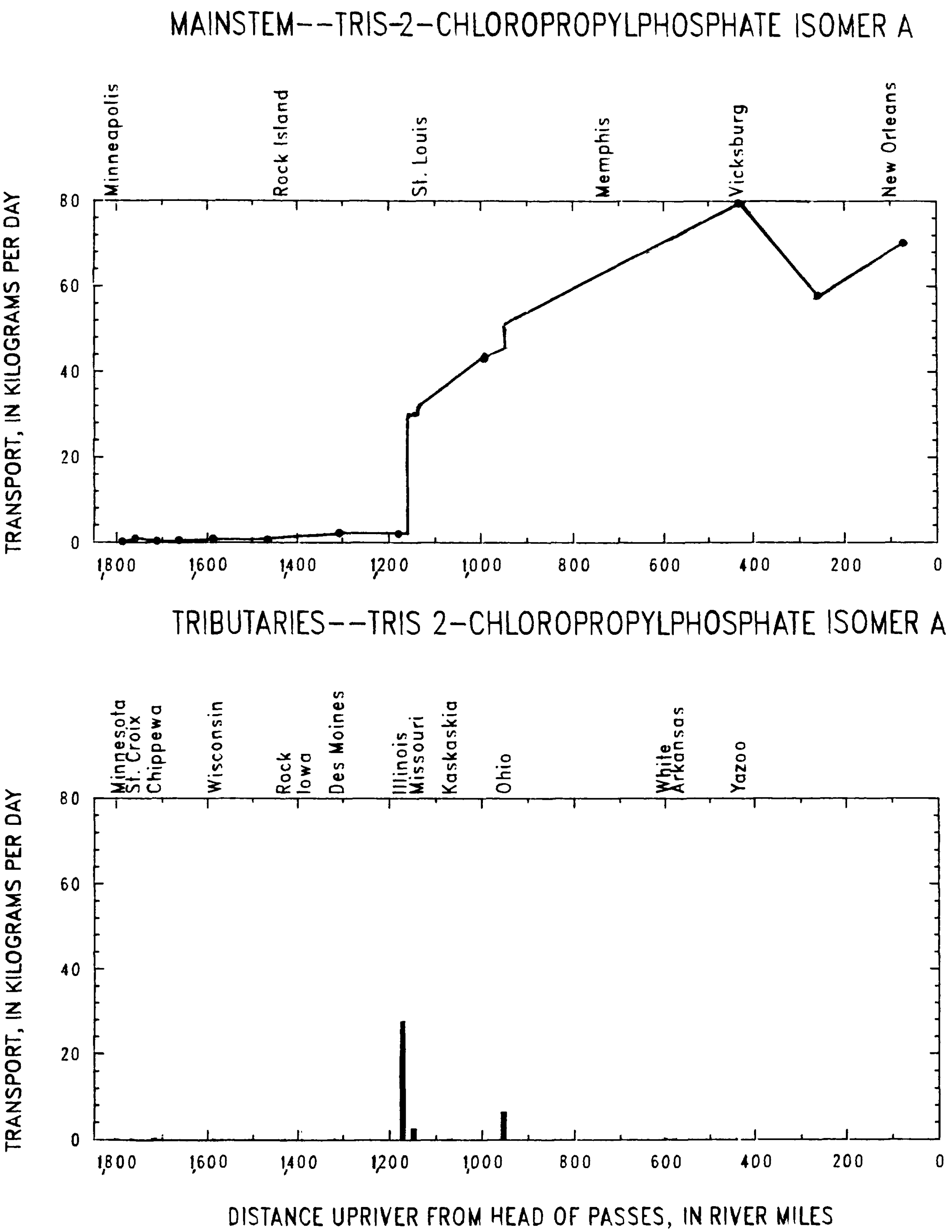


Figure 108.--Transport of tris-2-chloropropylphosphate isomer A in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

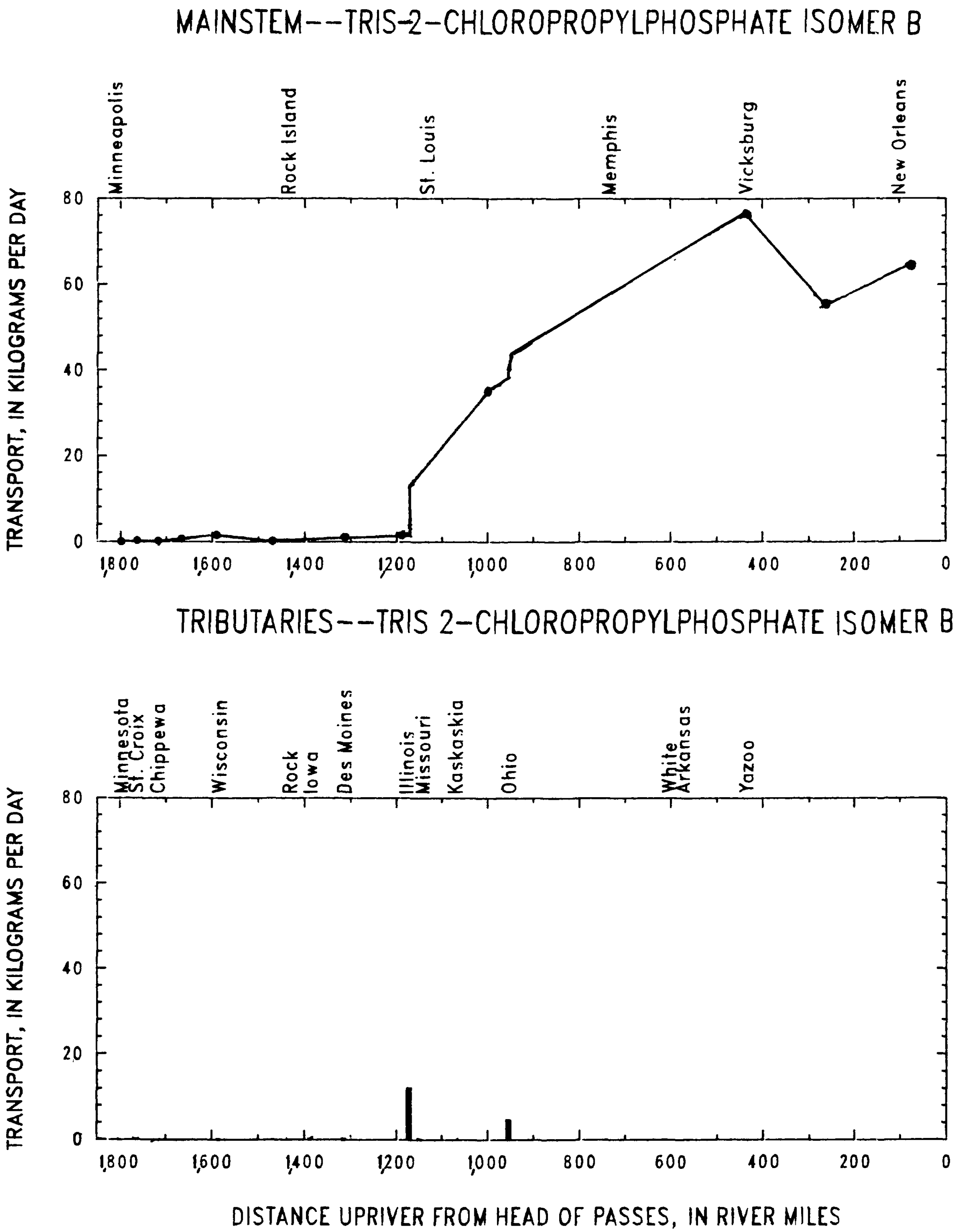


Figure 109.--Transport of tris-2-chloropropylphosphate isomer B in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between October 7 and November 13, 1991.

Table 24.--Concentrations of triazine herbicides and their transformation products in the Mississippi River and some of its tributaries for April–May 1992 cruise

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1992	Site name	Water discharge[1] (m³/s)	Concentrations of triazine herbicides, in ng/L										
			Ametryn	Atrazine	Desethylatrazine	Desisopropylatrazine	Cyanazine	Cyanazine-amide	Hexazinone	Metribuzin	Prometon	Prometryn	Simazine
4–06	Mississippi R. above St. Anthony Falls, Minn.	310	7	56	57	25	77	10	ND	ND	8	ND	12
4–08	Minnesota R. at Mile 3.5, Minn.	260	ND	42	36	ND	13	ND	ND	ND	13	ND	8
4–10	Mississippi R. at Hastings, Minn.[2]	570	ND	56	47	ND	40	ND	ND	ND	13	ND	12
			ND	52	42	ND	43	ND	ND	ND	15	ND	11
4–11	St. Croix R. at Mile 0.5, Wis.	320	ND	17	15	ND	ND	ND	ND	ND	ND	ND	7
4–12	Mississippi R. near Pepin, Wis.	950	ND	45	44	ND	36	37	ND	ND	11	ND	ND
4–12	Chippewa R. at Mile 1.7, Wis.	300	ND	19	21	12	ND	ND	ND	ND	ND	ND	7
4–14	Mississippi R. at Trempealeau, Wis.	1,330	ND	39	45	35	18	14	ND	ND	8	ND	9
4–17	Mississippi R. below Lock and Dam 9, Wis.	1,590	ND	44	51	ND	18	37	ND	ND	7	ND	10
4–17	Wisconsin R. at Mile ~1.0, Wis.	368	ND	51	53	27	10	10	ND	ND	ND	ND	ND
4–19	Mississippi R. at Clinton, Iowa	2,320	ND	58	65	ND	21	ND	ND	ND	6	ND	11
4–20	Rock R. at Mile ~1.0, Ill.	337	ND	410	200	32	220	47	ND	ND	23	ND	33
4–22	Iowa R. at Mile ~1.0, Iowa	685	ND	1,800	150	88	760	140	ND	35	75	ND	180
4–23	Mississippi R. at Keokuk, Iowa	4,220	ND	1,110	150	65	800	140	ND	23	12	ND	27
4–24	Des Moines R. at Mile ~1.0, Iowa	719	ND	400	110	60	530	100	ND	16	13	ND	13
4–26	Mississippi R. near Winfield, Mo.	5,070	ND	940	150	ND	640	53	ND	20	10	ND	21
4–27	Illinois R. at Hardin, Ill.	860	ND	1,200	160	76	720	100	ND	13	33	ND	34
4–29	Missouri R. at St. Charles, Mo.	3,560	5	2,200	210	61	600	110	ND	18	14	ND	31
4–30	Kaskaskia R. at Mile 1.5, Ill.	31	34	4,700	360	200	1,600	280	ND	73	34	ND	840
5–01	Mississippi R. at Thebes, Ill.[2]	10,500	ND	1,100	130	54	520	210	ND	ND	14	ND	31
			ND	1,100	160	53	620	97	ND	ND	34	ND	27
5–03	Ohio R. at Olmsted, Ill.[2]	6,150	ND	1,100	110	150	490	150	32	40	32	ND	190
			ND	990	91	130	420	95	9	28	25	ND	170
5–05	White R. at Mile 1.2, Ark.	920	ND	120	5	ND	ND	ND	18	ND	ND	ND	13
5–05	Arkansas R. at Mile 0.0, Ark.	710	ND	210	35	95	ND	ND	ND	ND	39	ND	42
5–07	Yazoo R. at Mile ~3.0, Miss.	70	ND	580	30	83	160	ND	7	20	ND	17	41
5–06	Mississippi R. below Vicksburg, Miss.[2]	21,700	ND	1,600	120	34	650	140	ND	30	28	ND	100
			ND	1,500	130	37	670	140	ND	33	28	ND	110
5–08	Mississippi R. near St. Francisville, La.	15,100	9	1,600	130	41	670	150	30	33	29	ND	100
5–10	Mississippi R. below Belle Chasse, La.	14,500	ND	1,600	130	33	660	150	ND	24	27	ND	120

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.
[2]Duplicate samples collected.

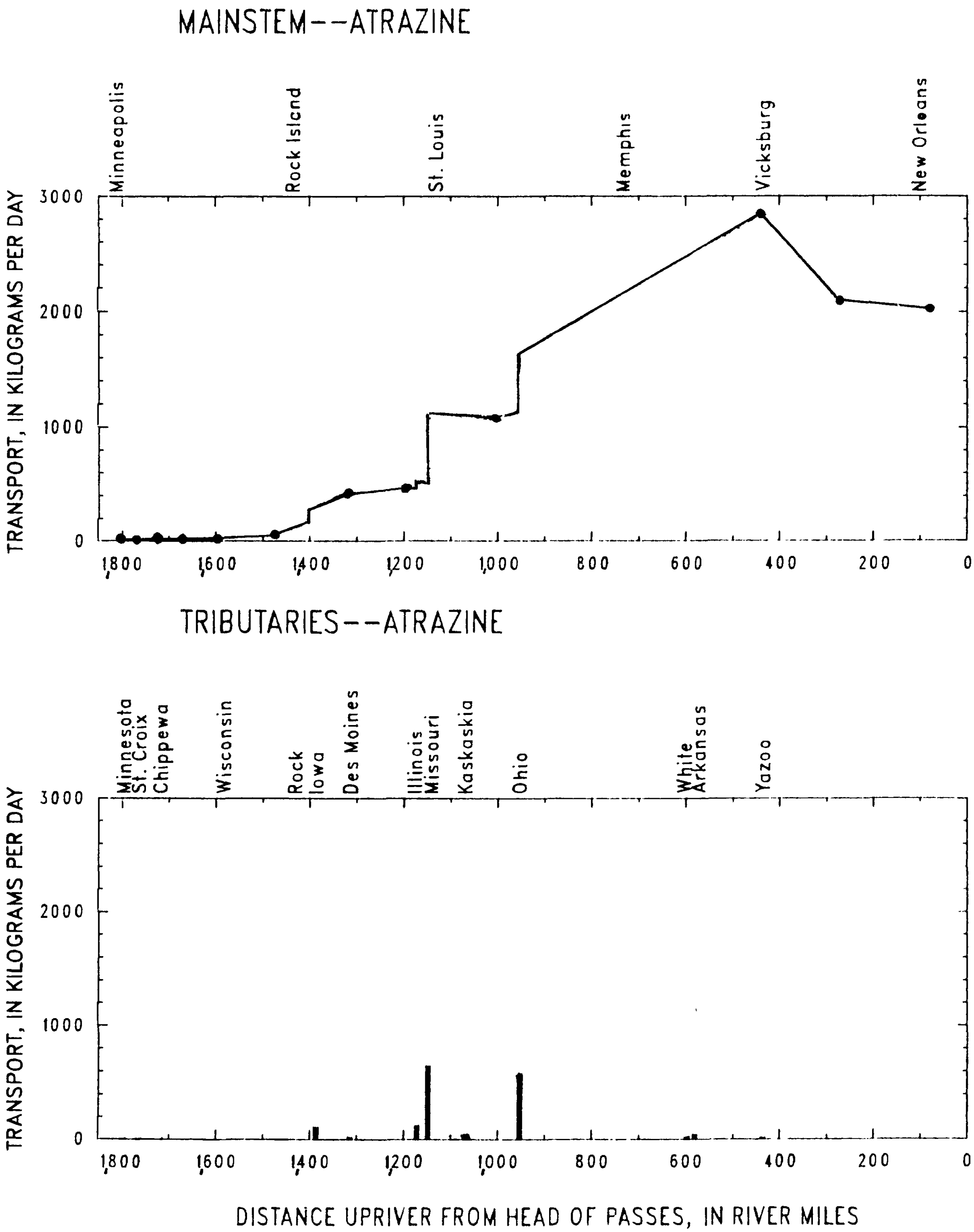


Figure 110.--Transport of atrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

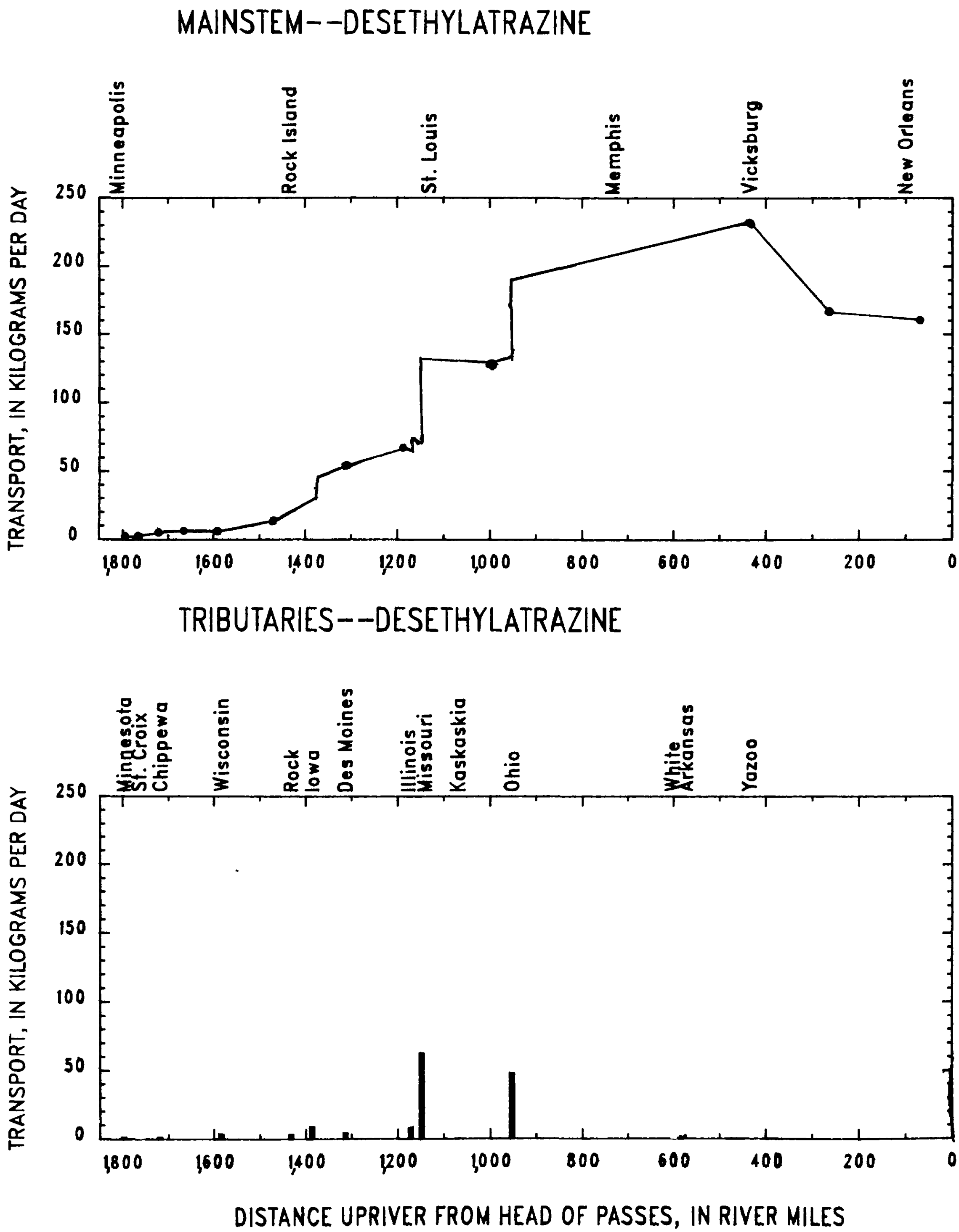


Figure 111.--Transport of desethylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

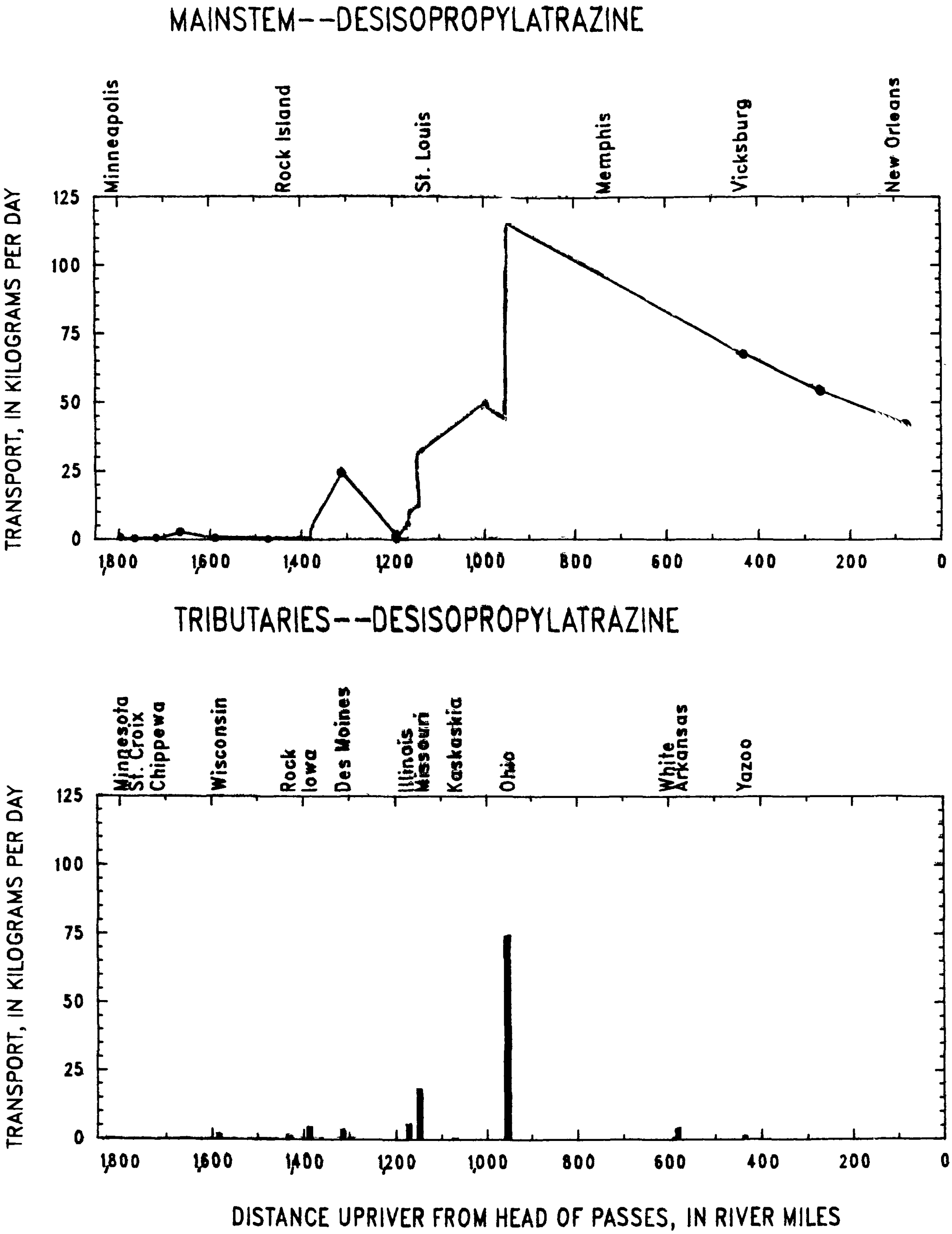


Figure 112.--Transport of desisopropylatrazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

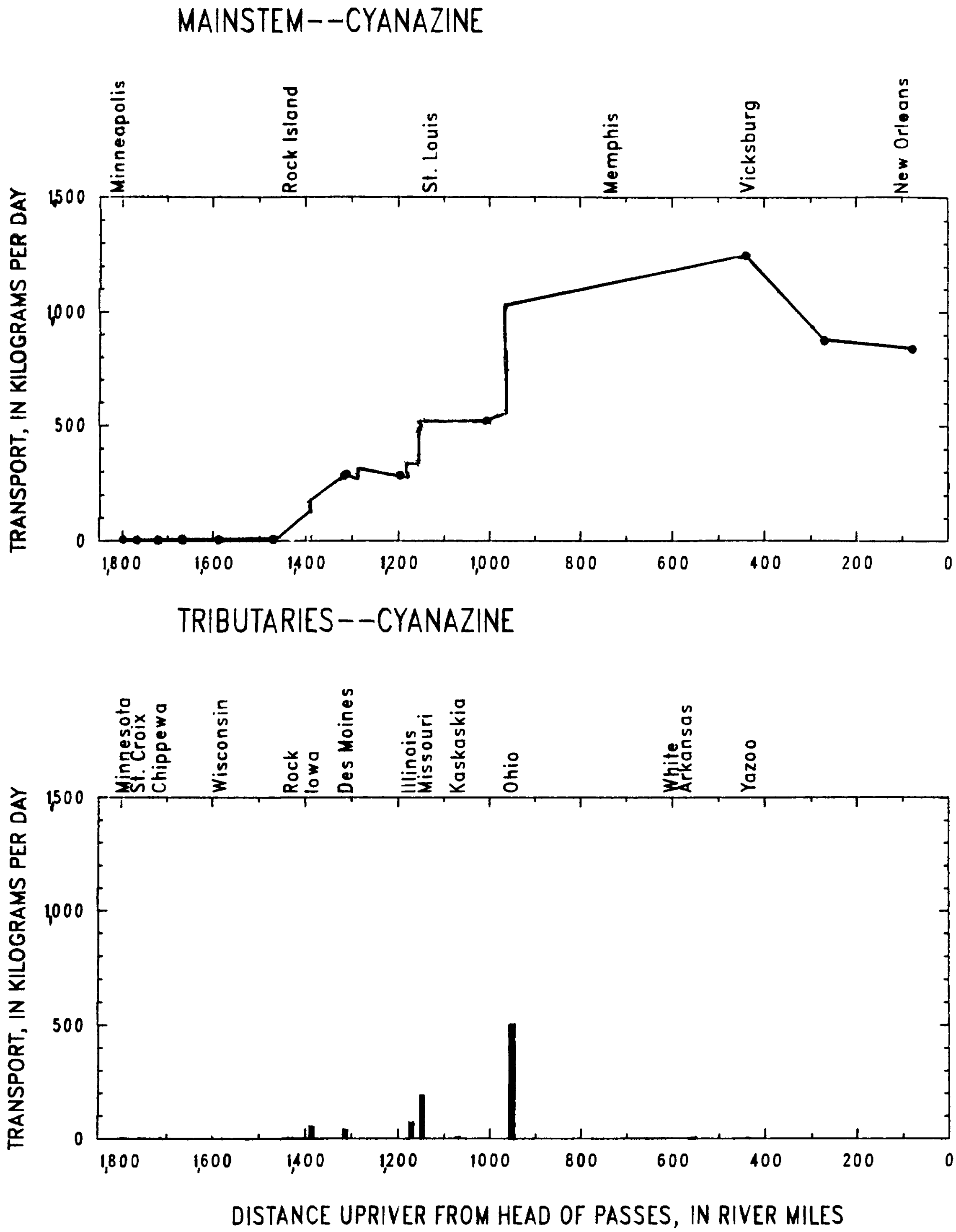


Figure 113.--Transport of cyanazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

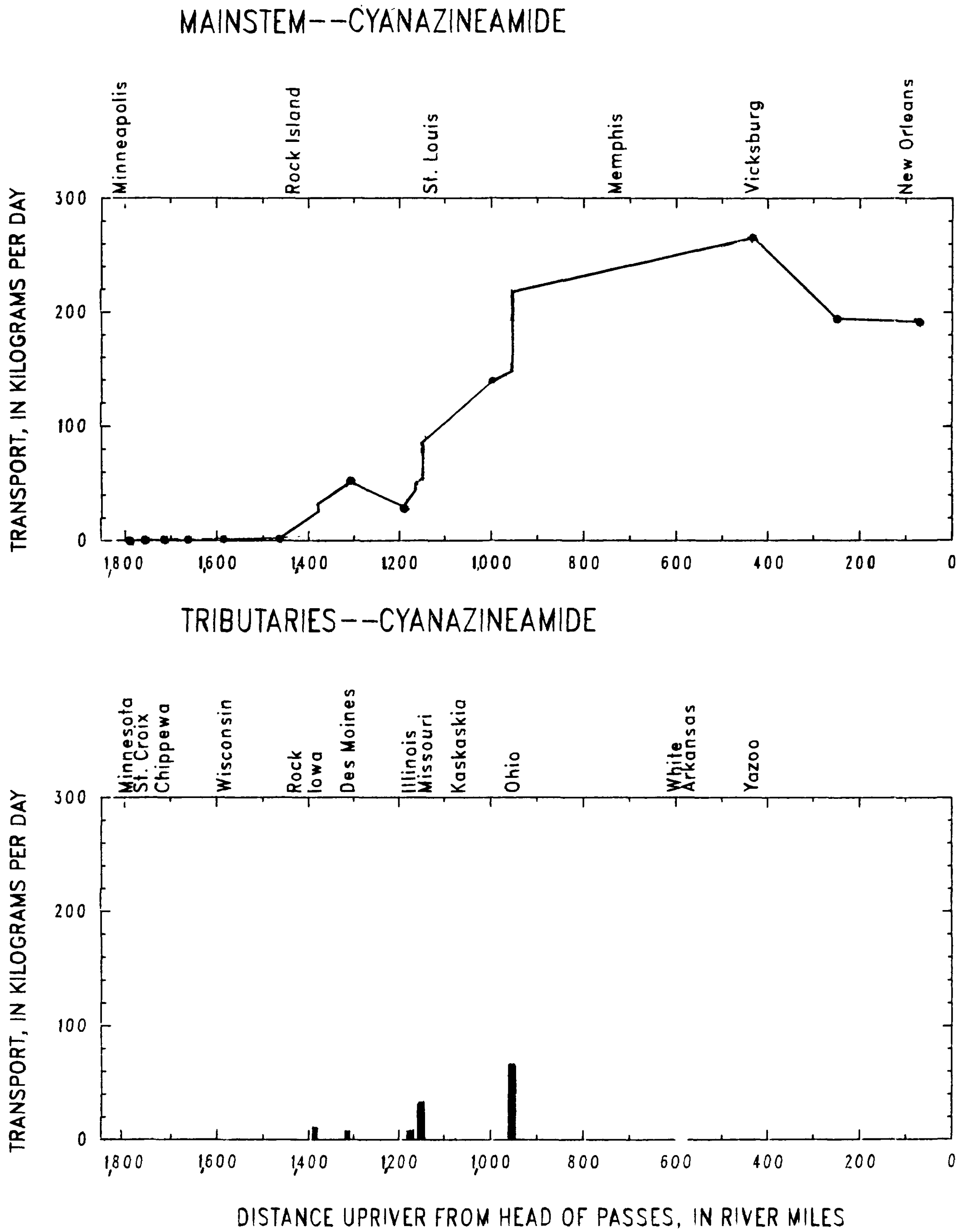


Figure 114.--Transport of cyanazineamide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

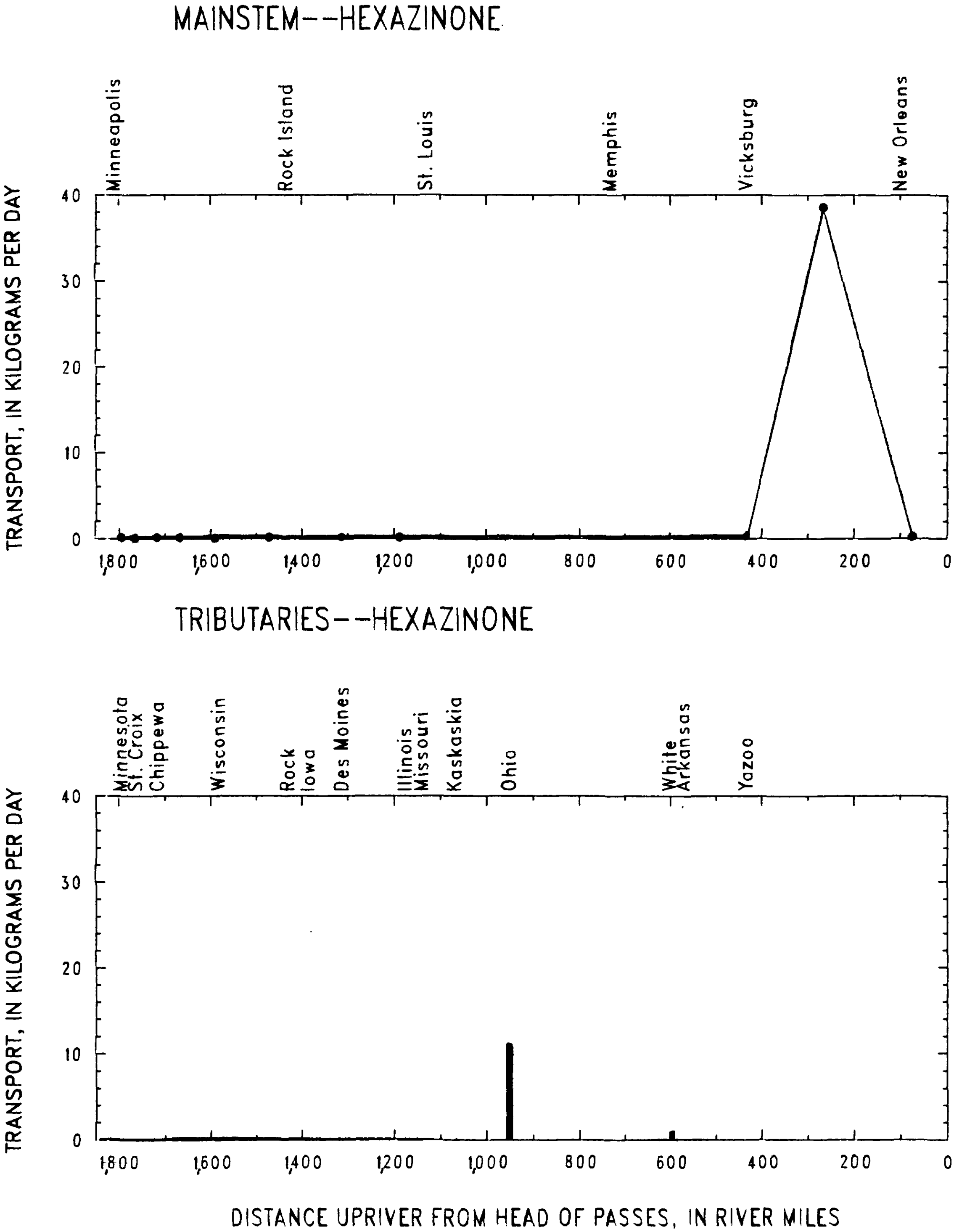


Figure 115.--Transport of hexazinone in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

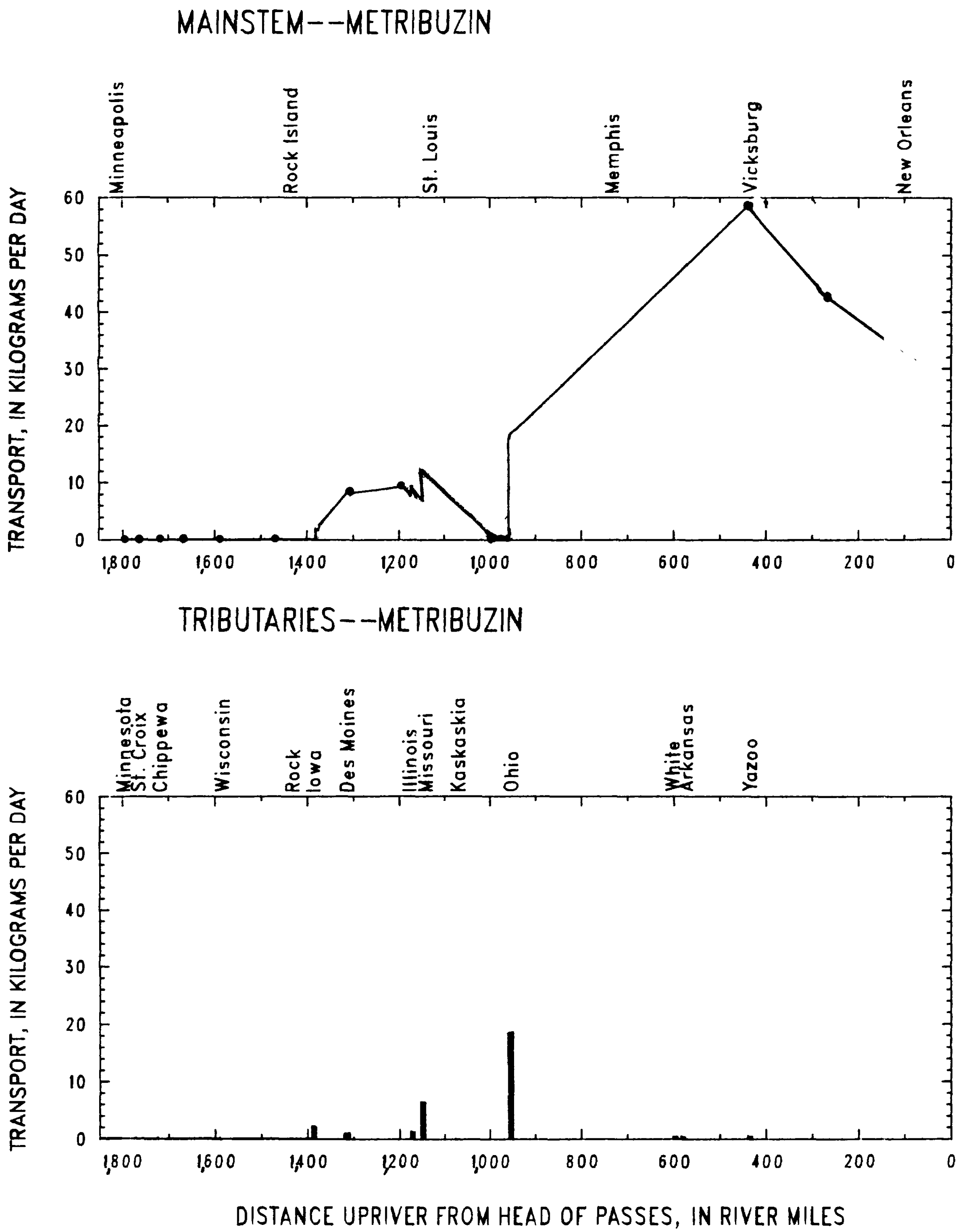


Figure 116.--Transport of metribuzin in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

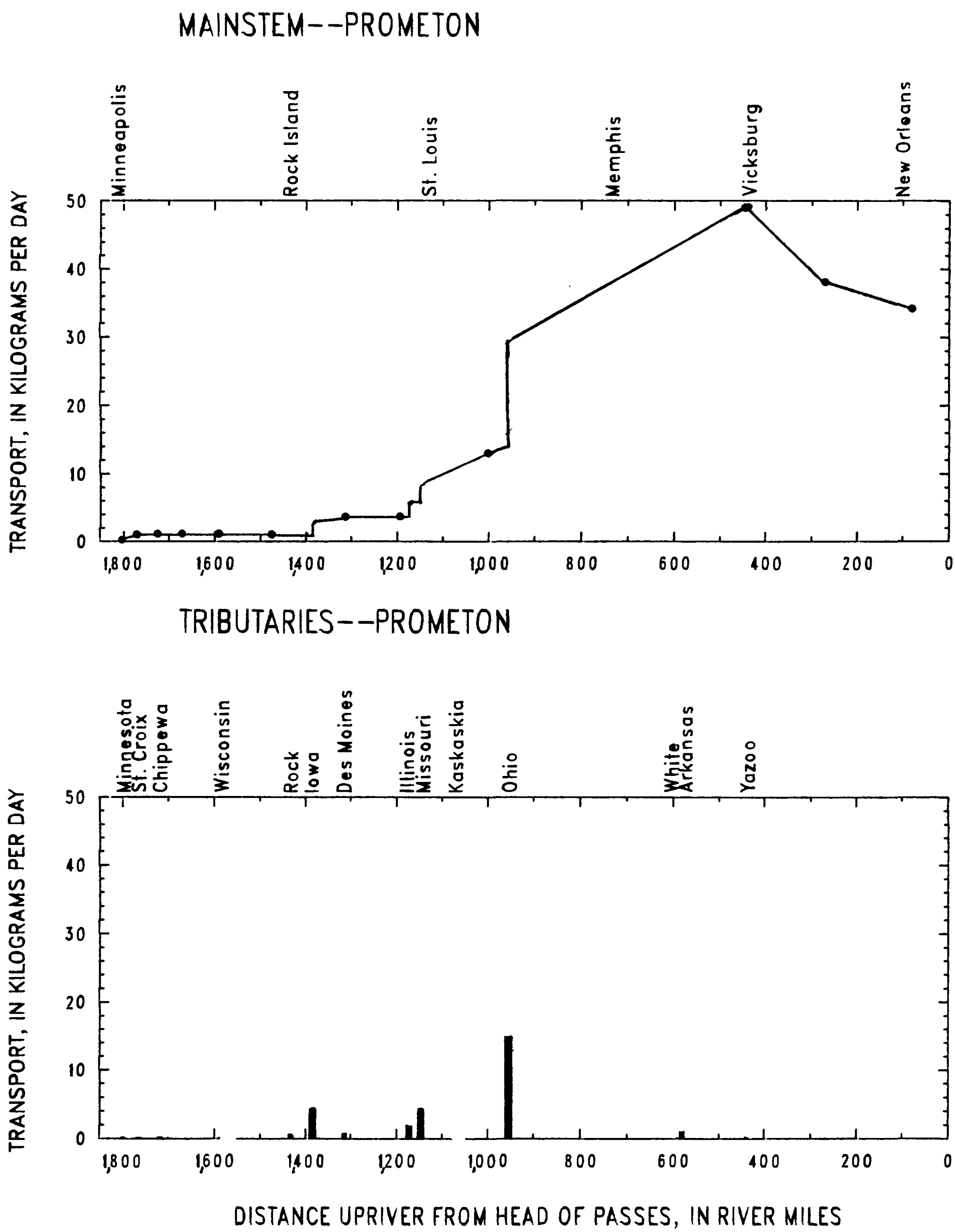


Figure 117.--Transport of prometon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

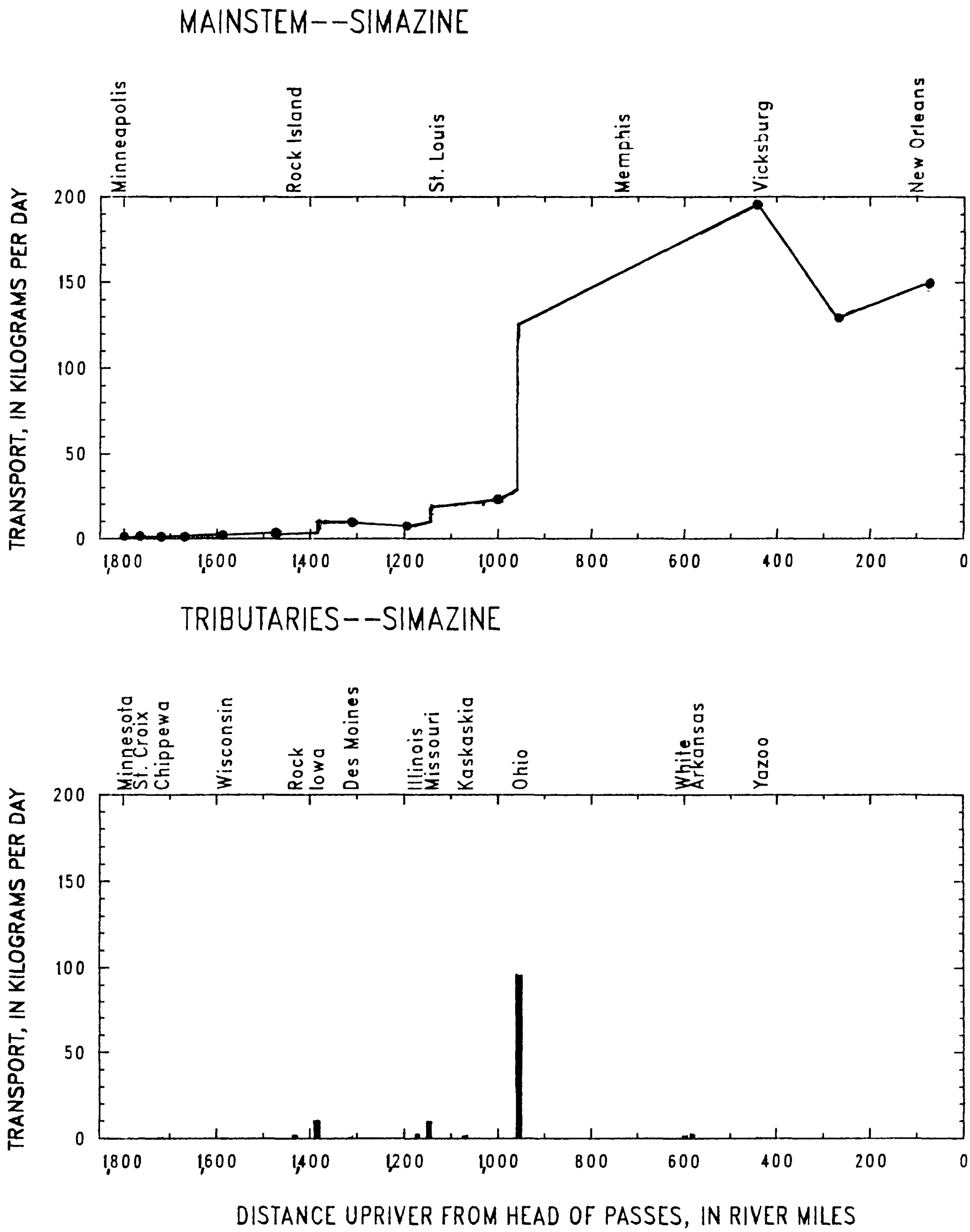


Figure 118.--Transport of simazine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

Table 25.--Concentrations of chloroacetanilide herbicides and their transformation products in the Mississippi River and some of its tributaries for April–May 1992 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1992	Site name	Water discharge[1] (m^3/s)	Concentration of chloroacetanilide herbicides, in ng/L			
			Alachlor	2-chloro-2′,6′-diethyl-acetanilide	2-hydroxy-2′,6′-diethyl-acetanilide	Metolachlor
4–06	Mississippi R. above St. Anthony Falls, Minn.	310	5	ND	61	18
4–08	Minnesota R. at Mile 3.5, Minn.	260	20	ND	29	75
4–10	Mississippi R. at Hastings, Minn.[2]	570	20	ND	61	48
			10	ND	26	45
4–11	St. Croix R. at Mile 0.5, Wis.	320	ND	ND	ND	ND
4–12	Mississippi R. near Pepin, Wis.	950	10	ND	ND	30
4–12	Chippewa R. at Mile 1.7, Wis.	300	ND	ND	ND	ND
4–14	Mississippi R. at Trempealeau, Wis.	1,330	8	ND	ND	23
4–17	Mississippi R. below Lock and Dam 9, Wis.	1,590	13	ND	ND	22
4–17	Wisconsin R. at Mile ~1.0, Wis.	368	5	ND	ND	9
4–19	Mississippi R. at Clinton, Iowa	2,320	13	ND	ND	27
4–20	Rock R. at Mile ~1.0, Ill.	337	84	ND	ND	640
4–22	Iowa R. at Mile ~1.0, Iowa	685	530	10	ND	1,500
4–23	Mississippi R. at Keokuk, Iowa	4,220	310	5	ND	580
4–24	Des Moines R. at Mile ~1.0, Iowa	719	59	ND	ND	240
4–26	Mississippi R. near Winfield, Mo.	5,070	230	ND	ND	580
4–27	Illinois R. at Hardin, Ill.	860	130	6	66	510
4–29	Missouri R. at St. Charles, Mo.	3,560	260	ND	28	840
4–30	Kaskaskia R. at Mile 1.5, Ill.	31	270	9	30	1,200
5–01	Mississippi R. at Thebes, Ill.[2]	10,500	180	ND	39	600
			180	ND	25	590
5–03	Ohio R. at Olmsted, Ill.[2]	6,150	190	ND	ND	570
			160	ND	ND	510
5–05	White R. at Mile 1.2, Ark.	920	21	ND	35	66
5–05	Arkansas R. at Mile 0.0, Ark.	710	ND	ND	ND	33
5–07	Yazoo R. at Mile ~3.0, Miss.	70	210	ND	ND	340
5–06	Mississippi R. below Vicksburg, Miss.[2]	21,700	250	ND	38	660
			260	ND	34	570
5–08	Mississippi R. near St. Francisville, La.	15,100	230	ND	ND	650
5–10	Mississippi R. below Belle Chasse, La.	14,500	240	ND	ND	640

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.
[2]Duplicate samples collected.

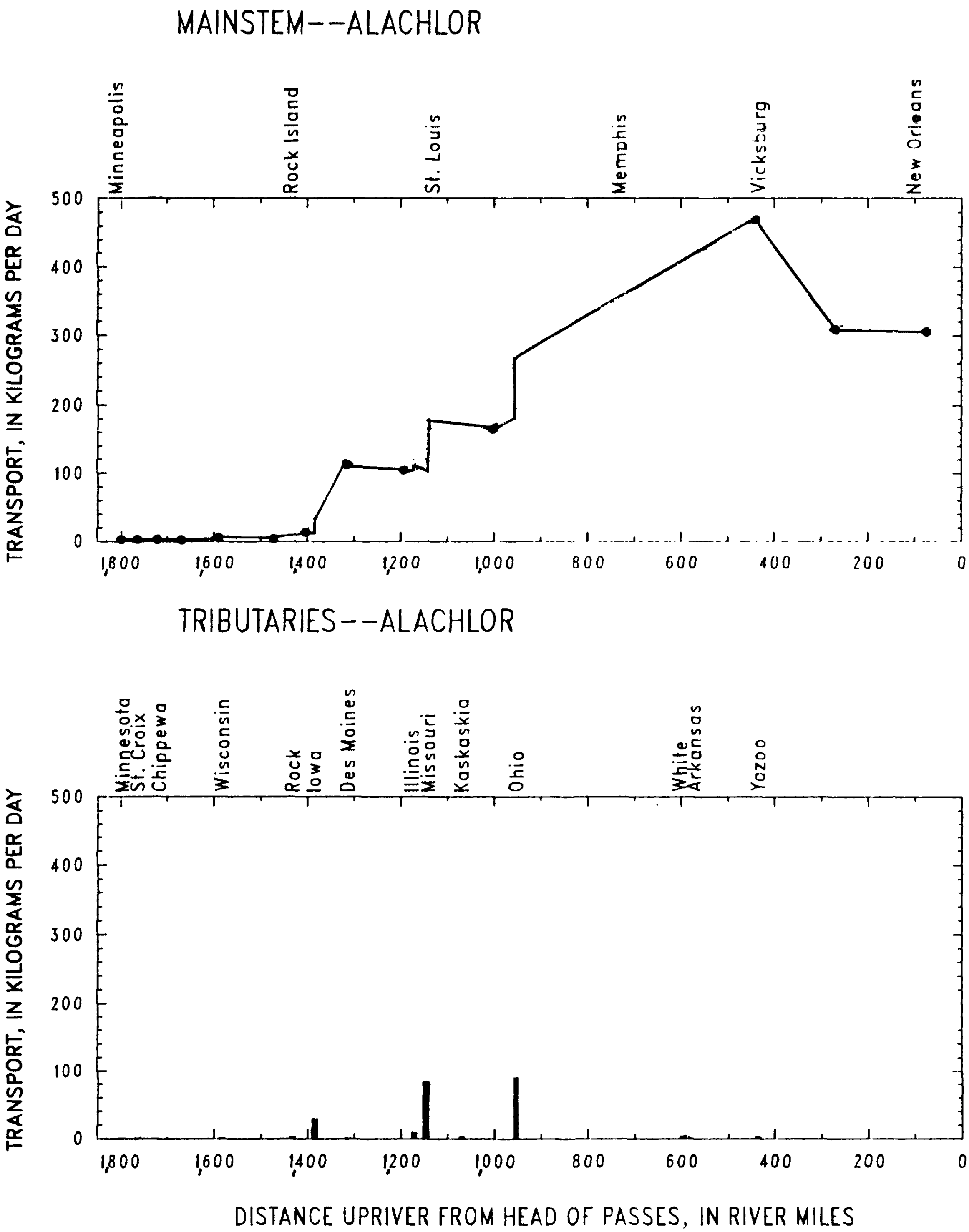


Figure 119.--Transport of alachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

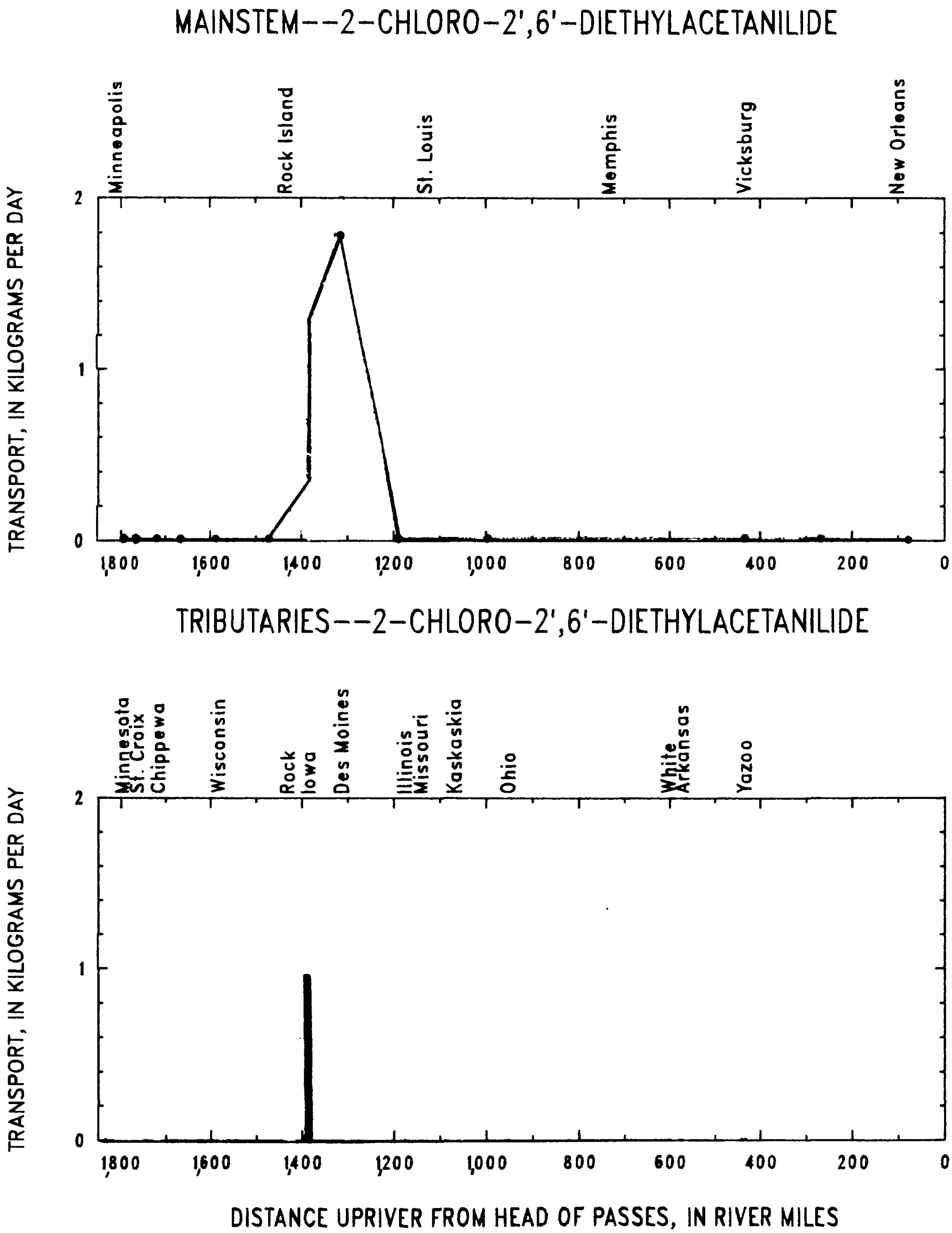


Figure 120.--Transport of 2-chloro-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

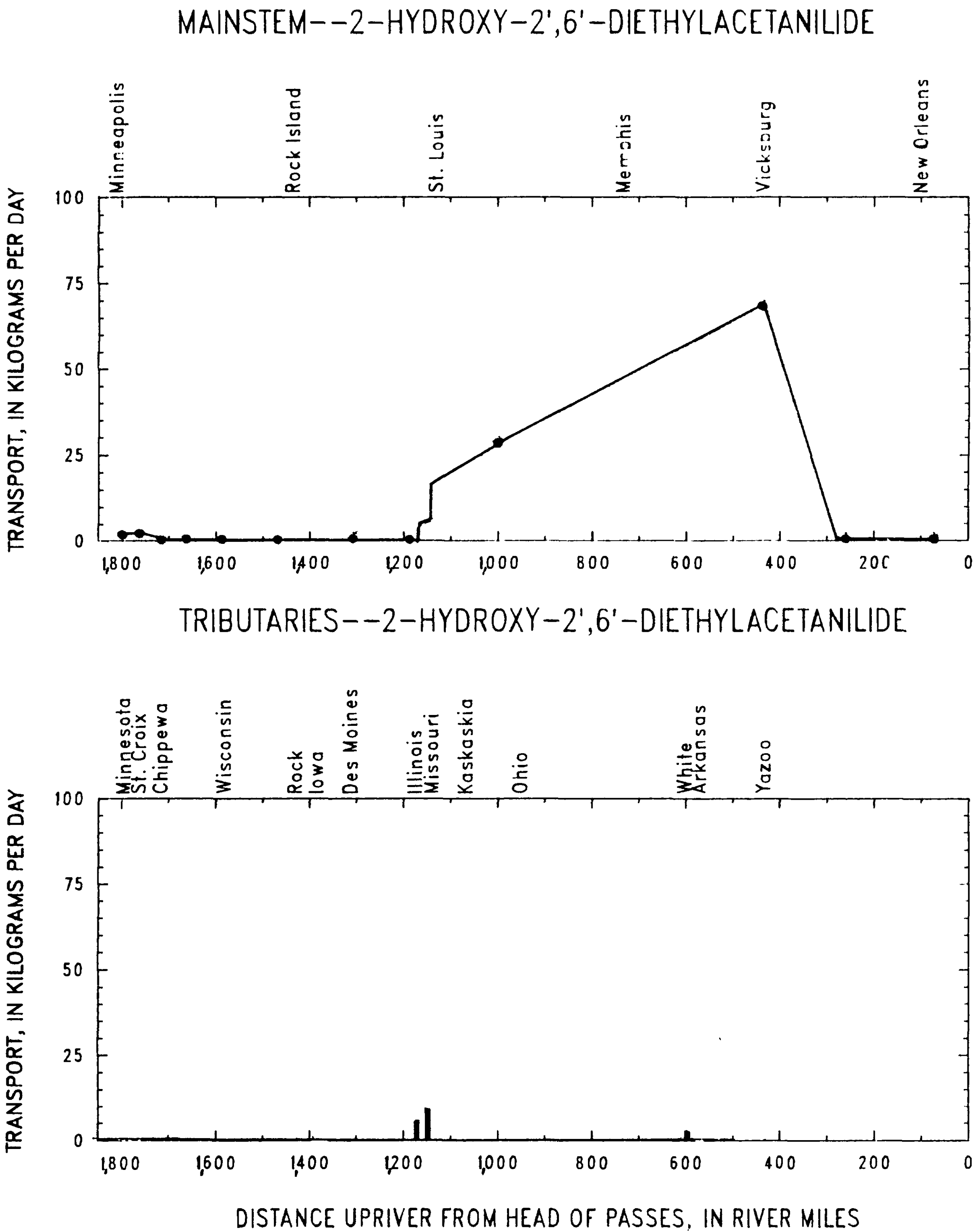


Figure 121.--Transport of 2-hydroxy-2′,6′-diethylacetanilide in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

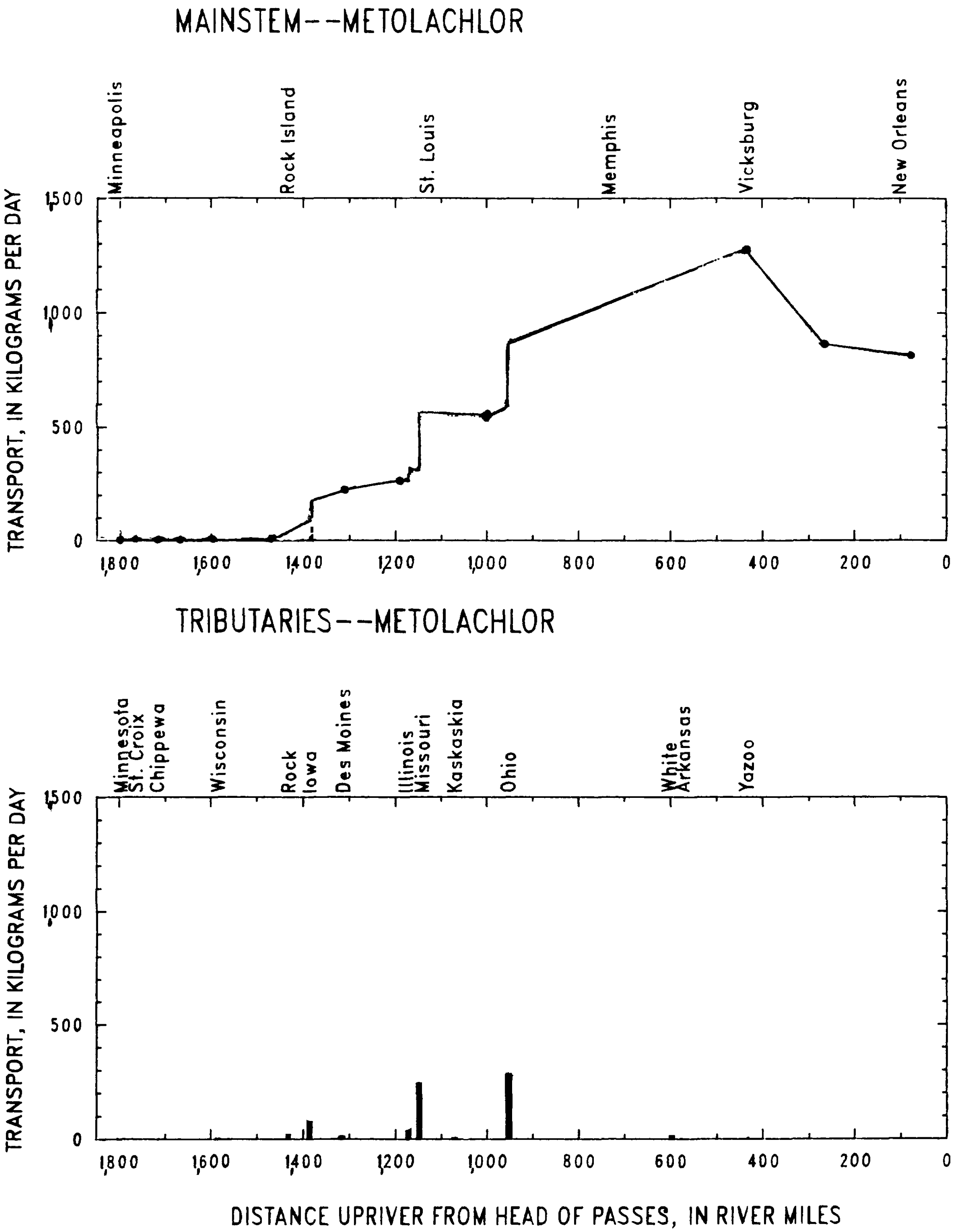


Figure 122.--Transport of metolachlor in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

Table 26.--Concentrations of miscellaneous pesticides and their transformation products in the Mississippi River and some of its tributaries for April–May 1992 cruise

[m^3/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1992	Site name	Water dis-charge[1] (m^3/s)	Concentration of miscellaneous pesticides and their transformation products, in ng/L							
			Deet	Diazi-non	Fluomet-uron	Moli-nate	4-keto-moli-nate	Norflur-azon	Desmethyl-norflurazon	Thio-ben-carb
4–06	Mississippi R. above St. Anthony Falls, Minn.	310	18	ND	ND	ND	ND	ND	ND	ND
4–08	Minnesota R. at Mile 3.5, Minn.	260	5	ND	ND	ND	ND	ND	ND	ND
4–10	Mississippi R. at Hastings, Minn.[2]	570	ND	ND	ND	ND	ND	ND	ND	ND
			ND	ND	ND	ND	ND	ND	ND	ND
4–11	St. Croix R. at Mile 0.5, Wis.	320	ND	ND	ND	ND	ND	ND	ND	ND
4–12	Mississippi R. near Pepin, Wis.	950	ND	ND	ND	ND	ND	ND	ND	ND
4–12	Chippewa R. at Mile 1.7, Wis.	300	ND	ND	ND	ND	ND	ND	ND	ND
4–14	Mississippi R. at Trempealeau, Wis.	1,330	7	ND	ND	ND	ND	ND	ND	ND
4–17	Mississippi R. below Lock and Dam 9, Wis.	1,590	ND	ND	ND	ND	ND	ND	ND	ND
4–17	Wisconsin R. at Mile ~1.0, Wis.	368	ND	ND	ND	ND	ND	ND	ND	ND
4–18	Mississippi R. at Clinton, Iowa	2,320	ND	ND	ND	ND	ND	ND	ND	ND
4–20	Rock R. at Mile ~1.0, Ill.	337	ND	ND	ND	ND	ND	ND	ND	ND
4–22	Iowa R. at Mile ~1.0, Iowa	685	ND	ND	ND	ND	ND	ND	ND	ND
4–23	Mississippi R. at Keokuk, Iowa	4,220	6	ND	ND	ND	ND	ND	ND	ND
4–24	Des Moines R. at Mile ~1.0, Iowa	719	ND	ND	ND	ND	ND	ND	ND	ND
4–26	Mississippi R. near Winfield, Mo.	5,070	ND	ND	ND	ND	ND	ND	ND	ND
4–27	Illinois R. at Hardin, Ill.	860	52	20	ND	ND	ND	ND	ND	ND
4–29	Missouri R. at St. Charles, Mo.	3,560	26	ND	ND	ND	ND	ND	ND	ND
4–30	Kaskaskia R. at Mile 1.5, Ill.	31	ND	ND	ND	ND	ND	ND	ND	ND
5–01	Mississippi R. at Thebes, Ill.[2]	10,500	13	ND	ND	ND	ND	ND	ND	ND
			13	ND	ND	ND	ND	ND	ND	ND
5–03	Ohio R. at Olmsted, Ill.[2]	6,150	23	ND	ND	ND	ND	ND	ND	ND
			18	ND	ND	ND	ND	ND	ND	ND
5–05	White R. at Mile 1.2, Ark.	920	ND	ND	ND	ND	ND	ND	ND	ND
5–05	Arkansas R. at Mile 0.0, Ark.	710	ND	12	ND	ND	ND	ND	ND	ND
5–07	Yazoo R. at Mile ~3.0, Miss.	70	ND	ND	520	ND	ND	320	310	ND
5–06	Mississippi R. below Vicksburg, Miss.[2]	21,800	74	11	13	ND	ND	ND	ND	ND
			79	13	14	ND	ND	ND	ND	ND
5–08	Mississippi R. near St. Francisville, La.	15,100	46	9	14	ND	ND	16	27	ND
5–10	Mississippi R. below Belle Chasse, La.	14,500	83	10	11	ND	ND	ND	ND	ND

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.

[2]Duplicate samples collected.

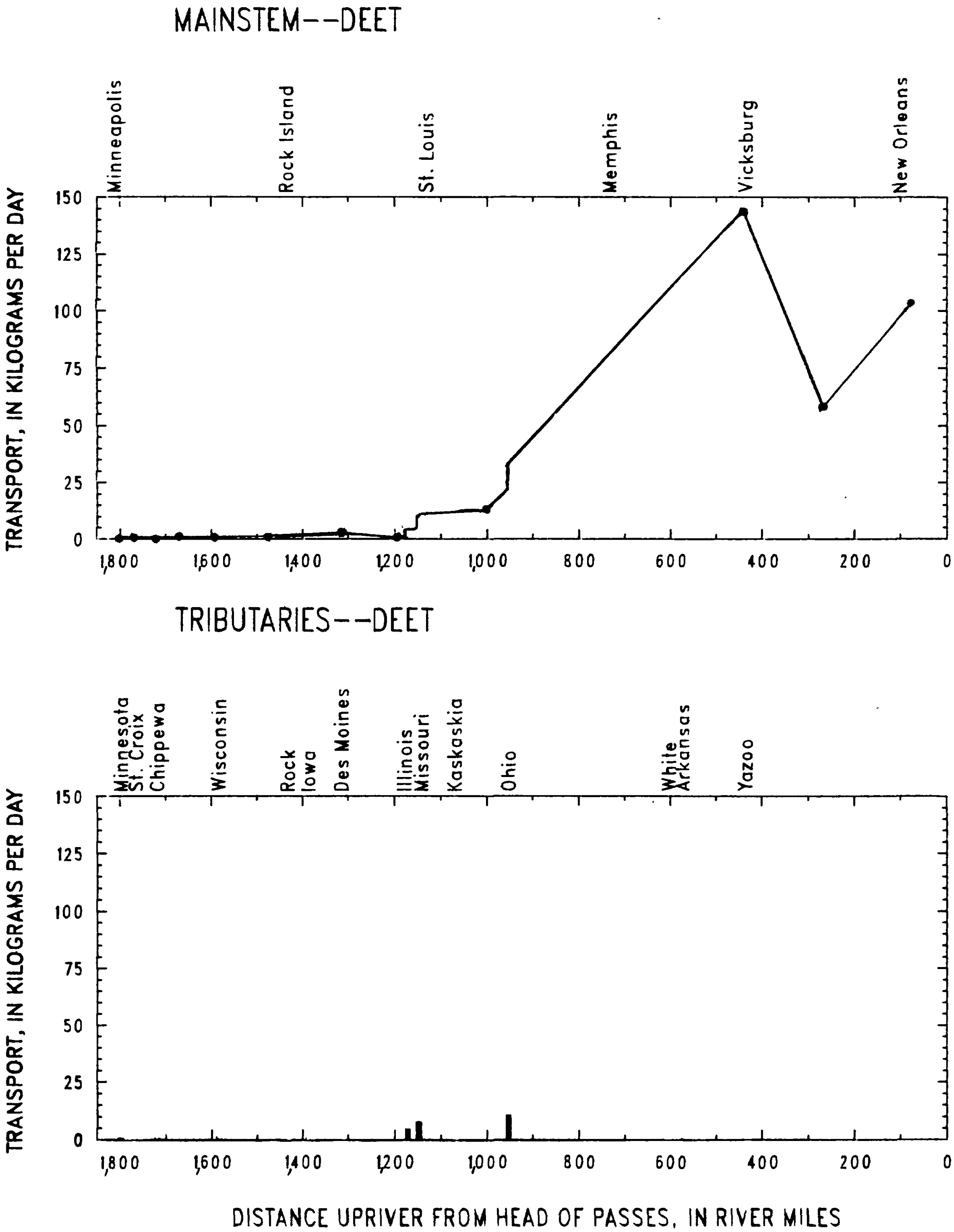


Figure 123.–Transport of deet in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

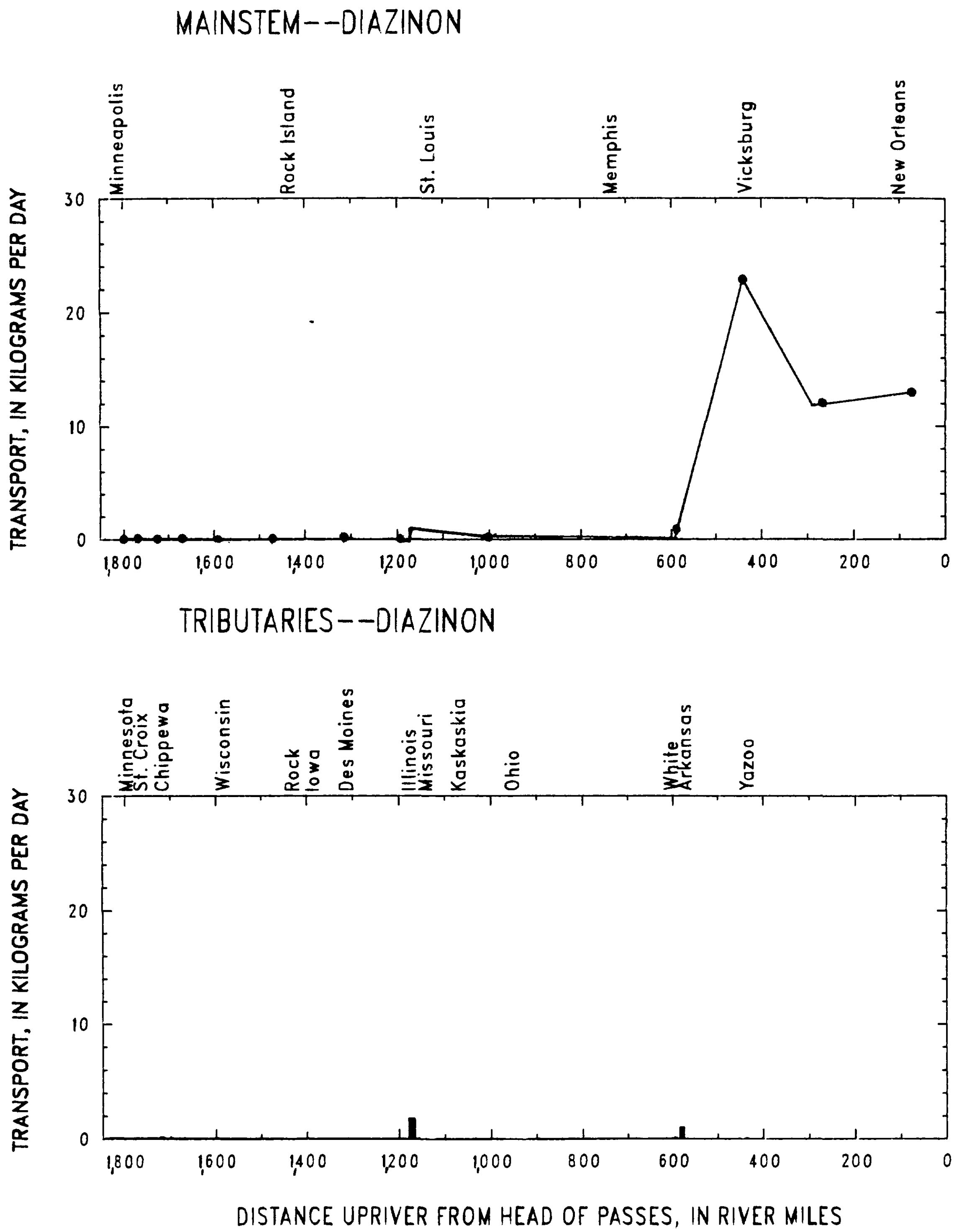


Figure 124.--Transport of diazinon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

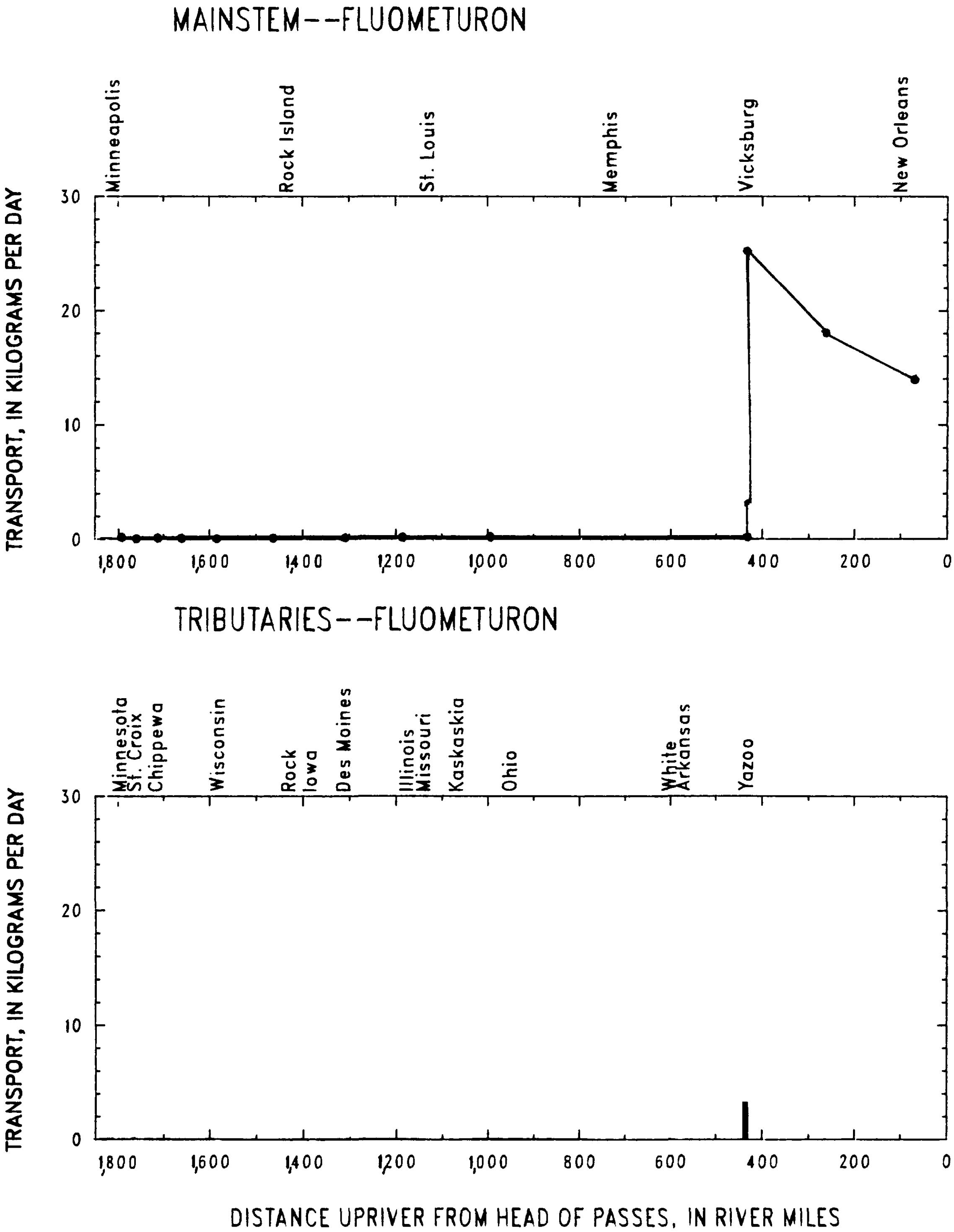


Figure 125.--Transport of fluometuron in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

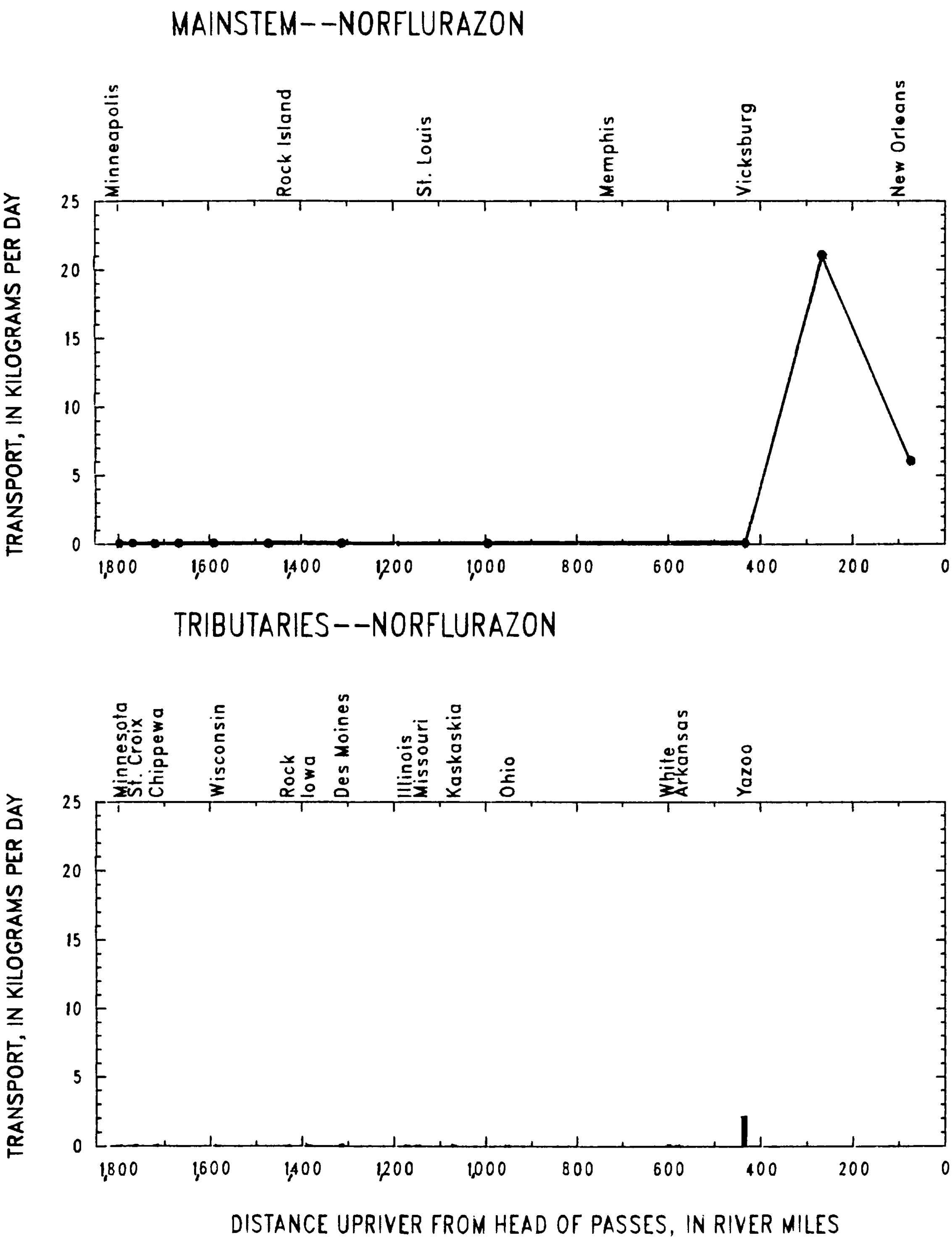


Figure 126.--Transport of norflurazon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

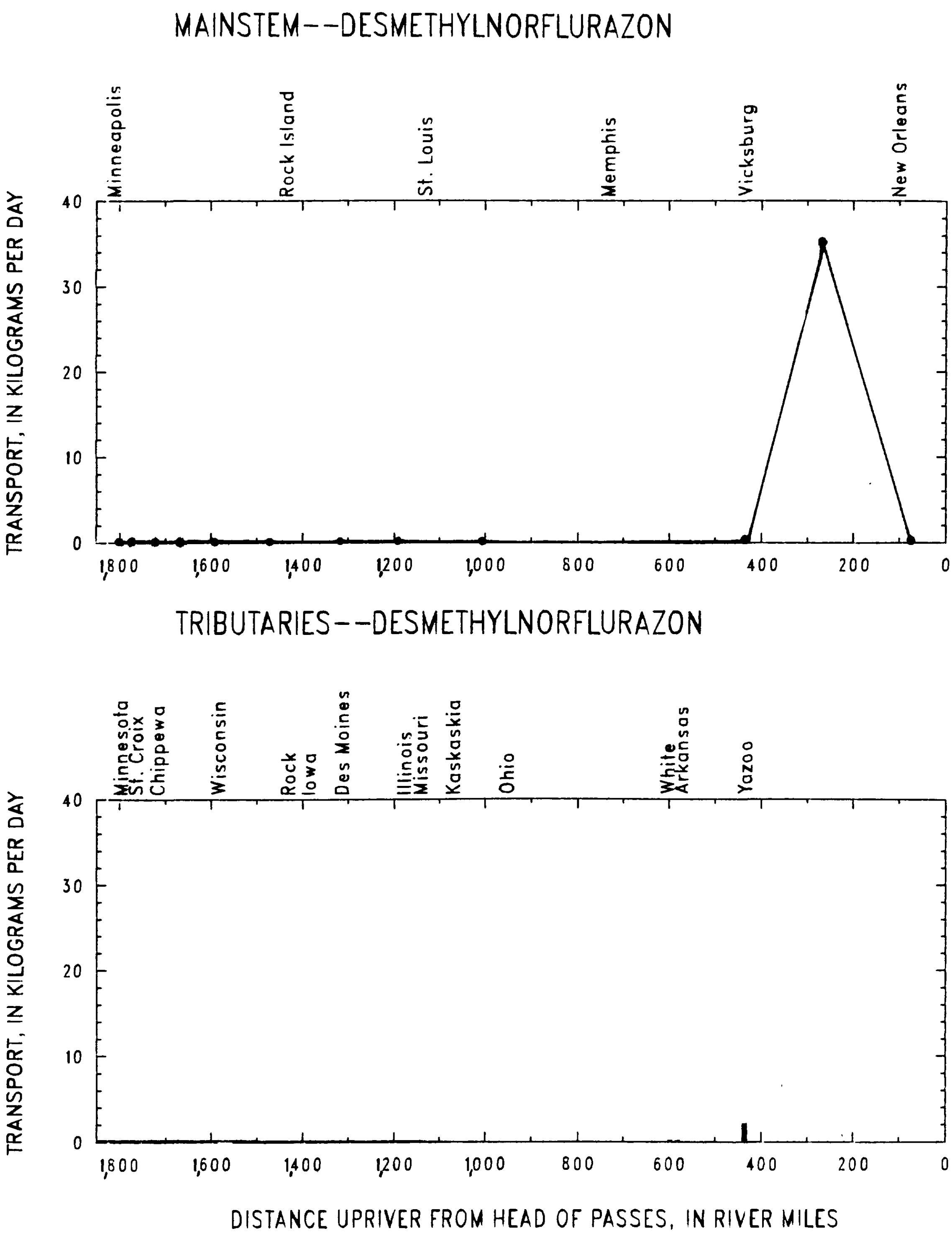


Figure 127.--Transport of desmethylnorflurazon in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

Table 27.--Concentrations of miscellaneous organic contaminants in the Mississippi R'ver and some of its tributaries for April–May 1992 cruise

[m³/s, cubic meter per second; ng/L, nanogram per liter; ND, not detected]

Date 1992	Site name	Water discharge[1] (m³/s)	Concentration of organic contaminants, in ng/L					
			2,6-diethyl-aniline	Caffeine	1,3,5-trimethyl-2,4,6-triazine-trione	Tris-2-chloro-ethyl-phosphate	Tris-2-chloro-propyl-phosphate isomer A	Tris-2-chloro-propyl-phosphate isomer B
4–06	Mississippi R. above St. Anthony Falls, Minn.	310	ND	68	ND	ND	7	ND
4–08	Minnesota R. at Mile 3.5, Minn.	260	ND	38	ND	9	8	ND
4–10	Mississippi R.at Hastings, Minn.[2]	570	ND	61	ND	13	12	ND
			ND	53	ND	13	11	ND
4–11	St. Croix R. at Mile 0.5, Wis.	320	ND	15	ND	ND	ND	ND
4–12	Mississippi R. near Pepin, Wis.	950	ND	46	ND	10	10	ND
4–12	Chippewa R. at Mile 1.7, Wis.	300	ND	29	ND	ND	ND	ND
4–14	Mississippi R. at Trempealeau, Wis.	1,330	ND	34	ND	6	11	ND
4–17	Mississippi R. below Lock and Dam 9, Wis.	1,590	ND	33	ND	5	6	ND
4–17	Wisconsin R. at Mile ~1.0, Wis.	368	ND	18	ND	ND	ND	ND
4–18	Mississippi R. at Clinton, Iowa	2,320	ND	29	ND	ND	9	ND
4–20	Rock R. at Mile ~1.0, Ill.	337	ND	39	ND	13	30	14
4–22	Iowa R. at Mile ~1.0, Iowa	685	ND	42	ND	8	24	13
4–23	Mississippi R. at Keokuk, Iowa	4,220	ND	25	ND	7	11	ND
4–24	Des Moines R. at Mile ~1.0, Iowa	719	ND	17	ND	ND	6	ND
4–26	Mississippi R. near Winfield, Mo.	5,070	ND	28	ND	ND	19	7
4–27	Illinois R. at Hardin, Ill.	860	ND	120	ND	75	430	220
4–29	Missouri R. at St. Charles, Mo.	3,560	ND	38	ND	ND	12	7
4–30	Kaskaskia R. at Mile 1.5, Ill.	31	ND	21	ND	ND	9	ND
5–01	Mississippi R. at Thebes, Ill.[2]	10,500	ND	32	ND	10	24	41
			ND	41	ND	9	55	36
5–03	Ohio R. at Olmsted, Ill.[2]	6,150	ND	54	560	10	14	12
			ND	42	530	5	11	9
5–05	White R. at Mile 1.2, Ark.	920	ND	ND	ND	ND	ND	ND
5–05	Arkansas R. at Mile 0.0, Ark.	710	ND	36	ND	ND	18	ND
5–07	Yazoo R. at Mile ~3.0, Miss.	70	ND	32	ND	ND	ND	ND
5–06	Mississippi R. below Vicksburg, Miss.[2]	21,800	ND	24	190	8	37	43
			ND	26	200	8	41	46
5–08	Mississippi R. near St. Francisville, La.	15,100	ND	22	160	13	42	36
5–10	Mississippi R. below Belle Chasse, La.	14,500	ND	19	110	6	40	30

[1]Discharges are listed by Moody and Meade (1995) with a discussion of errors.
[2]Duplicate samples collected.

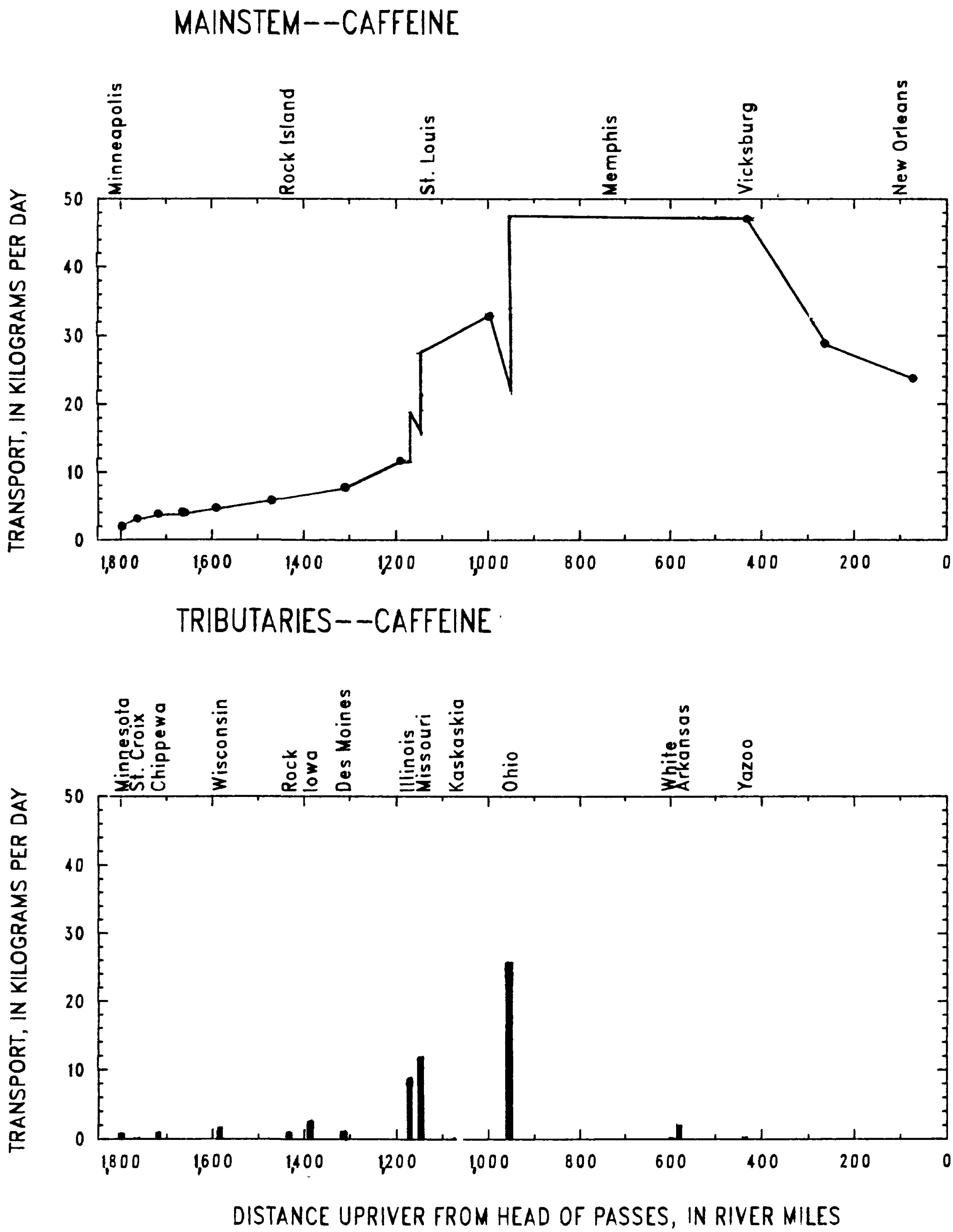


Figure 128.--Transport of caffeine in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

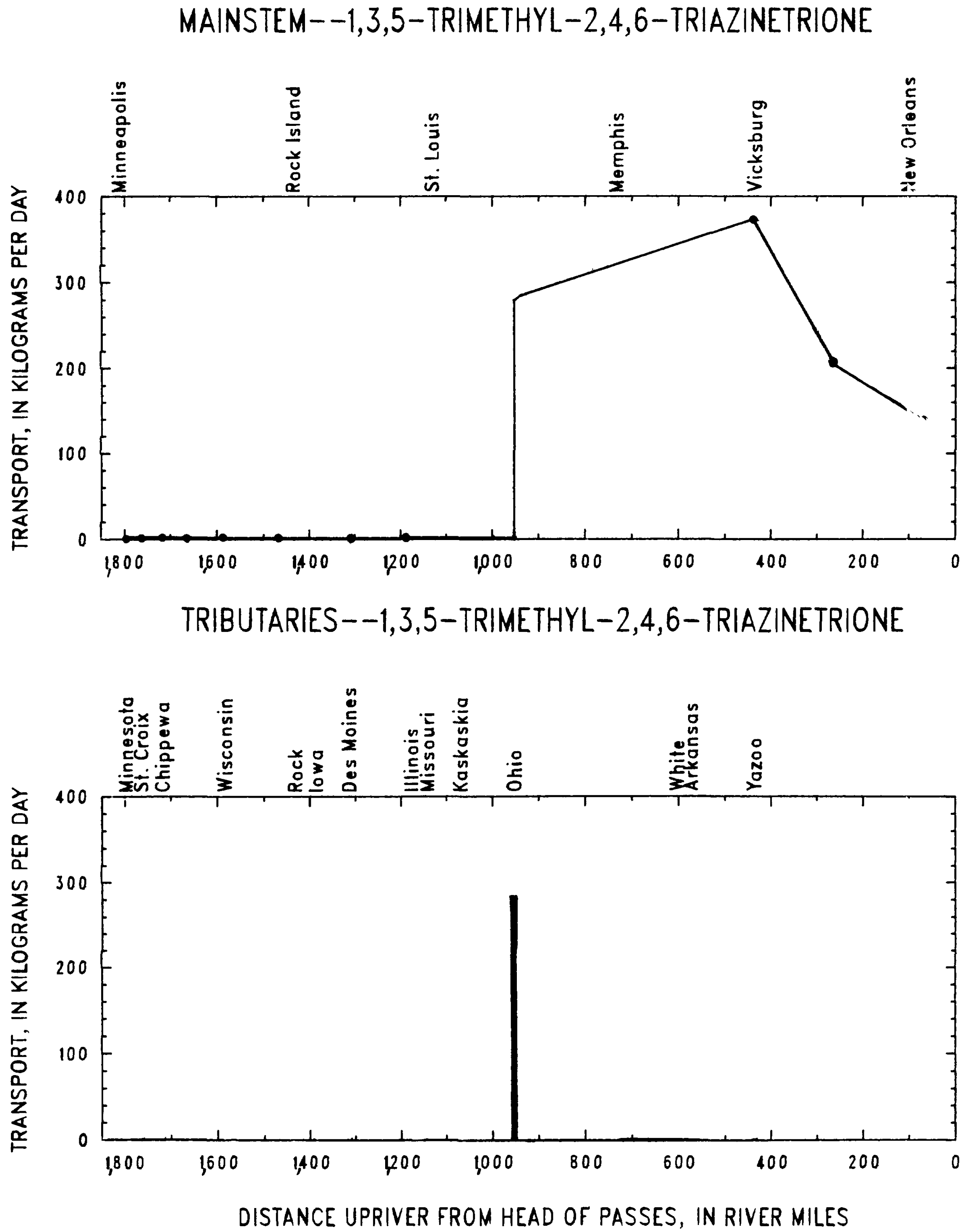


Figure 129.--Transport of 1,3,5-trimethyl-2,4,6-triazinetrione in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

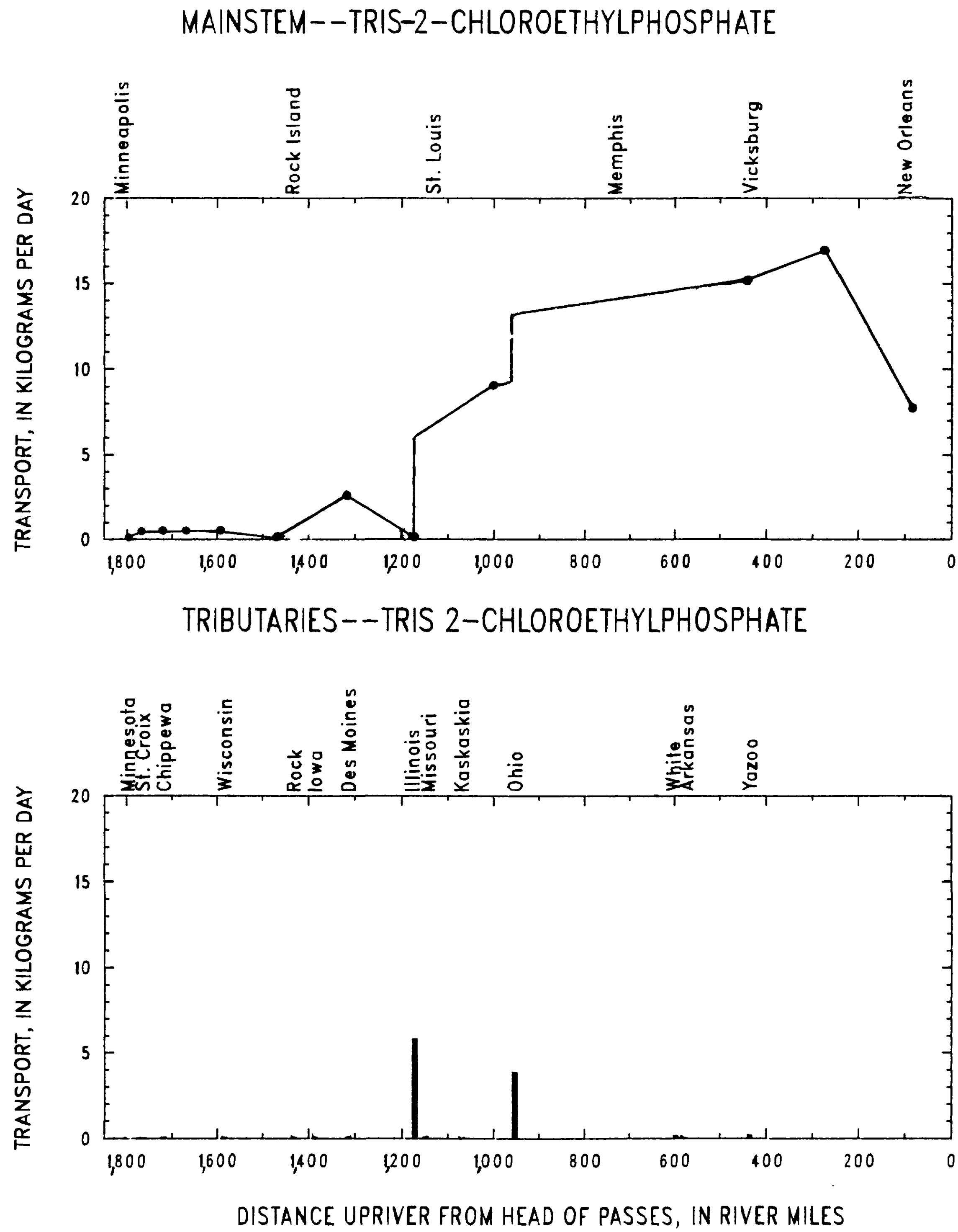


Figure 130.--Transport of tris-2-chloroethylphosphate in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

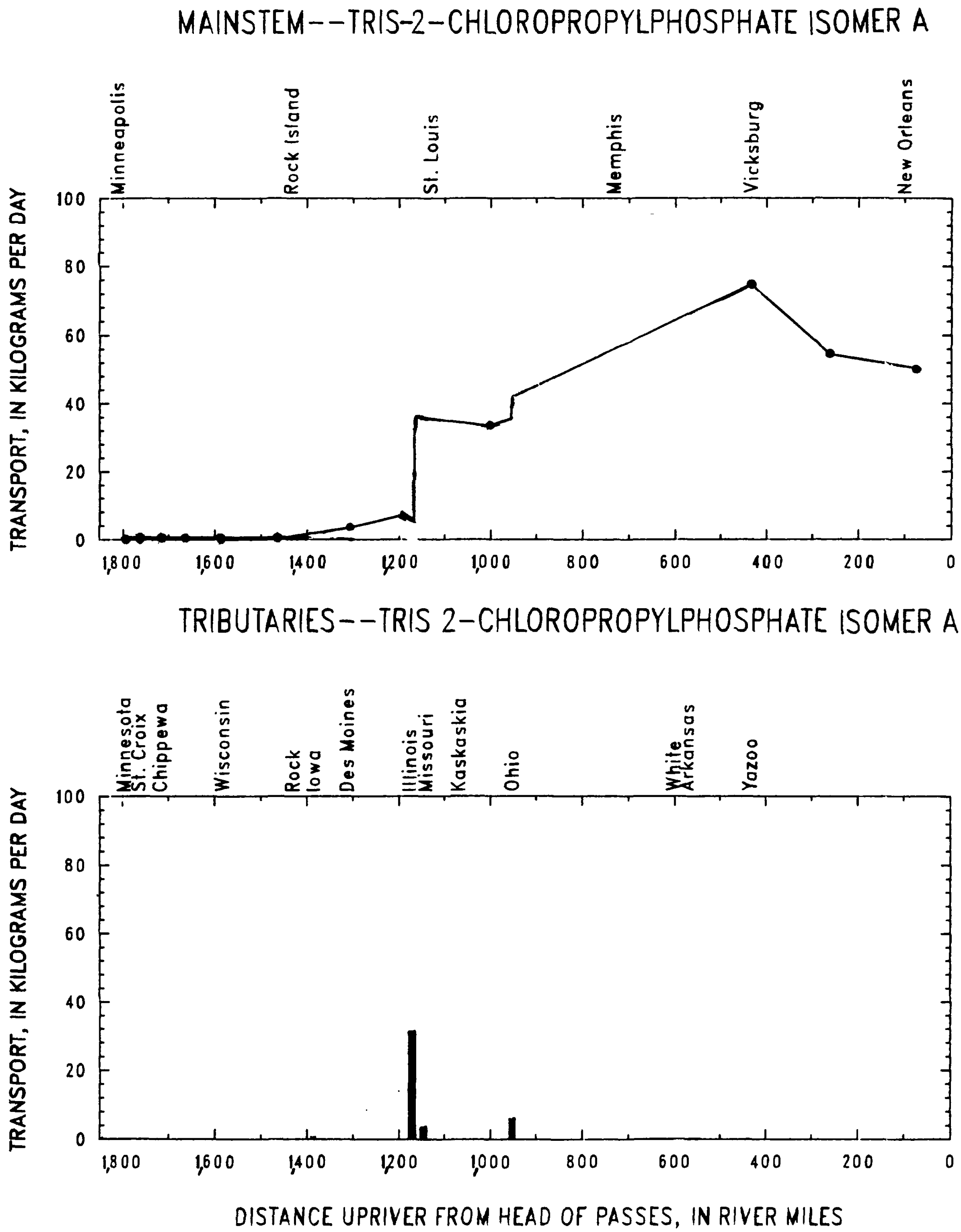


Figure 131.--Transport of tris-2-chloropropylphosphate isomer A in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

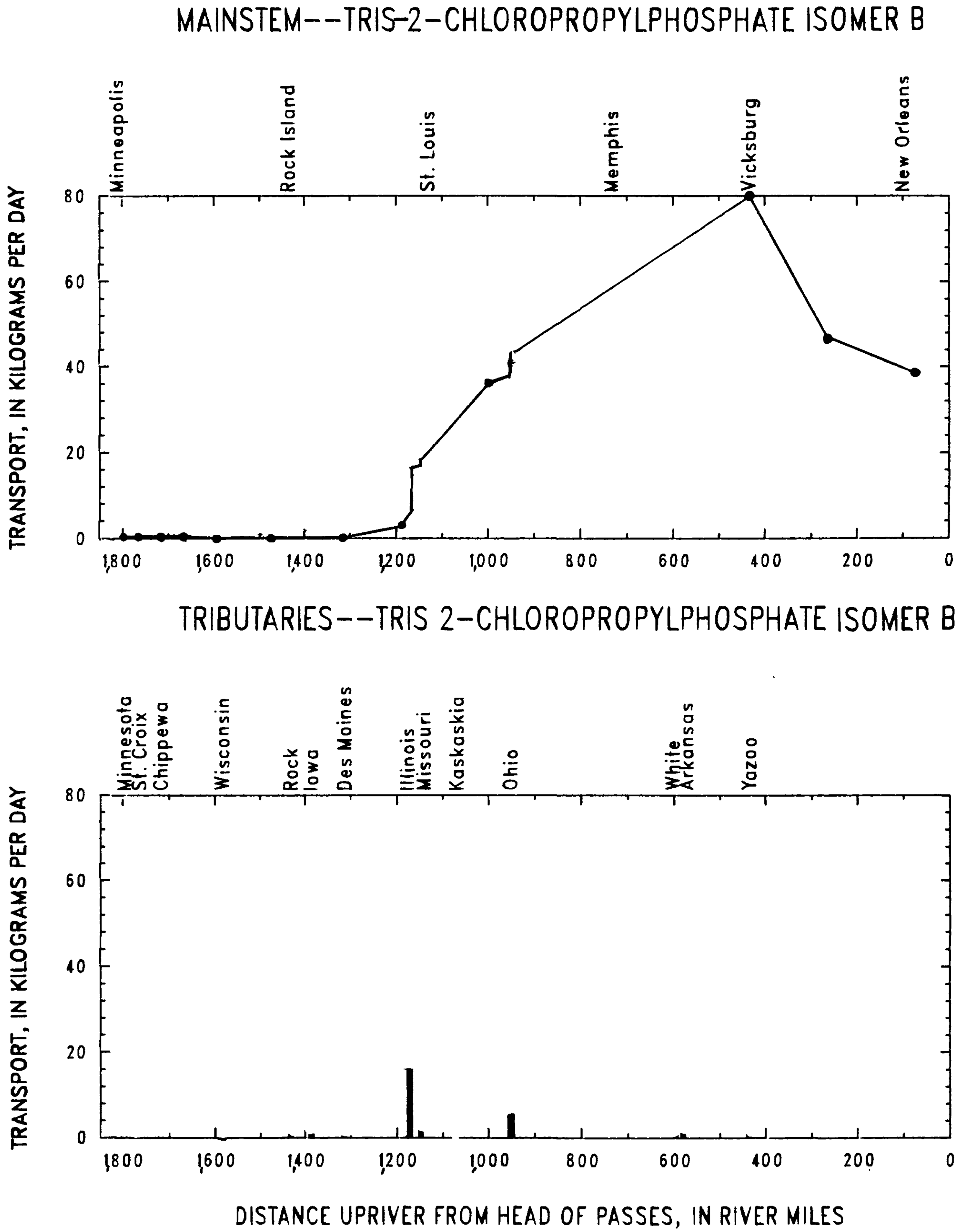


Figure 132.--Transport of tris-2-chloropropylphosphate isomer B in the Mississippi River, measured in downstream order and in an approximately Lagrangian time sequence between April 6 and May 10, 1992.

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