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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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SUBJECT Ecological Effects Branch Response to Chevron's 11/12/80 Response to September 19, 1980 Full Risk Assessment on Bolero Herbicides

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Attach to Branch File Review -

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I. Introduction

On September 19, 1980 the Ecological Effects Branch (EEB) completed a full risk assessment for the use of Bolero 8EC and Bolero 10G herbicides on rice fields. On October 23, 1980 representatives of EEB met with representatives of Chevron Chemical Company to discuss EEB's objections to the registrations of the two herbicides. On November 12, 1980 Chevron submitted a rebuttal of EEB's risk assessments to the Agency. This memo is EEB's response to that rebuttal.

II. Discussion of Chevron's Major Arguments

The major arguments presented in Chevron's rebuttals are presented here and are followed by EEB's responses.

A. Residues in Water

1. Location F_1 in Pleasant Bayou was 500 feet downstream of the confluence of the east and west forks and was 10 feet wide and 6 inches in depth at peak flow. "Flow in this section of Pleasant Bayou is recognized only during periods of rainfall or flushing activity. Otherwise the bayou is characterized by standing water. The upper 2.4 miles of Pleasant Bayou actually can be characterized in this same manner because of the limited volume of flow. A progressive increase in downstream discharge sources eventually contributes to a continuous and more permanent flow downstream from collection Location F_2... These higher levels of thiobencarb can be expected at F_1 relative to more distant and permanent downstream sampling locations (regardless of flush type) because of 1) the proximity of F_1 to the source (i.e. the treated fields were within 800 feet) and 2) the limited volume of water at F_1 available for dilution of corresponding residues."

EEB Response: Examination of the large aerial photo map verified that the area of Pleasant Bayou upstream from Location F_2 is not a characteristic bayou. Therefore, the high residues recovered at F_1 after an unscheduled flush (0.410 and 0.400 ppm one and two days post-application) are not characteristic of a true bayou situation. However, by refering to Location F_1 as a bayou and not enclosing a scaled map of the area EEB had no choice but to regard the location and its residues as a typical bayou situation. If the registrant maintains that this is not a true bayou, then it should not have been included in the Texas field study. In addition, the statement

that "the residues appeared to persist for up to 40 days after application because of the absence of additional samples after flush termination" needs to be clarified.

2. "Maximum thiobencarb residues observed in bayou water persisted for only 24 to 48 hours. The thiobencarb concentration was reduced to significantly lower levels after the drainage subsided and ceased to flow. In Area III of Halls Bayou, for example, the 0.164 ppm recovered from upstream bayou water had subsided to 0.007 ppm on the following day (Table 20). The 0.140 ppm recovered from downstream bayou water subsided to 0.004 ppm the following day. Similar reductions were observed in collections from Area II and Area I; however, in the latter areas the peak residue persisted for only 24 hours."

EEB'S Response: In each study area only a few ricefields were treated with Bolero. For example, in Halls Bayou, there were 3 fields totalling 231 acres in Area I, 4 fields totalling 311 acres in Area II, and 2 fields totalling 272 acres in Area III. In Area III the residue level of 0.164 ppm was measured upstream on April 6, 3 days after a scheduled flush overflow of one of the fields in Area III (12 days post-application of Bolero), and 0.140 ppm was measured the next day on April 7 when the other field was flushed (13 days post-application) (Table 10).

In Area II there were scheduled flush overflows of one field on April 4 (11 days post-application of Bolero), of 2 other fields on April 5, and of the fourth field on April 7 (14 days post-application). The thiobencarb residues measured upstream (E) and downstream (F) following these scheduled flushes were as follows (taken from Tables 9 and 20):

Date	E	F
4-5	0.041	0.033 ppm
4-6	0.048	0.040 ppm
4-7	0.083	0.064 ppm
4-8		0.033 ppm
4-9		0.010 ppm
4-10		0.011 ppm
4-11		0.014 ppm
4-12		0.021 ppm

The mean residue concentration at site F over an 8-day period was 0.028 ppm thiobencarb. The data indicate the possibility that the residues at site E during the same period would have been greater than or equal to the concentration at site F if the measurements had been conducted through April 12.

These data indicate that if several ricefields are flushed (either scheduled or unscheduled) on consecutive days into the same area that the thiobencarb residues can persist in the bayou water for a significant period of time (the significance is discussed in the section, RPAR Criteria).

This table also indicates that the residue levels downstream began to increase 3 days after the last field was flushed. Table 20 also shows a similar phenomenon in Area I. This indicates that the residues do not necessarily dissipate with time. If the residues are not coming from the fields then what is responsible for these increases--leaching from the soil? This also constitutes an increased hazard to aquatic organisms.

3. "Collections at Location D (the bayou discharge site) were samples of this residual water from within the drainage canal immediately adjacent to the bayou--not from within the bayou in the area of the discharge." Table 18 indicates the dilution that occurs from the discharge site to points upstream and downstream in the bayou.

   EEB's Response: EEB acknowledges that dilution of the residues occurs. However, it is reasonable to expect that the residues in the bayou adjacent to the discharge canal are greater than the residue levels measured at sites E and F.

B. Likelihood of Adverse Effects to Non-Target Organisms

1. "The survey by Moffett (Reference 30, acc #241484, 241495) does not accurately reflect the distribution of aquatic organisms in Halls Bayou, Pleasant Bayou and other bayous during the Texas study. Therefore, reliance on Moffett's description of species distribution in the Texas study is not appropriate."

   EEB's Response: If Chevron believes that the survey of Chocolate Bay estuary done by Moffett is not accurate, then it should not have been submitted to support the registration of Bolero 8EC.

   Chevron fails to recognize that EEB is concerned with all non-target aquatic organisms, including commercial and non-commercial freshwater and estuarine species, not only the species present in the Chocolate Bay watershed at the time of the study. Although the Chocolate Bay area was chosen to represent a "typical" bayou, the salinity and species composition patterns found there during the study in 1979 are not necessarily identical to those in other bayous in the rice regions of Texas and Louisiana or even to the patterns in Chocolate Bay in other years. In fact, Chevron concedes that when the salinity is sufficiently high, as during Moffett's study, that brown shrimp and other species as sheepshead minnow, sand seatrout, spot and silver perch are present in the Chocolate Bayou estuary. It is sufficient that these species can exist in the area when the environmental conditions are correct. Even if these species, per se, are not present, other species will be present that can be affected by the presence of thiobencarb residues.

2. The results of the field study indicate that the benthic population was not affected by Bolero residues. "There was no pattern suggesting that the populations at any station were depressed consistently following discharge; these data strongly suggest that the decrease in population density following

discharge from the fields was caused by a coincident salinity decrease; comparison of the numbers of species collected at each station in Area I through time reveals no pattern that can be interpreted as having been caused by any factor."

EEB's Response: Changes in relative abundance of the dominant species, the polychaetes Streblospio benedicti, Hypaniola floridus and the Tubificidae species, are a better indicator of stress than absolute numbers. The relative abundance of each species in relation to the total number of specimens at each sampling time was determined for the upstream, downstream and point of discharge collection sites for each sampling time.

Area I

Species	Upstream	Discharge	Downstream	Date**
Streblospio benedicti	55.0	65.6	31.4	3 Apr
	47.5	63.2	63.7	6 Apr
	51.3	61.3	47.2	7 Apr
	66.1	34.7	52.0	12 Apr
	22.1	55.2	44.8	25 Apr
Hypaniola floridus	34.7	20.7	54.1	3 Apr
	39.0	30.6	24.3	6 Apr
	44.0	25.5	40.2	7 Apr
	23.8	41.1	35.0	12 Apr
	40.7	29.3	33.6	25 Apr
Tubificidae A	6.5	9.5	1.3	3 Apr
	1.1	4.8	9.8	6 Apr
	2.6	10.2	8.9	7 Apr
	3.0	15.8	9.7	12 Apr
	4.4	9.9	13.8	25 Apr

Area II

Species	Upstream	Discharge	Downstream	Date
Streblospio benedicti	24.3	1.8	0	6 Apr
	17.3	1.1	5.5	7 Apr
	22.3	0.7	2.8	12 Apr
	6.0	0	0	25 Apr
Hypaniola floridus	33.0	15.7	50.0	6 Apr
	54.3	14.8	54.5	7 Apr
	39.8	34.7	38.2	12 Apr
	32.9	16.9	23.4	25 Apr
Tubificidae A	33.6*	63.3	26.7*	6 Apr
	21.8*	70.3	21.8	7 Apr
	25.9	58.5	43.8	12 Apr
	50.3	70.5	68.3	25 Apr

*A and B

** Date: 3 Apr-the day prior to flooding the fields
6 Apr. and 7 Apr-early and peak discharge flows, respectively
12 Apr-a week after discharge began
25 Apr-a week after a second discharge to drain excess rain water off the fields

It is noted that for Area I Streblospio is generally most abundant and the Tubificidae the least abundant at each site throughout the study. The report states that the polychaetes decreased in abundance after April 7. This may be true in terms of absolute numbers, but in terms of relative abundance, the populations of Streblospio at the discharge site and Hypaniola at the upstream site increased sharply after April 12. The relative abundances of the Tubificidae were generally stable at each site. For Area II, Hypaniola decreased in abundance and the Tubificidae increased at the 3 sites after April 12.

Although changes in salinity may be partially responsible for the changes in relative abundance of the 3 species through time, other factors, including tidal cycles and the presence of Bolero in the water, are responsible for either the unexpected differences in relative abundance of each species at each site on any given day or the response of the Tubificidae in Area II. Although the upstream sites were supposed to be control sites, on several occasions (April 12 and 25) species abundances were lower when compared to the other two sites. Additionally, responses at the sites of discharge were not always the lowest (April 7 - day of peak flow).

Although low salinity may be responsible for the low abundance of Streblospio in Area II, it cannot account for the responses of Hypaniola (which one would have expected to increase as in Area I) and the Tubificidae (indicator species for stressed environments). Something other than solely salinity is causing the decreases in relative abundance of the two latter species - possibly Bolero.

Therefore, the influence of Bolero cannot be discounted, particularly in Area II. However, since the study was conducted in an estuary, which is a dynamic ecosystem, many other factors are also operating. The data do not allow for any definitive conclusions.

3. "No adverse effects to aquatic inhabitants occurred in the Texas study. Harper and Landry demonstrated that representative benthos, nektos and planktos were not adversely affected during peak occurrence of thiobencarb in Halls Bayou... Any unusual depressions in population abundance... may reflect a response to a salinity depression, particularly for saline sensitive organisms."

EEB's Response: As indicated above, the data regarding the benthos are inconclusive, but the influence of Bolero on observed population changes cannot be discounted. There were many deficiencies in the nekton and plankton studies, not only with experimental design but also with data analyses.

Although the basic sampling techniques in the nekton study are valid, they are not sufficient to assess changes in species composition and population dynamics in Halls Bayou. The introduction to the nekton study states that preliminary sampling was conducted at least one month prior to the first flushing of the fields. Supposedly this data would determine species composition and population density prior to introduction of a potential toxicant into the ecosystem, but these data are not included in this report.

A preferred method would have been to conduct the preliminary sampling the previous April in order to determine typical species composition, density, distribution and migrations for this time period. If this was not possible, then a better method to estimate population, at least for the fish species, would have been to use an accepted capture-recapture method.

Instead of using total abundance as a measure of pesticide impact, a species diversity index was calculated for upstream and downstream sites on each sampling date in both areas, since changes in species diversity are indicative of environmental changes. A common index is the Shannon-Weiner index:

$H = -\sum p_i \ln p_i$, where pi is the proportion of total sample belonging to i th species.

Additionally, an index of similarity between Areas I and II was calculated for each sampling method. The formula is: $S = 2c/a+b$, where a = number of species in Area I, b = number of species in Area II, c = species occurring in both areas. The results are as follows:

Gillnet - Species Diversity Index (H) and Index of Similarity (S)

	6 Apr		7 Apr		12 Apr		22 Apr	
Area I	E	F	E	F	E	F	E	F
H	0	1.24	1.33	1.03	1.23	1.76	1.52	0.64
S	0		0.25		0.83		0.29	
Area II								
H	1.87	0.50	1.56	0.69	1.82	2.04	0.95	0
S	0.36		0.57		0.67		0	

Index of similarity between Areas I and II = 0.72.

Seine - Species Diversity Index

	29 Mar		6 Apr		7 Apr		12 Apr		22 Apr	
Area I	E	F	E	F	E	F	E	F	E	F
H	0.83	0.91	2.30	2.10	0.79	1.28	0.64	0.87	2.07	0.67
S	0.81		0.80		0.74		0.58		0.71	
Area II										
H	0.79	0.70	0.37	0.22	0.22	0.15	0.19	0.29	1.54	1.53
S	0.67		0.59		0.59		0.77		0.58	

Index of similarity between Area I and II = 0.73

Trawl-Species Diversity Index

	6 Apr		7 Apr		12 Apr		22 Apr	
Area I	E	F	E	F	E	F	E	F
H	0.48	0.07	0.57	0.72	0.56	0.43	1.09	0.87
S	0.46		0.67		0.62		0.83	

Index of similarity between Stations E and F = 0.75

phytoplankton patterns. The data are inconclusive regarding the effects of Bolero on phytoplankton.

The caged fish and shrimp study was determined to be scientifically invalid because of poor experimental design. The specimens were stressed from either improper acclimation, mishandling or overcrowding. The results of the caged mollusk study are inconclusive since salinity in the bayou was less than optimal.

Finally, major discrepancies were noted between the Lauck report (Table 20) and the Harper report regarding thiobencarb residue levels in Area I for 4 April to 12 April.

	Area I (Lauck)		Area I (Harper)	
	Site E	Site F	Site E	Site F
4 Apr.		0.002	-	-
5 Apr.	0.002	0.002	0.002	0.002
6 Apr.	0.002	0.003	0.000	-
7 Apr.	0.040	0.003	0.084	0.012
8 Apr.	0.031	0.008	0.031	0.051
9 Apr.	0.004	0.003	0.044	0.010
10 Apr.		0.003	-	-
11 Apr.	0.009	0.002	0.009	0.011
12 Apr.		0.010	-	-

Also, the Lauck report gives the dates of significant rainfall as 22, 23, 24, 25 March, 2, 3, 4 April and 18, 19, 20 April. The rainfalls in March and the end of April caused an unscheduled flush overflow. The Harper report varies slightly in the dates given for the early April rainfall, 5 and 6 April, in addition to the 3 earlier days. This may be significant since it indicates that it rained during the scheduled flush overflow. It is important to clarify these discrepancies.

C. RPAR Risk Criteria

1. The residue concentrations of 0.40 to 0.41 ppm measured at sampling station F_1 in Pleasant Bayou should not be used to determine RPAR risk criteria for estuarine organisms since the area is not a typical bayou (refer to section A.1 of this memo). Likewise, the values of 0.14 to 0.164 ppm thiobencarb measured in Area III of Halls Bayou should not be used to determine RPAR risk criteria to estuarine organisms since this is a freshwater habitat.

   EEB's Response: EEB accepts the fact that the area between sites F_1 and F_2 in Pleasant Bayou is not a true bayou system. However, it can be used to represent a freshwater habitat. Rice is planted not only in estuarine areas but also in freshwater areas. It is not unreasonable to expect freshwater streams similar in size to the F_1-F_2 system to be present in these inland rice areas. It may be that the water in this area of Pleasant Bayou stagnates after the rice growing season; however it cannot be assumed that this will occur in other freshwater habitats. Therefore, the residue levels measured at site F_1 can be used to determine RPAR risk criteria in freshwater rice regions.

EEB feels that the lack of residue levels for F_2 in Pleasant Bayou is a serious omission. It is at the F_2 site where Area IV in Pleasant Bayou becomes a true bayou. Residue measurements at this site would have aided in the risk assessment.

Although Area III of Halls Bayou was a freshwater system at the time of this field study, under different environmental conditions the salt wedge could extend farther up the bayou, as indicated in Moffett's study. There are no data to indicate that the residues measured in Area III would have been any different if the salinity had been higher. Physical conditions such as volume of water, size of the area, and flow rate influence residue concentrations. It must be remembered that EEB is concerned with all estuarine areas in the rice region not just Halls Bayou. It is probable that there are brackish conditions in areas similar to Area III. The residue levels measured in Area III can be used to determine RPAR risk criteria to estuarine organisms.

2. "Estuarine species such as oyster larvae and sheepshead minnow should not be used to determine risk to freshwater species".

   EEB's Response: The sheepshead minnow data are used to determine risk to embryo-larvae stages of freshwater fishes, and the oyster larvae data are used to determine risk to freshwater mollusks since we have no data on these stages of freshwater species.

3. "The acute risk criteria in 40 CFR 162.11 (a)(3)(i)(B)(3) for aquatic organisms are not exceeded or fulfilled from use of Bolero 8EC in dry seeded rice culture."

   EEB's Response: The RPAR risk criteria are exceeded for oyster larvae (LC_{50}=0.56 ppm) and Daphnia (LC_{50}=0.101 ppm) in freshwater habitats, based upon 0.41 ppm thiobencarb residues, and they are exceeded for mysid shrimp (LC_{50}=0.148 ppm, based on a new study submitted in October) and white shrimp (LC_{50}=0.264 ppm) in estuarine habitats, based upon 0.164 ppm thiobencarb residues.

   Furthermore, as indicated in section B.3 of this memo, the results of the field studies conducted by Harper and Landry do not prove that Bolero is safe for aquatic organisms. Therefore, it may constitute an acute risk to classes of organisms not indicated above.

4. "The chronic toxicity criterion for determination of unreasonable adverse effects has not been fulfilled."

   EEB's Response: Table 20 indicates that in Area II the mean thiobencarb residue concentration at the downstream location (F) for 4 days from April 5 through April 8 was 0.043 ppm. This concentration exceeds the MATC values for grass shrimp and mysid shrimp. Although the mean concentration over the 8-day period in which the residues were measured is slightly less than the upper MATC range (0.028 ppm vs. 0.030 ppm), EEB still believes that there may be a chronic effect on estuarine invertebrates. This is based upon the evidence that thiobencarb residues not only persisted but also increased in concentration (see table 20) even after flushing had ceased. As stated in

section A.2 of this memo Bolero can be applied to a greater number of ricefields than were used in the study. Not only will there be more ricefields that can be flushed on consecutive days into the same system of water, but also greater amounts of thiobencarb in the soil can be desorbed into the water. These factors can maintain the residue concentrations at levels greater than those reported for longer periods, creating a chronic hazard to estuarine organisms.

The freshwater residue data indicate that Bolero can persist for over a month at levels in excess of the MATC's of Daphnia (Tables 11 and 20) and of sheepshead minnow (Table 11--location F_1). Therefore, chronic toxicity effects on freshwater invertebrates and freshwater and estuarine fish are suggested by these representative species.

D. Bolero 10G Herbicide

The results of the Texas field study should not have been used to determine the risks associated with the application of the 10G formulation in California.

EEB's Response: EEB understands that rice culture is different between the southern states and California. However, Chevron submitted the data from the Texas field study to support the registration of Bolero 10G. Therefore, as stated in the conclusions of the review, until we receive the results of the EUP program in California we had to base our decision on the available data.

E. Conclusions

EEB has completed the review of Chevron's rebuttal and maintains its position as stated in the review of September 19, 1980. The caged field studies are not scientifically valid and the nektos, planktos and benthos studies are inconclusive. Chevron has not demonstrated the environmental safety of Bolero. The available data indicate that the RPAR risk criteria for acute and chronic hazards to estuarine and freshwater organisms are exceeded.

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