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Benzo(a)pyrene Concentrations in Somatic and Gonad Tissues of Bay Mussels, *Mytilus edulis*

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Recent studies have demonstrated clearly that polynuclear aromatic hydrocarbons (PNAH) are ubiquitous environmental contaminants (NEFF 1979). Bivalve molluscs, especially *M. edulis*, have been used as biological monitors for evaluating levels of PNAH in marine ecosystems. Most reports have been limited to concentrations of benzo(a)pyrene (BAP) in mussels (DUNN & STICH 1975, DUNN & YOUNG 1976, MIX et al. 1977, MIX & SCHAFFER 1979). Benzo-(a)pyrene, a known carcinogen, has been considered to be a general indicator compound for PNAH (DUNN 1980, BROWN et al. 1980).

Results from various shellfish monitoring programs tend to support the belief that shellfish can be useful biomonitors of the marine environment. However, certain questions about seasonality and tissue storage sites remain to be resolved. While some attempts have been made to determine tissue storage sites of BAP in shellfish (LEE et al. 1978, COUCH et al. 1979), the data are limited. The purposes of the present study were to measure BAP concentrations in the somatic and gonadal tissues of *M. edulis* and determine whether or not variations in those two tissue compartments could be related to seasonal fluctuations described previously (MIX & SCHAFFER 1979).

MATERIALS AND METHODS

Mussels from site Y2M, located along the bayfront in Yaquina Bay, Oregon, were utilized for this study since they were known to contain relatively high BAP concentrations (MIX & SCHAFFER 1979); high concentrations were necessary for detection when small amounts of gonadal material (< 5g) were analyzed during the winter.

Twelve samples, each consisting of 30 mussels, 40-60 mm in length, were collected from pilings at Y2M and placed in individual 20x30 cm fiberglass bags. These 12 bags were then placed in a single 46x92 cm nylon mesh bag and suspended at the same level (+2 MLLW) and location from which they were collected.

Samples were collected at approximately 10 day intervals beginning on 9 Jan 79, when no gonadal tissue was detectable grossly, and ending on 25 May 79 after spawning had occurred. Mussels were placed in an ice-filled cooler and transported immediately back to our lab in Corvallis, where they were cleaned and removed

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from the shell. The gonad was carefully excised from each animal and pooled to form one sample. Somatic tissues, consisting of the remaining tissues, excluding the byssal threads, from the 30 mussels were also pooled into a single sample. One collection of 30 mussels would typically yield 5g gonadal tissue and 25g somatic tissue. No effort was made to separate males and females in the present study. The tissues were blotted dry, placed in plastic bags, labeled and maintained at -10°C until analyzed.

Dunn's TLC methods (DUNN 1976, MIX & SCHAFFER 1979) were used to measure BAP concentrations. Concentrations are reported in µg/kg, wet weight.

RESULTS AND DISCUSSION

The objectives of this study were to measure the concentrations of BAP in somatic and gonadal tissues of *M. edulis* over several months and determine whether or not changes in levels in these tissues could account for winter-spring fluctuations in BAP concentrations; the period of high January-February concentrations noted previously (MIX & SCHAFFER 1979) was of special interest.

Table 1 contains quantitative data from the 5-month study. In common with a previous study (MIX & SCHAFFER 1979), BAP concentrations in the whole mussel tended to be greater during the winter and declined throughout the spring. The mean BAP concentration in whole mussels for the study period was 33.81 µg/kg (± 15.7). That compares with means of 27.5, 24.2, 29.6 and 28.9 µg/kg for Y2M mussels analyzed during the same period in 1977, 1978, 1979 and 1980, respectively (MIX & SCHAFFER 1979, MIX IN PRESS). There was no significant difference between the mean concentrations calculated for the 4 years (calculated $F = 0.4 < F_{.05(4,16)} = 3.73$).

Figure 1 illustrates the seasonal variation, in percent, in weights of somatic and gonadal tissue and the amount of BAP associated with each of these tissues. Inspection of Figure 1 reveals that the gonad accounted for 11-20% of the total body weight during the 5-month study while somatic tissues contributed 80-90%. Percentage concentrations of BAP in the gonad fluctuated between 5-20% (i.e. 5-20% of the total BAP in the body was sequestered in the gonad) except on 5/3/79 when it accounted for 36%. The amount of BAP in the somatic tissues, on a percentage basis, ranged from 80-97% except for the 5/3/79 date when it decreased to 64%.

To further identify and define relationships between BAP concentrations in the whole body and the two compartments analyzed in this study, various statistical tests were performed on the data in Table 1. Each piece percentage data was transformed to its arcsine before the analyses were performed (ZAR 1974).

TABLE 1. Benzo(a)pyrene concentrations in the gonad and somatic tissues of *M. edulis* from Yaquina Bay, Oregon.

	GONAD		SOMATIC		WHOLE MUSSEL (GONAD + SOMATIC)				
DATE SAMPLED[1]	(A) WEIGHT (GRAMS)	(B) BAP CONC. (µg/kg)	(C) WEIGHT (GRAMS)	(D) BAP CONC. (µg/kg)	(E) BAP CONC. (µg/kg)[2]	%WEIGHT GONAD[3]	% BAP GONAD[4]	% WEIGHT SOMATIC[5]	% BAP SOMATIC[6]
1/9/79	4.8	31.4	37.4	70.4	66.0	11.4	5.4	88.6	94.6
1/22/79	5.1	50.7	26.2	43.9	45.0	16.3	18.4	83.7	81.6
2/2/79	5.0	42.3	37.6	29.2	30.7	11.7	16.2	88.3	83.8
2/15/79	4.4	13.5	26.6	20.9	19.8	14.2	9.6	85.8	90.4
3/13/79	3.8	39.5	24.3	25.3	27.2	13.5	19.6	86.5	80.4
4/16/79	4.2	21.8	33.8	38.7	36.8	11.0	6.5	89.0	93.5
4/20/79	5.6	30.4	25.0	44.9	42.2	18.3	13.2	81.7	86.8
5/3/79	5.0	30.2	20.2	13.3	16.6	19.8	36.0	80.2	64.0
5/25/79	2.9	4.2	17.9	22.6	20.0	13.9	2.9	86.1	97.1

[1]samples collected on 3/1/79, 3/21/79 and 4/3/79 were excluded because of analytical error.

[2]determined by the formula, (A) (B) + (C) (D) / A+C

[3]determined by the formula, A / A+C

[4]determined by the formula, [(A) (B) / A+C] E x 100

[5]determined by the formula, C / A+C

[6]100 - % BAP GONAD

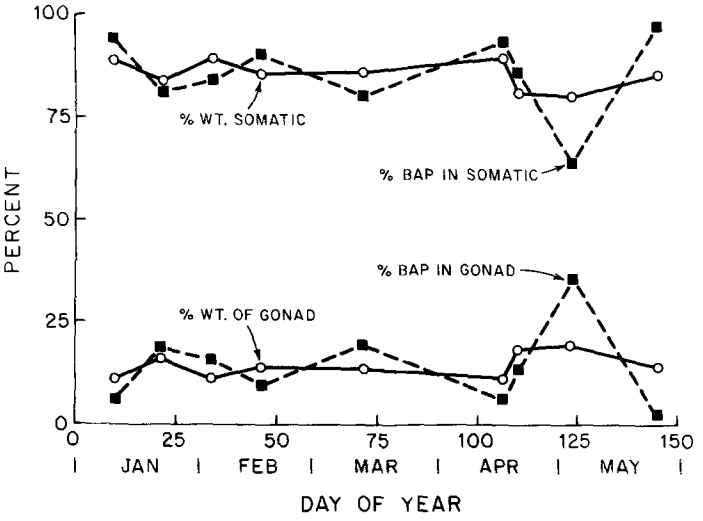

Fig. 1. The relationship between day of year and: (1) the proportion of whole body weight contributed by gonadal and somatic tissues; (2) the proportion of BAP contained within each of the two tissue compartments. None of the regression relationships, where X = percent and Y = day of year, were significant.

Two results from linear regression analyses were significant: the somatic tissue weights declined as the day of the year increased (observed $F = 6.0 > F_{.05(1,7)} = 5.59$; $R^2 = 0.46$); and, the whole body BAP concentrations were related to BAP concentrations in the somatic tissues (Figure 2). The latter relationship was highly significant (observed $F = 444.6 > F_{.05(1,7)} = 5.59$; $R^2 = 0.98$). No other statistically significant relationships were identified.

The results of this study indicate that gametogenesis and/or incorporation of BAP and presumably other lipophilic PNAH, were not associated in a significant way with whole body BAP concentrations or long-term seasonal BAP variations in the whole mussel. Except for the 5/3/79 date, there were no measurable increases in either the gonad weight or the % BAP contributed by the gonad. It may be possible that an accelerated period of gamete production and/or BAP incorporation into the gonad immediately preceded that period. However, spawning normally occurs much earlier in the spring in Yaquina Bay mussels (typically, Feb-Mar).

From the statistical analyses, it is evident that BAP storage occurred primarily in the somatic tissues compared to the gonad, even during the presumed spring spawning period. This agrees with others (LEE et al. 1972, DISALVO et al. 1975) who

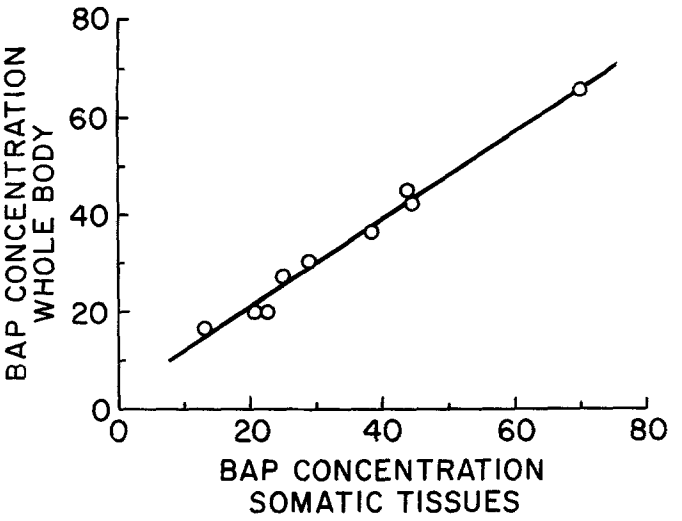

Fig. 2. The linear regression relationship indicating BAP concentrations in the whole body (X) are dependent on the concentrations in the somatic tissues (Y). $\hat{Y} = 2.82 + 0.90X$; $R^2 = 0.98$.

reported that somatic tissues, especially the hepatopancreas, contained higher concentrations of aromatic hydrocarbons than the gonad.

Our results show that for the Y2M mussels examined in this study, whole body BAP concentrations were dependent on BAP concentrations in the somatic tissues. Benzo(a)pyrene concentrated in the gonad accounted for a minor portion of the whole body concentrations and did not measurably affect seasonal variation in whole body BAP concentrations.

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