MRID

DATA EVALUATION RECORD

1. Chemical: Fenthion

2. Test Material: unspecified % ai ?

3. Study Type: Estuarine Invertebrate life-cycle
   Species: *Mysidopsis bahia*

4. Study ID: Influence of the organophosphate insecticide fenthion on *Mysidopsis bahia* exposed during a complete life cycle. Survival, reproduction, and age-specific growth. Charles L. McKenney, Jr. U.S. Environmental Protection Agency, ERL, Gulf Breeze, Florida, August 16, 1985.

5. Reviewed by: Richard Stevens, Biologist, EEB/HED — Signature: [signature] — Date: 7/21/87

6. Approved by: Ray Matheny, Head, Section 1, EEB/HED — Signature: Ray W. Matheny — Date: 7/22/87

7. Conclusions: This study is scientifically sound and satisfies guideline requirements for such a study.

   Survival, growth, and various measures of reproductive performance were examined for an estuarine mysid, *Mysidopsis bahia*, throughout its life cycle during exposure to fenthion. Concentrations of fenthion responsible for lethality (300 ng/l) did not vary significantly from that observed after 4 days exposure of newly released juvenile mysids and that produced with continuous exposure through maturation and production of young. Exposure of maturing juveniles to 166 ng fenthion/l postponed the onset of reproduction by 4 days. Both individual fecundity of females and total population production of young were reduced by fenthion concentrations of 79 ng/l and higher. Suppression of mysid growth rates was evident after only 4 days exposure of juvenile mysids

Reproductive Effect-MATC ≤ 79 PPT (ng/L), but no percent ai mentioned in this review

B. Montague

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to sublethal fenthion concentrations; lower concentrations (79 ng/l) retarded growth rates of the more rapidly growing advanced juveniles after approximately 2 weeks exposure. Reduced survival capacity, retarded growth rates, and dimished reproductive success of mysid populations with chronic, low-level exposure to fenthion would result in lowered production rates of an improtant prey population for commercially important fish that utilize the estuary as a nursery.

11. Materials and Methods: (excerpted from study)

"Replicate groups of *Mysidopsis bahia* were exposed to fenthion through an entire life cycle, using a proportional diluter as described by Schoor and McKenney (1983). Every three minutes, the diluter produced one liter of filtered (20 um) seawater for each of five fenthion exposure concentrations and a carrier control. All exposure conditions contained 5 ul of the carrier (triethylene glyco)/l. Each liter was delivered to a glass aquarim divided into three replicate chambers (58 cm x 16 x 27 cm). As each chamber achieved its maximum volume of 12 liters, a self-starting siphon drained the water to a volume of 2 liters. Seawater in the exposure system was maintained at 20 ± 1°C.

"Throughout the course of the study, fenthion concentrations for each exposure condition were determined weekly by gas chromatography using a procedure described by Lores *et al*. (1985). Measured fenthion concentrations (mean ± standard error) were 0 (carrier control; below the limit of detection, 10 ng/l), 16 ± 4, 37 ± 10, 79 ± 18, 166 ± 23, 300 ± 45 ng fenthion/l.

"Newly released juvenile *Mysidopsis bahia* (<24-n old) were obtained from ovigerous females maintained in static, recirculating culture with the same salinity-temperature conditions described above. Fifteen of these juveniles were pipetted into Nites® baskets constructed of 15-cm glass Petri dishes. Each basket was placed in one of three replicate chambers for each exposure concentration. Similar groups of mysids were placed in separate baskets at each exposure concentration for subsequent subsampling for growth measurements. Throughout the study, all groups of mysids were fed an abundance of freshly hatched *Artemia nauplii* daily.

"Exposed mysids were observed daily for survival at each exposure concentration. As juveniles matured, ovigerous females were isolated. Daily records were maintained for the day of release of the first brood and number of young released in the first brood by isolated females. The study was terminated 1 wk after the mean day of release of the first brood by control mysids, since past experience has shown that any toxicant-induced delay in release of young occurs within 1 wk.

"On days representative of various mysid life stages (Day 0- newly released juvenile, Day 4- early juvenile, Day 9- juvenile, Day 16- advanced juvenile/young adult), 8 mysids were subsampled from each fenthion concentration. Each individual was briefly rinsed in distilled water and placed in an oven at 60° to dry for 48 h. Dry weights of individual mysids were subsequently measured to the nearest 0.1 ng on a Cahn 21 Automatic Electrobalance."

Statistical Analysis

Differences in biological responses for the various fenthion concentrations were analyzed by analysis of variance, using Dunnett's procedure for multiple means comparisions (Zar, 1974). Relationships between biological responses and fenthion exposure concentrations were examined by regression analysis, using both a linear and quadratic model, and multiple regression analysis.

12. Reported Results (exerpted from study) Survival:

SURVIVAL:

"Continuous exposure to measured fenthion concentrations ranging from 16 to 300 ng/l produced differential survival patterns in populations of *Mysidopsis bahia* during entire life cycle (Table 1). Four days of exposure to a concentration of 300 ng fenthion/l resulted in significant mortality (92%, $p<0.05$) in juvenile mysids. Although exposure to 166 ng fenthion/l reduced juvenile survival rates to less than 80% following 16 days of exposure, analysis of variance demonstrated that fenthion concentrations $\leq$ 166 ng/l produced no significant reductions in mysid survival through the juvenile of the life cycle. An analysis of variance demonstrated no further reductions in mysid survival rates through release of their first brood at fenthion concentrations up to 166 ng/l.

REPRODUCTION:

"Initiation of reproduction by *Mysidopsis bahia* was influenced by sublethal exposure to fenthion (Table 2). Exposure to 166 ng fenthion/l significantly delayed release of the first brood of *M. bahia* by 4 days. Fenthion concentrations of 79 ng/l or less had no significant effects on initiation of production of young by mysids exposed throughout their life cycle.

"Production of young individual female mysids was modified by sublethal fenthion exposure throughout their life cycle (Table 2).

"Fenthion significantly reduced production of young from 9.0 per female in the first brood to 4.4 and 3.4 young in exposures of 79 and 166 ng/l, respectively.

"As with individual female fecundity, total production of young by isolated mysid populations was significantly influenced by sublethal fenthion exposure through the life cycle of the individuals (Table 2). Continual life-cycle exposure to fenthion significantly reduced population production of young from 49.0 young in the first brood to 16.7 and 9.7 young in concentrations of 79 and 166 ng/l, respectively.

GROWTH:

"Differential weights were attained by various life stages of *Mysidopsis bahia* exposed to a range of fenthion concentration from release as juveniles until maturation (Table 3). An analysis of variance of age-specific growth rates (ug day^{-1}) calculated from these dry weights demonstrated that mysid growth rates were significantly ($p<0.0001$) influenced by the age of the mysid, fenthion exposure concentration, and an interaction between age and fenthion exposure.

"Since the two-way analysis of variance demonstrated that mysid growth was significantly influenced by an interaction between age of mysid and fenthion exposure concentration, growth rates of individual life stages were regressed on fenthion concentration (Fig.5). Growth rates of early juvenile mysids were significantly ($p<0.05$) retarded by four days of exposure to 166 ng fenthion/l, while exposure to concentration $\leq$ 76 ng/l did not. During this period in the life cycle of *Mysidopsis bahia*, growth rates were significantly retarded by 166 ng fenthion/l, but not influenced by an lower concentrations. Growth rates of older juveniles (late juveniles and early adults) were higher than for younger juveniles and their growth responses to fenthion exposure was more curvilinear than that of the intermediate-aged juveniles with significant reductions in growth accompanying exposure to 76 ng fenthion/l.

"To explore further the relationships between mysid age and fenthion exposure on growth rates of *Mysidopsis bahia*, linear regression analysis was performed on the entire growth data set (Table 4). This analysis suggested that mysid growth rates were most strongly influenced by an interaction between age of the mysid and fenthion exposure concentration.

This relationship is best depicted by the second-order polynomial function

$$WG = 46.2224 + 0.3474CONC - 0.0012CONC^2 - 2.0709AGE + 0.3139AGE^2 - 0.0471(CONC \times AGE)$$

where WG = daily weight gain (ug day^{-1}) and other terms are those described in Equation 3. Response surface curves were developed from these coefficients to illustrate the relationship of continuous fenthion exposure on mysid growth rates through one complete life cycle (Fig. 6). As shown by the intensity shading of the isopleths, mysid growth rates progressively increased through the juvenile period without fenthion exposure from less than 50 ng per day to more than 100 ng per day as young adults. Fenthion exposure has a minimal influence on early juvenile growth rates, as a juveniles developed and approached maturity, fenthion exposure retarded growth in a more linear fashion.

13. Reviewers Evaluation

Mortality patterns of *Mysidopsis bahia* exposed to fenthion during its entire life cycle suggest that early juvenile stages were the most sensitive to fenthion. Concentrations of fenthion responsible for direct lethality of M. bahia after 4 days exposure of newly released juvenile mysids did not vary significantly from those producing significant mortality with continuous exposure of juveniles for approximately 3 weeks through maturation and production of their first brood of young (Table 1 and Fig. 1). Sublethal exposure of maturing *Mysidopsis bahia* juveniles to fenthion postponed the onset of reproduction. Time of release of the first brood was delayed by 4 days with exposure to 166 ng fenthion/l. In addition to maturation delays, exposure to sublethal concentrations of fenthion reduced the individual fecundity of *Mysidopsis bahia* females. Exposure of maturing juveniles mysids to fenthion concentrations of 79 and 166 ng/l reduced young production in the first brood from 9 younger per female to 4 and 3 young, respectively. Chronic exposure of discrete populations of juveniles through maturation and egg production to sublethal fenthion concentrations of 79 and 166 ng/l resulted in 66% and 80% fewer young beng produced, respectively, in the first brood of each population. Were this inhibition in young production to continue with subsequent broods, modifications in the age structure of the population would follow.

Table 1. <u>Mysidopsis bahia</u>. Survival ... ntage (mean ± SE) with continuous exposure to fenthion from release as juveniles until maturation.

Fenthion (ng/ℓ)	Day 4	Day 9	Day 16
0	95 ± 2	93 ± 4	93 ± 4
16	97 ± 2	95 ± 5	95 ± 5
37	98 ± 2	98 ± 4	98 ± 2
79	98 ± 2	95 ± 2	92 ± 5
166	95 ± 5	83 ± 10	77 ± 5
300	8 ± 6[a]	0 ± 0[a]	0 ± 0[a]

[a] Significantly different from the control (0)($p<0.05$)

Table 2. *Mysidopsis bahia*. Influence of continuous fenthion exposure through the complete life cycle on several reproductive responses. Each value represents mean ± SE.

Reproductive Response	Fenthion (ng/ℓ)				
	0	16	37	79	166
Mean day of 1st brood release	19.4 ± 0.7	19.7 ± 0.7	19.3 ± 0.5	20.2 ± 0.9	23.4 ± 0.6[a]
Number of young per female in 1st brood	9.0 ± 0.6	8.4 ± 0.6	7.8 ± 1.3 NOEL ?	4.4 ± 0.6[a]	3.4 ± 1.8[a]
Total number of young in 1st brood	49.0 ± 14.6	41.7 ± 5.4	49.7 ± 9.6	16.7 ± 6.7[a]	9.7 ± 7.8[a]

[a] Significantly different from the control (0)($p<0.05$)

Table 3. *Mysidopsis bahia*. Dry weights (mean ± SE) with continuous exposure to fenthion from release as juveniles until maturation.

Fenthion (ng/ℓ)	Day 4	Day 9	Day 16
0	91.2 ± 3.4	215.0 ± 16.1	575.4 ± 18.1
16	84.3 ± 7.3	232.0 ± 18.9	646.2 ± 42.9
37	83.4 ± 3.0	230.3 ± 23.0	612.0 ± 58.0
79	81.3 ± 6.4	215.8 ± 24.0	394.9 ± 19.5
166	74.5 ± 7.0	131.9 ± 60.8	-

Table 4. *Mysidopsis bahia*. Multiple linear regression analysis of daily growth rates (μg day^{-1}) as influenced by age and continuous fenthion exposure from 16 to 166 ng/ℓ. R = 0.810.

Source of variation	DF	SS	F-value	p-value
Total	89	43129.03		
Model	5	28290.25	32.03	<0.0001
CONC	1	1130.16	6.40	0.0133
$CONC^2$	1	235.43	1.33	0.2516
AGE	1	626.69	3.55	0.0631
AGE^2	1	2389.92	13.53	0.0004
CONC x AGE	1	4641.97	26.28	<0.0001
Error	84	14838.77		

Figure Legends

Figure 1. Mysidopsis bahia. Survival percentage of population as a function of fenthion exposure through the complete life cycle. Values represent mean ± SE. Darkened circles are significantly different from control ($p<0.05$).

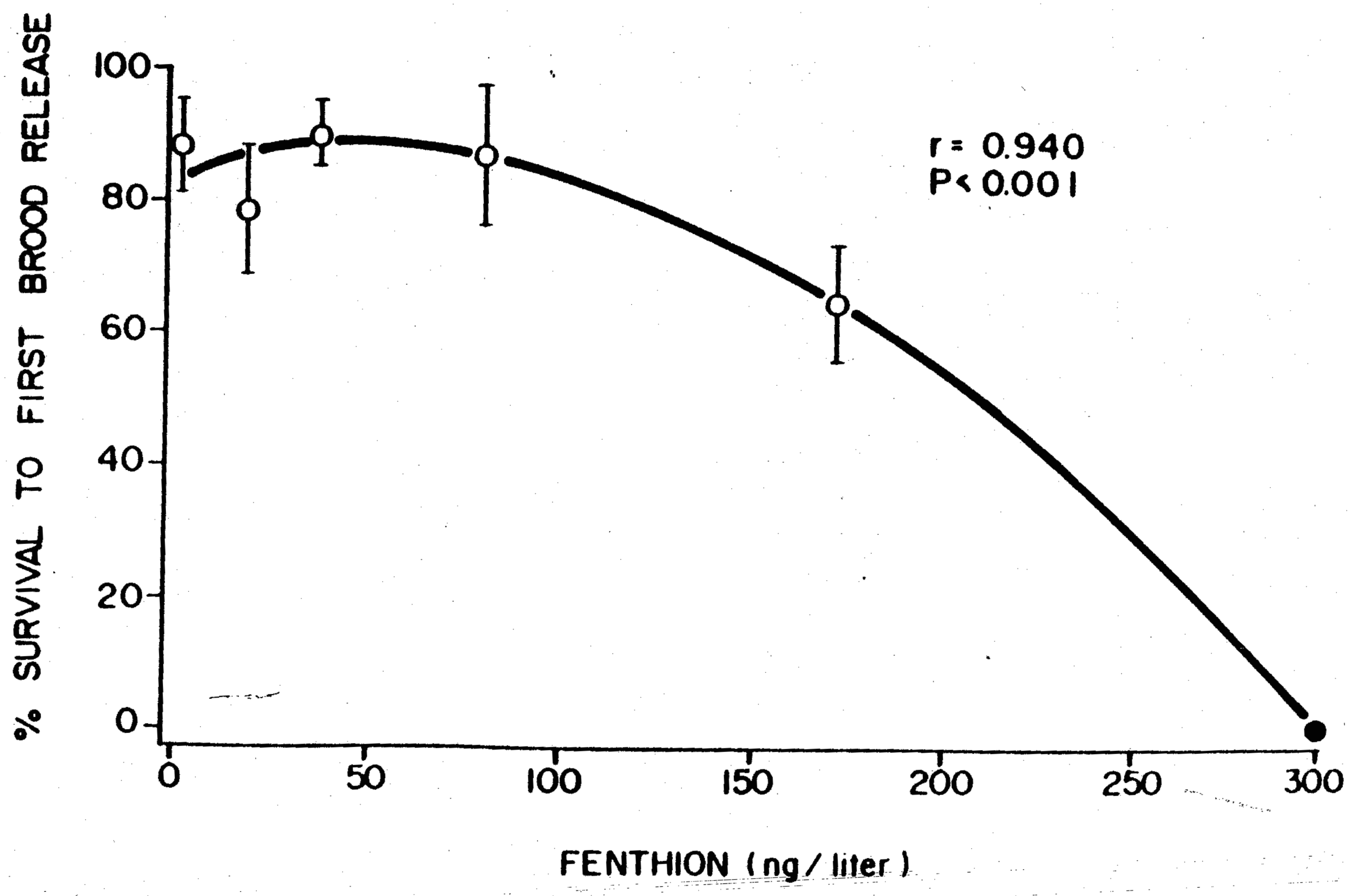
Figure 2. Mysidopsis bahia. Mean day of release of first brood in population as a function of fenthion exposure through the complete life cycle. Values represent mean ± SE. Darkened circles are significantly different from control ($p<0.05$).

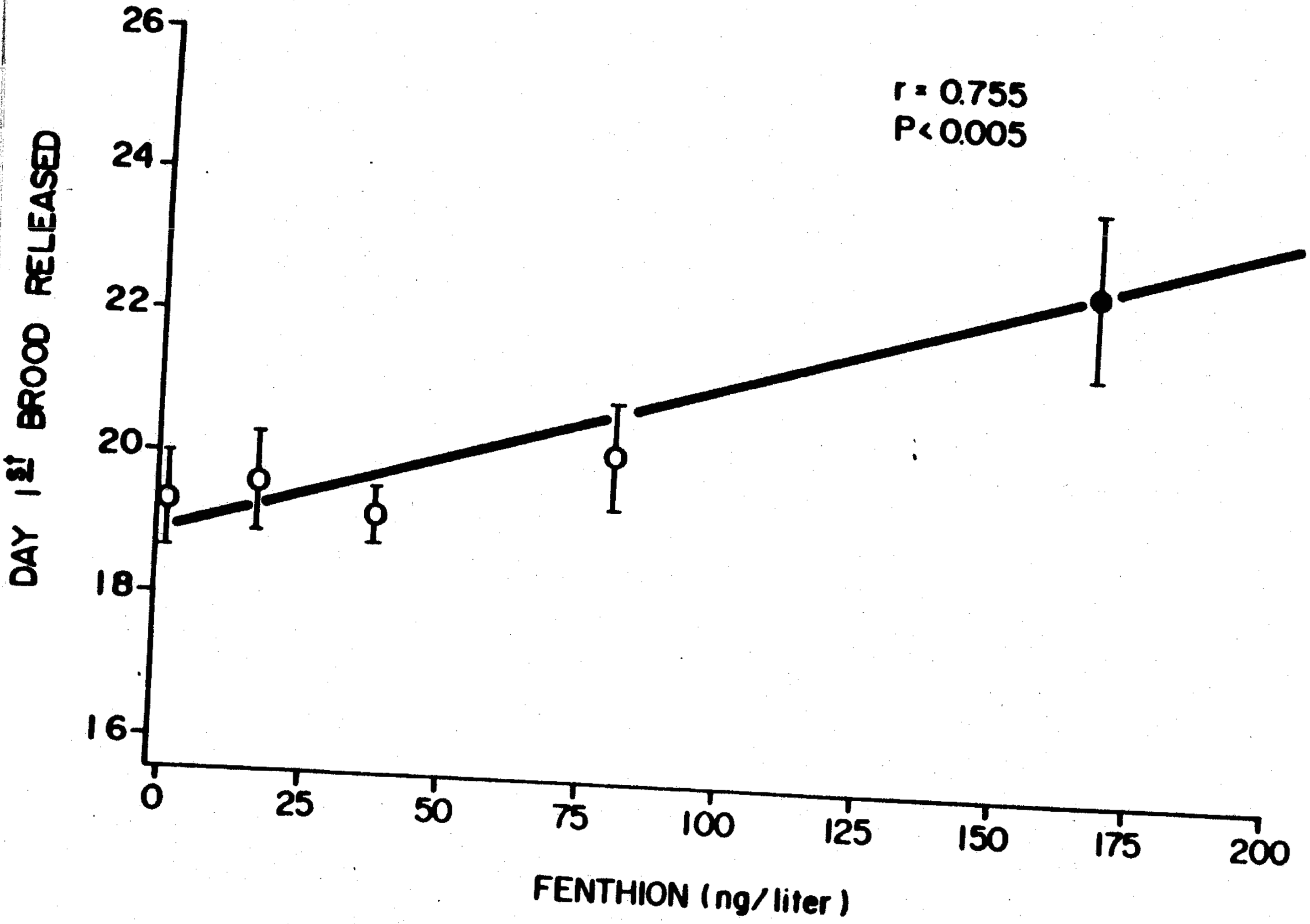
Figure 3. Mysidopsis bahia. Young production per female in population as a function of fenthion exposure through the complete life cycle. Values represent mean ± SE. Darkened circles are significantly different from control ($p<0.05$).

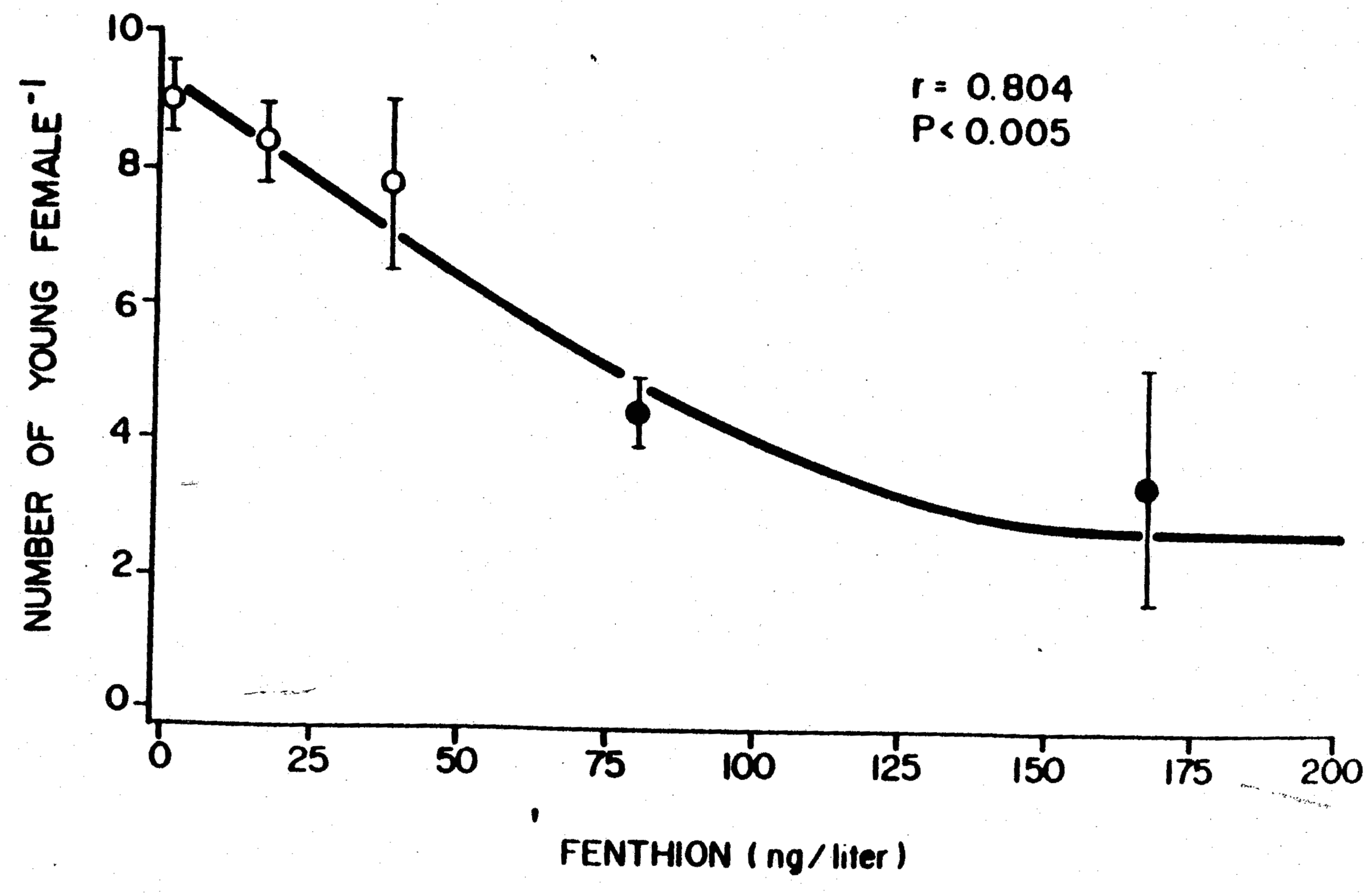
Figure 4. Mysidopsis bahia. Total production of young by population as a function of fenthion exposure through the complete life cycle. Values represent mean ± SE. Darkened circles are significantly different from control ($p<0.05$).

Figure 5. Mysidopsis bahia. Growth rates of various life stages as a function of continuous fenthion exposure through the complete life cycle. Values represent mean ± SE. Darkened circles are significantly different from control ($p<0.05$).

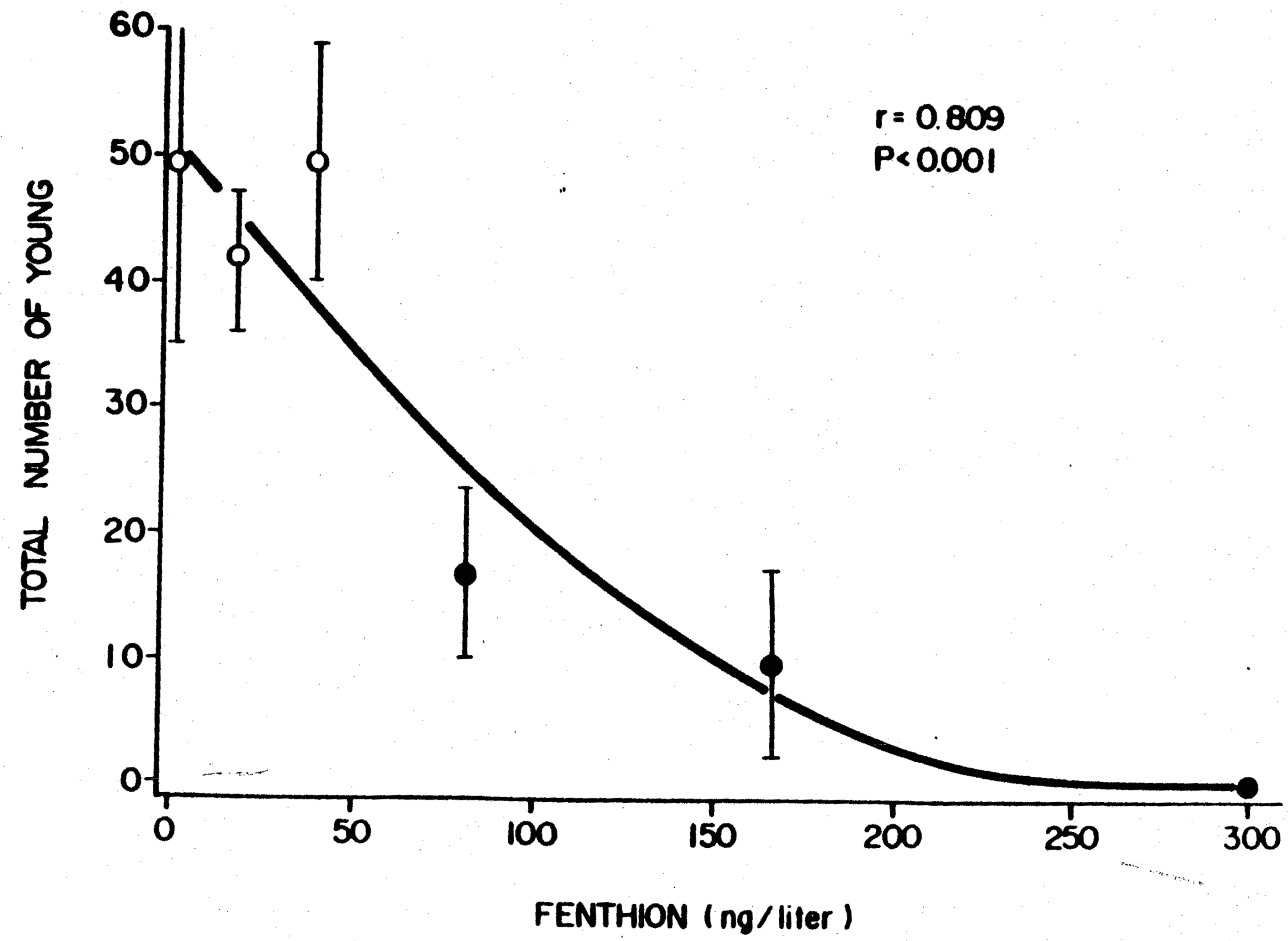
Figure 6. Mysidopsis bahia. Response surface of growth rates as influenced by continuous fenthion exposure through the complete life cycle. The darker shading of the isopleths corresponds with the higher growth rates (numerically labeled μg day^{-1}).


% SURVIVAL TO FIRST BROOD RELEASE
100
80
60
40
20
0
0
50
100
150
200
250
300
r = 0.940
P < 0.001
FENTHION (ng/liter)

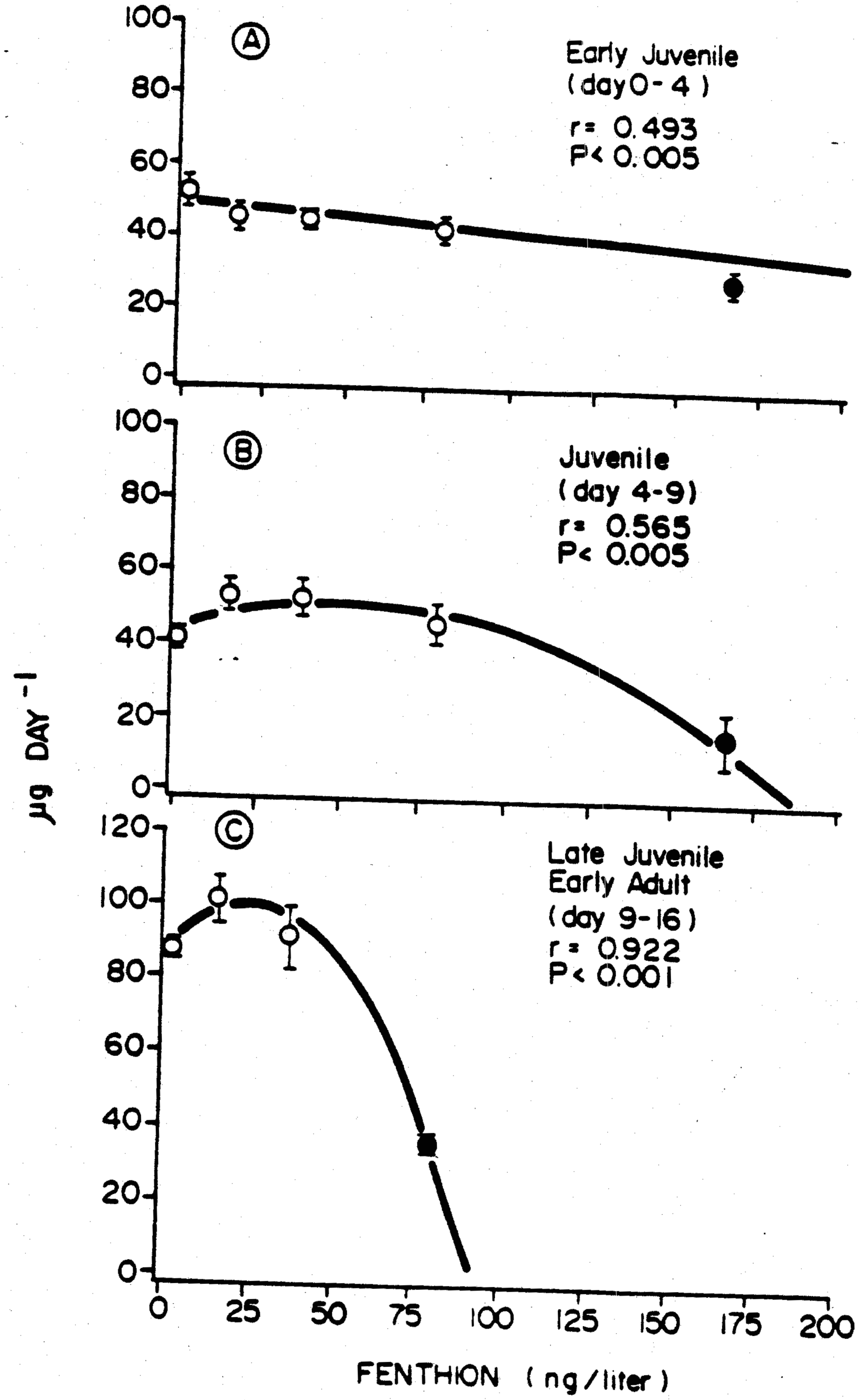

DAY 1st BROOD RELEASED
26
24
22
20
18
16
r = 0.755
P < 0.005
0
25
50
75
100
125
150
175
200
FENTHION (ng/liter)



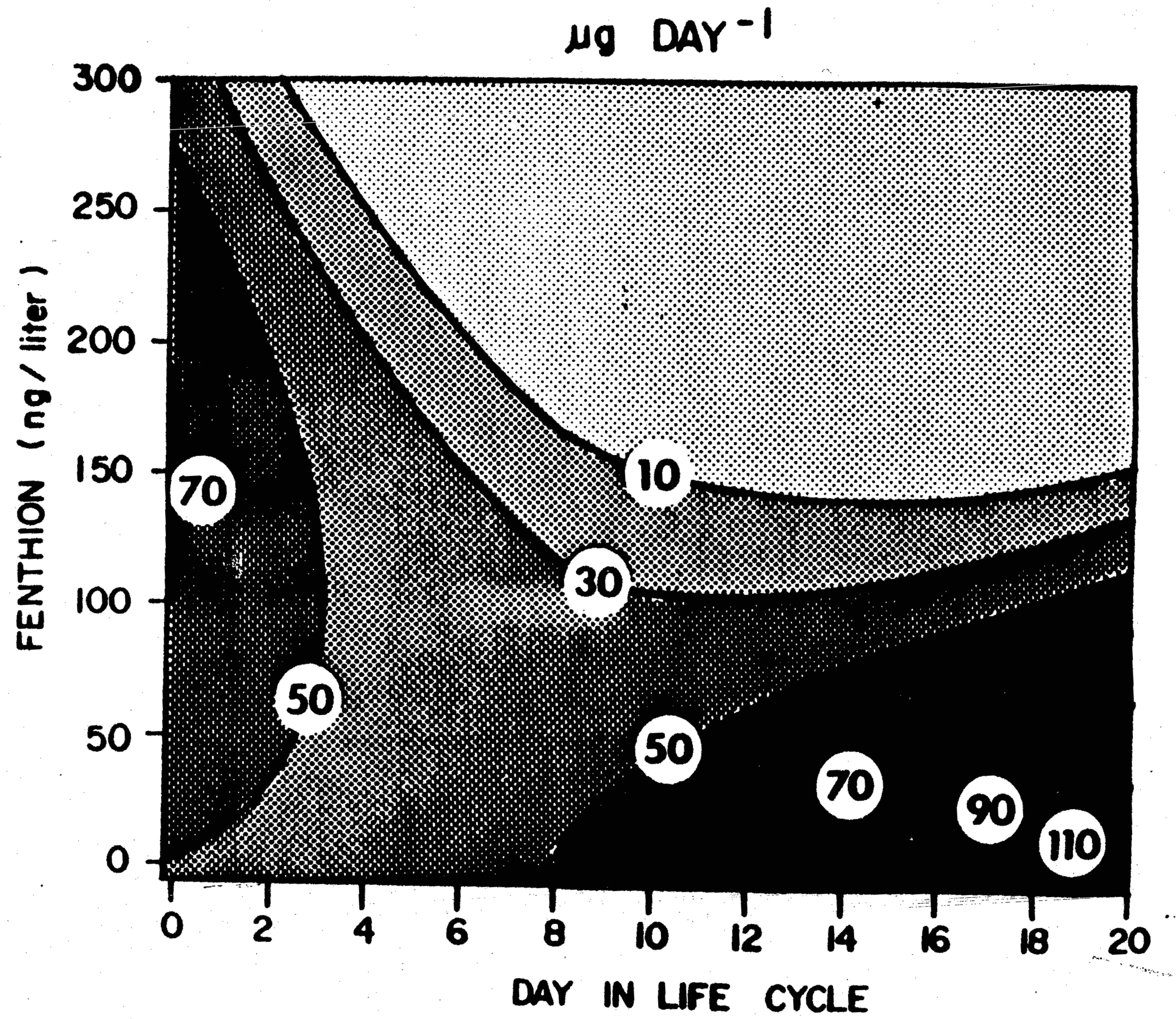
NUMBER OF YOUNG FEMALE^{-1}
10
8
6
4
2
0
r = 0.804
P< 0.005
0
25
50
75
100
125
150
175
200
FENTHION (ng/liter)



TOTAL NUMBER OF YOUNG
0
10
20
30
40
50
60
0
50
100
150
200
250
300
FENTHION (ng/liter)
r = 0.809
P< 0.001



A
Early Juvenile
(day 0-4)
r= 0.493
P< 0.005
B
Juvenile
(day 4-9)
r= 0.565
P< 0.005
C
Late Juvenile
Early Adult
(day 9-16)
r= 0.922
P< 0.001
µg DAY -1
0
20
40
60
80
100
120
0
25
50
75
100
125
150
175
200
FENTHION (ng/liter)


µg DAY -1
FENTHION (ng/liter)
300
250
200
150
100
50
0
70
50
10
30
50
70
90
110
0
2
4
6
8
10
12
14
16
18
20
DAY IN LIFE CYCLE

In addition to sublethal alterations in the reproductive capacity of Mysidopsis bahia with chronic, low-level exposure to fenthion, growth dynamic of mysids were modified to these retardations in growth rates varied with life stage. Suppression in growth rates was evident after only 4 days exposure of juveniles to fenthion. Lower concentrations (79 ng/l) retarded growth in the more rapidly growing advanced juveniles after approximately two weeks exposure. The stronger influence of fenthion on growth rates of older than on younger juveniles could indicate increased sensitivity of older juveniles, greater impact of the pesticide after a longer exposure time with the potential for more bioaccumulation, or growth suppression being more than during the most radiply growing period in the juvenile phase of the life cycle.

The concentrations of fenthion causing growth suppression in Mysidopsis bahia juveniles were ultimately the same as those associated with reproductive inhibition in adult mysids. Stress from chronic pesticide exposure that reduces the individual's survival, reproductive, and growth capacity can have profound ecologicial consequences for the population. Reduced rates of secondary production in such an important prey population (as exemplified in this study by reduced survival capacity, retarded growth rates, and diminisned reproductive success of mysid populations) would alter the energy-flow patterns between connected trophic levels in the ecosystem.

The study generally complies with the recommendations contained in standard evaluation procedures for the conduct of such studies. Statistical analysis of the data coincide with that of the author's.

Adequacy of Study:
Classification: ~~Core~~ No % ai noted — Supplemental
Rationale: N/A
Repairability: N/A

B. Montague