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# FEEDING AND FOOD PREFERENCES BY THREE SYMPATRIC SPECIES OF CYPRINODONTID FISHES

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A thesis presented in partial fulfillment of the requirements for the Degree of

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ABSTRACT

The feeding and food utilization by three sympatric species of cyprinodontid fishes was examined using a modified Ivlev Electivity Co-efficient. Results indicated that although *Fundulus heteroclitus* and *Fundulus majalis* are sympatric in the area examined, their usage of the available food source varied noticeably. The third investigated species, *Cyprinodon variegatus*, fed mainly upon a vegetal detritus food source varied by the consumption of invertebrate and vertebrate food items. Slight intra-specific variances of diet between crespuscular periods was also discussed.

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# INTRODUCTION

*Fundulus heteroclitus*, *Fundulus majalis*, and *Cyprinodon variegatus* occupy a sympatric range from at least Massachusetts in the north to northern Florida in the south (Rosen, 1973). Their habitats overlap in that they all live in brackish waters in semi-enclosed areas along the Atlantic coast of the United States and co-occur in relative abundance in many near-shore habitats of Chesapeake Bay (Hildebrand and Schroeder, 1928).

Although much work has been done on the foods eaten by several species of cyprinodontid fishes including *F. heteroclitus*, *F. majalis*, and *C. variegatus* (Fritz, 1974; Atmar and Stewart, 1972; Harrington and Harrington, 1972; and others), little is known of their direct competition for food. Within this family of small fishes, habitat overlap is common (Rosen, 1973; Hildebrand and Schroeder, 1928) and the evolution of methods to avoid competition may be expected.

In order to help understand resource partitioning among these three sympatric species, and possibly help illuminate resource partitioning among other cyprinodontids, this study investigated the natural feeding and food preferences of *Fundulus heteroclitus*, *Fundulus majalis*, and *Cyprinodon variegatus*. The approach used was similar to that developed by Ivlev (1961) and determined electivity and adjusted electivity values for the naturally available foods.

## METHODS AND MATERIALS

The general sampling area chosen was the lower region of Lynnhaven Bay, an embayment located just inside the Atlantic Ocean entrance to Chesapeake Bay. One collection each was made at four sites (Figure 1) during both solar crepuscular periods, on the incoming tide, in the late spring and early summer of 1973. Previous personal work with *Fundulus heteroclitus* and *Fundulus majalis* has indicated high activity during these light periods (Baer, 1972), while the action of the incoming tide helped to replenish the available food supply.

Site 1 was characterized by a sandy beach well covered with *Spartina alterniflora*. The bottom was muddy sand partially covered with the oyster *Crassostrea virginica* and organic debris. This detrital covered bottom extended shoreward to about the level of mean low water. Behind the beach, about three meters from the water's edge, the land rose sharply about one meter and was there covered by a dense growth of grass and pine trees.

Site 2 was near a small cove that had been dredged to permit the anchorage of commercial fishing vessels. The spoilage from this dredging formed the northern boundary of the sampling site. The shoreline at this site was very muddy and heavily overgrown with

*S. alterniflora*. The bottom, although practically all mud, was almost entirely covered with oysters.

The bottom of Site 3, bordered on the north by a dredged channel, consisted of a sandy bottom grading into a mud flat benthic environment. About 80% of the shoreline was bulkheaded with the remainder having only a sparse growth of *Spartina*. Small patches of the alga *Ulva lactuca* were scattered near the bulkheaded portion of the shoreline.

Site 4 was markedly different from the other three sites. It was a small lagoon, located near the Lynnhaven Bay entrance, which had a sand bottom with a light covering of plant debris. The eastern shore of the lagoon was grass-free sand while the western shore was heavily covered with *Spartina alterniflora*. The bottom had a number of large patches of *Ulva lactuca* growing on it and almost completely lacked oysters. A strong temperature and salinity gradient was evident with the incoming tide at this station. Many small *Lucania parva*, another cyprinodontid, were present here. Their size was such that they could be easily swallowed by medium-sized *Fundulus* and *Cyprinodon variegatus*.

All four sampling areas were exposed to a mean annual tidal fluctuation of approximately two feet (Johnson et al., 1974).

The fish were collected with a 5mm bar mesh pole seine and, after being field sorted into species, were immediately preserved in a 10% formalin solution. After initial preservation, the field containers were emptied and the fish washed and placed in 60% iso-propyl alcohol. The formalin solution was filtered through a #6 mesh plankton net (0.241mm apeture) and the regurgitated food items saved for analysis. The available food was collected from the sampling sites by obtaining water, in a bucket, from among the *Spartina* and passing it through a #6 mesh plankton net for gross filtering. At each collection approximately 300 liters of water was filtered. These filtered samples were then placed in 10% formalin and later transferred to 60% iso-propyl alcohol. The physical parameter of temperature was taked at the time of sampling, while water for salinity determination was returned to the laboratory for hydrometer analysis. (These results appear in Table 1.)

After complete preservation, the fishes were measured, weighed, and their sex determined. The stomachs were then taken from the fishes and their contents removed. Stomach contents, regurgitated food, and plankton samples were then identified. In the case of both species of *Fundulus*, their lack of a discrete stomach (Barrington, 1957) dictated the examination of the fore-gut section of the digestive tract (Atmar and Stewart, 1972). Each individual food item was measured to determine its size for later per cent volume calculations. Less substantial items such as copepods and *Tubifex* worms were converted into amphipod units: the number of amphipods of the same length needed to occupy the same space as the less substantial organism.

Having identified and quantitized the ration and the available food items, electivity co-efficients were calculated. This was done with the use of Ivlev's Electivity Formula:

$$E = \frac{r_i - p_i}{r_i + p_i} \quad . \tag{1}$$

$r_i$ = the per cent (%) of an item category of the total food eaten, or ration

$p_i$ = the per cent (%) of the same item available in the environment

The ration, $r_i$, is comprised of the sum of the stomach contents and the regurgitated items for each food type. The environmental value, $p_i$, is derived from the organisms filtered from the sampled water. Using this definition of electivity, or selectivity, gives an electivity co-efficient range of -1 to +1, where -1 means complete avoidance and +1 indicates the highest possible positive selection for a food type.

When stomach contents were examined, some items either could not be identified due to the progress of the digestive process or were obviously detrital in nature: such as sand, decayed plant material, and microphytoplankton. For the digested material, referred to as partially digested animal matter (PDAM), and the detritus, electivity values could not be calculated because reliable environmental values, $p_i$, could not be obtained. For this reason, adjusted electivity values were also determined. These values are those computed from the environmental percentages, $p_i$, and the ration percentages, $r_i$, resulting from the removal of the indeterminate values, PDAM and detritus, from the total ration.

Benthic samples were not taken due to the difficulties of quantifying data for valid comparison with the water column results.

## RESULTS AND DISCUSSION

From examination of gut contents of these three species of cyprinodontids, it was evident that *Cyprinodon variegatus* utilized a greatly different segment of the available food, $p_i$, than either *Fundulus heteroclitus* or *Fundulus majalis*. For this reason, *Cyprinodon variegatus* will be discussed in a separate sub-section which follows the discussions of *F. heteroclitus* and *F. majalis*. (Tables and figures presenting station results are referenced under the station headings.)

### *Fundulus heteroclitus*

*Fundulus heteroclitus* was the most numerous species collected at all sites, except for Station 4 where it was collected about equally with *Cyprinodon variegatus*. Specimens collected ranged from a weight of 0.03g to 16.45g and a length of 1.6cm to 8.4cm. A total of 119 fishes of this species was examined.

Previous workers (Hildebrand and Schroeder, 1928; Chidester, 1920) have indicated that this species is an omnivorous feeder, eating small crustaceans, molluscs, annelids, insects, fish, seeds, algae, blades of grass, roots, and small amounts of sand. This seems to generally correspond to the foods taken by other species of *Fundulus* (Atmar and Stewart, 1972; Harrington and Harrington, 1972; Odum, 1971; Harrington and Harrington, 1961).

Station 1
(Tables 2 & 3, Figure 2)

The collections at this site were made several weeks apart (Table 1) with the evening crepuscular period being sampled prior to the morning period. Therefore, if there is any seasonal shift in food utilization, its effects will be more pronounced here than at any of the other three stations.

The intake of detritus at this station fits well into a generalized detrital feeding pattern evident at other stations. This pattern is one of greater utilization of detritus in the evening feeding periods than in the mornings. This suggests that the unavailability of the more preferable foods during the daylight hours may force *F. heteroclitus* to rely more upon the plant dominated detritus for food.

Amphipod and polychaete intake follows a pattern opposite that of detrital feeding. The electivity values for amphipods and polychaetes show more positive electivity values during the morning activity period than in the evening. These three food categories were the ones that are most commonly utilized by *F. heteroclitus* at all stations. Less commonly utilized food types provided some variety of diet. Although calanoid copepods comprised 66.9% of all available non-detrital food in the morning, they made up only 1.3% of the adjusted ration for an electivity of -.96. In the evening sample, calanoid copepods were present in the environment at a value of 3.8%, but were strictly avoided for an E-value of -1.00. Insects gave a somewhat uncertain picture at this station, varying from a moderately high electivity to the extreme of E = -1.00. In the morning, brachyuran larva made up a major portion of the ration even though they are about the same size as the avoided calanoid copepods. This heavy utilization may be due to local clumping of these larva which would allow a fish to consume a large number of these organisms if they encountered them at all. The utilization of *Tubifex* worms may also follow this clumping pattern. Fish, although present at every station as evidenced by the results of the seine hauls, but not always captured by bucket, do not play a major part in the rations of this station. Other food items play only minor roles at this station.

Station 2
(Tables 4 & 5, Figure 3)

As at Station 1, detritus was utilized during the evening crepuscular period while none was eaten during the dawn hours. As previously mentioned, unavailability of alternate food items may influence this pattern of utilization. Amphipod and polychaete utilization follows the pattern established for Station 1 with higher electivities in the morning than in the evening. Calanoid copepods were actively rejected as food items, as at Station 1. The common grass shrimp, *Palaemonetes pugio*, was also selected against. Where *P. pugio* was present in the environment, its numbers were frequently so great that some shrimp had to be discarded to prevent fouling of the plankton net. Therefore, environmental percentages, $p_i$, are artificially low in some cases thus forcing the calculated electivity co-efficients to be higher than their true value. Insects seemed to be avoided in the morning yet selected for in the evening, contrary to Station 1 data. Insects may be a transitional type of food and may have no general election preference. Fish eggs, which made up 47.7% of the morning's adjusted ration and 6.6% of the evening's were selected for with their electivity co-efficients being 1.00 in both cases. This may result either from clumping and the missampling it implies, or active selection by *F. heteroclitus*. When compared to brachyuran larva, which was also an important fraction of the morning diet, the relatively large size of fish eggs possibly made them easier to find and subsequently increased their utilization. The red alga, *Polysiphonia*, is probably taken incidentally in the capture of other foods, as may also be the case with bivalves.

Station 3
(Tables 6 & 7, Figure 4)

Both detritus and partially digested animal matter were found in relatively small quantities at Station 3. Adjusted ration percentages and electivities therefore show only slight differences from the non-adjusted values. This numerical stability increased the reliability of the data.

The fish showed almost no preference, positive or negative, for amphipods in the morning analysis, and a relatively high negative electivity, E = -.56, in the evening data. Polychaetes were the most important single food for *F. heteroclitus* at this station, comprising about three-quarters of the evening food. The high electivity values, .87 and 1.00, illustrate this importance as related to the availability of polychaetes. In both the morning and evening, these fish showed almost no preference for insects. The inconsistency of *F. heteroclitus*' feeding behavior where insects are concerned might be explained by the small number of insects available for consumption. Insects usually occurred in the environment in quantities of less than 10% of the total and do not seem to play a significant role in the total food picture for this fish in Lynnhaven Bay. Therefore, feeding preferences involving *F. heteroclitus* and insects may not be well developed here. Calanoid copepods, *Palaemonetes pugio*, and bivalves all continue to be selected against. Small fishes were eaten in the evening, but the environmental component, $p_i$, and consequently the electivity co-efficient are once again in doubt.

Station 4
(Tables 8 & 9, Figure 5)

No amphipods were taken from the digestive systems of the *Fundulus heteroclitus* collected in the morning.

Examination of the evening sample yielded an amphipod ration percentage, $r_i$, of 9.1% and an electivity of 1.00. Polychaetes were again a prominent food in both the morning and the evening with electivities of 1.00 for both times. Insects were avoided during both periods. *Palaemonetes pugio* was eaten at this site and an electivity of 1.00 was calculated, but the sampling technique for *P. pugio* and its subsequent biases lessen the credibility of this figure. Jeffries (1972) indicated that *Fundulus heteroclitus* feed heavily on *P. pugio*. In the evening insects made up a large percentage (20%) of the food available, yet the fish-insect electivity value is -1.00. The only other instance where the insect $p_i$ was greater than 10% (Station 2 - morning) also gave a highly negative electivity co-efficient (-.91). Small fishes were eaten here and the resulting electivity is highly positive. The difficulty of capturing small fishes in a bucket and their removal from the area by seining immediately prior to the food sampling probably distorted this electivity value. Bivalves and calanoid copepods were again avoided.

All Stations Combined

Mornings versus Evenings (Tables 10 & 11, Figure 7): There were some distinct differences between the morning and the evening electivities displayed by *Fundulus heteroclitus*. The fish increased predation on two food types, insects and detritus, morning to evening. These increases helped balance the decreased consumption of amphipods, brachyuran larva, and *Palaemonetes pugio* as darkness approached. The feeding on polychaetes, fish eggs, and fishes remained relatively equal for both crepuscular periods.

All Fish Combined (Table 12, Figure 7): Although *F. heteroclitus* consumed organisms from nineteen different food categories, only eight, plus partially digested animal matter (PDAM), occurred in quantities greater than 5% of the combined food from all stations. These eight identifiable food items were: polychaetes, amphipods, fish eggs, brachyuran larva, detritus, fishes, insects, and *Palaemonetes pugio*. These nine groups comprised 94.4% of the total ration. Of the eight identifiable groups, only three are positively elected: polychaetes, fish eggs, and brachyuran larva. Furthermore, fish eggs and brachyuran larva are foods somewhat limited to seasonal availability. This preference for seasonally available foods suggestes that *F. heteroclitus* has a year long preference for only a few food types and will choose seasonally available organisms whenever they occur.

A particle size analysis of the non-detrital foods eaten by *F. heteroclitus* showed that larger fish consumed a greater percentage of large items than did smaller fish. (Figure 8) This increase in food size would provide the fishes with more caloric intake per capture and thus increase their feeding efficiency.

## *Fundulus majalis*

*Fundulus majalis*, a fish which moves through marsh channels with the tides (Mast, 1915), was collected at three of the four sampling sites, Stations 1, 3, and 4 (Figure 1). Where it was collected it was far less abundant than *Fundulus heteroclitus*. Therefore, in most cases, every specimen caught was examined. Thirty-nine fish were examined ranging from 1.5cm to 11.1cm standard length and from 0.06g to 20.71g in weight. Comparing these values to data obtained by Clemmer and Schwartz (1964), the age range of the *F. majalis* examined in this study was from less than one year to about four years. Hildebrand and Schroeder (1928) found that the food of *F. majalis* was much the same as that eaten by *F. heteroclitus*, ie., small molluscs, crustaceans, fish, vegetable debris, sand, and adult and larval insects.

### Station 1
(Tables 13 & 14, Figure 9)

In the morning amphipods, polychaetes, and calanoid copepods made up the entire non-detrital diet. Even though calanoid copepods comprised 26.2% of the adjusted ration ($r_i$) they were 66.9% of the food available (pi) giving the adjusted electivity of -.44. The relatively larged sized crustacean *Hippolyte sp.*, although abundant, was ignored. In the evening, the major identifiable non-detrital food items were amphipods, polychaetes, and mysids. A very large percentage, 45.8%, of the non-adjusted ration was classified as partially digested animal matter (PDAM). This probably resulted from late afternoon feeding which would allow digestion to proceed to the stage where identification of the original food items was impossible. A reversal in importance between amphipods and polychaetes from the morning pattern is evident at this station. This reversal may be due to a seasonal fluctuation accentuated by the length of the period between samples. Insects, fishes, spiders, and brachyuran larva were avoided.

Station 3
(Tables 15 & 16, Figure 10)

Very little detritus was eaten at this station, 0.5% of the total ration in the morning and 0.0% in the evening. Therefore, the adjusted and non-adjusted electivity co-efficients are identical and give high reliability. Amphipods comprised a rather minor part of the diet of *F. majalis* although they made up a substantial fraction of the available food (greater than 25% during both periods). This indicated a negative feeding preference with a daily pattern opposite that of Station 1. Polychaetes were the most important component of the diet. In both crepuscular periods they represented greater than 75% of the organisms consumed and were preferentially selected for. Insects were occurance utilized ($E \simeq 0$) in the morning and avoided in the evening, E = -.51. The other items utilized for food comprised less than 10% of the total ration.

Station 4
(Tables 17 & 18, Figure 11)

The food at this site differed measurably from that at other stations in the high percentage of detritus consumed, 34.3% in the morning and 24.0% in the evening. Thusly, a large variation in the ration versus the adjusted ration may be expected to greatly alter the electivity co-efficients; however, this is not the case as only a few different items were eaten and several of these displayed electivity co-efficient values of unity. Of those adjustable items, amphipods, polychaetes, and fishes were of major importance. In the morning amphipods were occurance utilized where as in the evening they occurred in neither the ration nor the environment. Polychaetes were heavily fed upon in the morning, adjusted ration of 80.0%, and occurance utilized in the evening, adjusted E = -.02. Fishes, though not eaten in the morning, replace polychaetes in the evening as the dominant food. Here they represent an adjusted ration of 71.9%. The calculated electivity co-efficient of 1.00 is misleading for the reasons previously mentioned. Insects, calanoid copepods, bivalves, brachyuran larva, and fish eggs were avoided when present.

All Stations Combined

Mornings versus Evenings (Tables 19 & 20, Figure 12): Few large scale differences between morning and evening feeding electivities were evidenced by *Fundulus majalis*. Insects were elected for in the mornings but not in the evenings, while the opposite was true of fishes. Polychaetes were of somewhat greater importance in the mornings than in the evenings, E ≃ .30, while amphipods were of greater importance in the evenings than in the mornings, E ≃ .20.

All Fish Combined (Table 21, Figure 13): Of the sixteen available quantifiable food types, *Fundulus majalis* utilized only nine, or about 56%. The major food type utilized was polychaetes with an adjusted ration of 66.1% and an adjusted electivity co-efficient of .85. The second major utilized food type was amphipods with an adjusted ration of 13.2% but an adjusted electivity co-efficient of -.32. Comparison of these first two major foods indicated definite food electivity by *Fundulus majalis*. The next two major utilized food types, fishes and insects, also show positive and negative preferences respectively. The adjusted rations were 8.9% for fishes versus 4.7% for insects with respective adjusted electivity co-efficients of .34 and -.31. The calculated electivity value for the fishes is probably high due to distortion in sampling. Calanoid copepods were heavily avoided with an adjusted electivity co-efficient of -.75, as are bivalves with an adjusted electivity co-efficient equal to -.54. *Palaemonetes pugio*, *Hippolyte sp.*, barnacles, isopods, fish eggs, and *Tubifex sp.* were all completely ignored.

*Fundulus heteroclitus* compared to *Fundulus majalis* (Figure 14)

The most striking general characteristic evident when comparing the food utilization of these two species is the degree of feeding generalization. Of the twenty-two food types to which *F. heteroclitus* was exposed (excluding PDAM) nineteen, or 86.4% were utilized to some degree. *F. majalis* was exposed to eighteen food types (excluding PDAM) but utilized only eleven, or 61.1%. Of the items which were eaten and could be adjusted, *F. heteroclitus* selected for nine and against eight while *F. majalis* preferred four and avoided five.

The single most important food type for both species of fish was polychaetes. Although polychaetes are closely associated with the bottom (Meglitsch, 1967), they comprised 32.0% of the food of *F. heteroclitus* and more than twice that for *F. majalis*. This great emphasis of predation upon polychaetes by *F. majalis* is the single greatest difference in the food utilization between these two species of fishes. Another benthic food consumed by both fishes was amphipods. For these crustaceans, which were usually smaller than the poly-chaetes, a negative electivity co-efficient was calculated for both species of fishes, although the amphipods did play a larger role in the diet of *Fundulus heteroclitus* than for *Fundulus majalis*. Fishes, whose actual environmental availability was difficult to determine, made up an almost equal percentage of the ration of both species. Where these ration percentages ($r_i$) were compared to the environmental percentages ($p_i$) *F. majalis* showed a relatively positive electivity co-efficient, .26 - .34, while *F. heteroclitus* proved to be an occurance utilizer of fishes, E = -.02 - -.08.

Small food items such as fish eggs, brachyuran larva, and *Tubifex sp.* were positively elected for by *F. heteroclitus* and negatively elected by *F. majalis*. Other food types including insects, *Palaemonetes pugio*, and *Hippolyte sp.* showed negative electivities with *F. majalis* displaying greater abstention. The only small neritic food type shown greater preference by *F. majalis* than *F. heteroclitus* was calanoid copepods. This is a case of large negative electivity co-efficient values, -.75 and -.97 respectively. Bivalves, usually rejected by both species of fishes, were eaten more often by *F. majalis*. This may be the result of detrital uptake incidental to polychaete capture.

Detrital intake by these fishes is an interesting facet of feeding. Barrington (1957) described members of the genus *Fundulus* as being "stomachless teleosts". Because of this lack of a discrete stomach and the short total length of their digestive systems, Atmar and Stewart

(1972) and Odum (1971) have expressed the opinion that plant material can not be digested by these fishes and is taken in incidentally with the capture of other foods. By analyzing the fatty-acid content and the carbon chain length in material taken from *F. heteroclitus* and *F. majalis*, Jeffries (1972) has stated that the most probable food composition for these species of fish is a ration of five parts of plant detritus to one part of the marine invertebrate *Palaemonetes pugio*. (The marine invertebrates were not exclusively limited to *P. pugio*, but it was the only species which was specifically mentioned.) Information obtained in this study has indicated that approximately 10% of the total food intake for both species is detrital. Jeffries' method suggests that the entire digestive system was analyzed. This type of analysis would distort the importance of undigestable detritus in the lower intestine found by Atmar and Stewart (1972). The percentage of detritus in the ration found in this study indicates that the incidental uptake of debris is a plausible explanation for the detritus found in the digestive system of *Fundulus*.

## *Cyprinodon variegatus*

*Cyprinodon variegatus* is the widest ranging of the three fish discussed in this study. They are common from Cape Cod to Mexico (Hildebrand and Schroeder, 1928) and live in fresh, brackish, and occasionally pure salt water (Hildebrand, 1919). These fish travel in schools and on the rising tide swim into shallow water, working their way among the shoreline grasses.

*Cyprinodon variegatus* was collected at two of the four sampling sites with only a solitary specimen being collected at Station 2. Sixteen specimens ranging from 0.10g to 3.68g and 1.5cm to 4.3cm were examined. No great variances in their diets were observed.

Being a wide ranging brackish water species, extensive work has been done with this fish. Previous work (Odum, 1971; Harrington and Harrington, 1961; Hildebrand and Schroeder, 1928; Hildebrand, 1919) has indicated that the major part of the diet of *C. variegatus* is composed of filamentous algae and detritus, while Martin (1970) has suggested that this ingestion of algae is incidental with food capture. Harrington and Harrington (1961) also indicated that in calm waters, where mosquitos breed, *C. variegatus* feeds heavily (38% of the total diet) on all stages of larval forms with the larger fishes eating the larger instars. Hildebrand (1919) indicated that *C. variegatus* will successfully attack *Fundulus heteroclitus* and *Fundulus majalis*.

Station 2
(Table 22, Figure 15)

Only one specimen was collected in the morning at this station and it is the only fish of this species which was collected at Stations 1, 2, and 3. The entire diet of this single fish consisted of detritus. The detritus was composed of several species of diatoms and blue-green algae, small molluscs, partially decayed filamentous and non-filamentous plant matter, and sand.

Station 4
(Tables 23 & 24, Figure 16)

As in Station 2, detritus made up the greatest portion of the fishes' diet. In the morning 86.5% of the food was detrital and in the evening 58.3%. Of the remaining morning food, or the adjusted ration, forty percent was bivalves, an item likely to have been ingested with the detritus. Because of the large percentage of detritus, the differences between the actual and adjusted electivity co-efficients were large. All food types except bivalves displayed negative actual electivity co-efficients and only one of these, amphipods, had a positive adjusted electivity co-efficient. The evening food utilization is much the same as that in the morning. Although seven non-detrital foods were available, only three were utilized: polychaetes, fishes, and *Palaemonetes pugio*. Of these three foods, fishes and *P. pugio* had electivity co-efficients of 1.00. The remaining food, polychaetes, was heavily selected against.

All Stations Combined

Mornings versus Evening (Table 25 & 26, Figure 17): The morning and evening comparison is essentially that discussed for Station 4. Detrital intake was reduced in the evening while predation on vertebrates increased.

In the evening, utilization of *P. pugio*, although not collected in the environmental sample, comprised 19.4% of the total food intake. *C. variegatus* seemed to vary its diet as darkness approached. Although changing light conditions may be a direct stimulus to feeding behavior, the pre-dawn lowered light levels might seriously limit sight feeding. This reduced ability to sight feed could result in detritus being the only utilizable food for *Cyprinodon variegatus*.

All Fish Combined (Table 27, Figure 18): Data gathered in this study supports the earlier conclusion of the direct ingestion of detritus. *C. variegatus* is primarily a herbivore which will augment its diet with animals. *Cyprinodon variegatus* is not similar to the genus *Fundulus* when considering digestive systems. The long and highly convoluted intestine of *C. variegatus* is well suited for the digestion of decaying marsh grasses (Hildebrand, 1919).

## Body Form and Feeding Relationships

The evident preference for benthic organisms displayed by *Fundulus majalis*, with 76.9% of the total ration versus 51.6% for *Fundulus heteroclitus*, might possibly be explained by some of the physical characteristics of these two fishes. *Fundulus majalis* is more laterally compressed, has a more acute snout and terminal mouth, and relatively slightly more vertical fin area than does *Fundulus heteroclitus* (Jordan and Evermann, 1896). In submerged forms, roll stability is dependant upon the relative planform area of a body (Blagoveshchensky, 1962). Its more terete shape, in conjunction with its slightly greater relative vertical fin area, may help *F. majalis* to increase its roll stability and, along with its more acute snout and terminal mouth, may allow it to more accurately select benthic organisms than *F. heteroclitus* can.

This body form difference might be related to the feeding habits of these fishes. If this is so, *Fundulus majalis* is able to excell over *Fundulus heteroclitus* in the picking of organisms from the benthos without the uptake of plant debris which it can not digest. For *F. heteroclitus* 17.3% of the benthic food types (detritus, amphipods, polychaetes, bivalves, and harpacticoid copepods) was composed of plant debris, while for *F. majalis* plant debris made up only 9.1%: a 190% difference. This relative difference in the garnishment of useable food from the bottom may be related to body form stability in the environment.

# SUMMARY

*Fundulus heteroclitus* and *Fundulus majalis* live in close proximity and, therefore, are exposed to nearly identical prey organisms; yet their utilization of these available foods differed to a noticeable extent. *F. heteroclitus* was a more generalized feeder than was *F. majalis* and the sources of its emphasized foods were more diverse than those of *F. majalis*. While *Fundulus heteroclitus* and *Fundulus majalis* consumed organisms from the same benthic groups (detritus, amphipods, polychaetes, bivalves, and harpacticoid copepods), 51.6% of the diet of *F. heteroclitus* was made up of these groups as compared to 76.9% for *F. majalis*. This difference was due almost entirely to the preference shown by *F. majalis* for polychaetes.

Utilization of relatively small planktonic food organisms usually followed one of two major patterns. Occurance utilization ($E \approx 0$) was displayed by *F. majalis* for insects, but was not displayed at all by *F. heteroclitus*. Negative electivity co-efficients were displayed by both species of *Fundulus*. Each showed avoidance feeding of calanoid copepods, $E = -.93$ by *F. heteroclitus* and $E = -.78$ by *F. majalis*. Both avoided isopods, $E = -1.00$, and spiders, $E = -1.00$. *F. heteroclitus* selected against mysids, $E = -.87$, and chaetognaths, $E = -.50$; while *F. majalis* avoided brachyuran larva, $E = -.71$.

Larger planktonic organisms such as *Palaemonetes pugio* and *Hippolyte sp.* were selected against by both fish species: E = -.45 and E = -.58 respectively for *F. heteroclitus* and E = -1.00 and E = -1.00 for *F. majalis*.

The most favored food for both species of fish was polychaetes: E = .70 for *F. heteroclitus* and E = .83 for *F. majalis*. Although amphipods comprised a major portion of the diets of both of these fishes (19.5% for *F. heteroclitus* and 13.2% for *F. majalis*) they were selected against in each case: E = -.20 by *F. heteroclitus* and E = -.40 by *F. majalis*.

*Cyprinodon variegatus*'s elongated and convoluted intestine allowed this fish to favor detrital feeding. Augmentation of a detrital diet was accomplished mainly through the capture of small fishes and crustaceans. By feeding primarily on organic debris with only an occasional switch to animal prey, *Cyprinodon variegatus* lessened its competition with *Fundulus heteroclitus* and *Fundulus majalis*.

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APPENDIX A

TABLE 1. Station data for non-biological parameters

| STATION | DATE | WATER TEMPERATURE °C | SALINITY o/oo |
|---|---|---|---|
| 1 | | | |
| Morning | 16 July 1973 | 27.0 | 14.3 |
| Evening | 14 June 1973 | 30.0 | 13.6 |
| 2 | | | |
| Morning | 30 June 1973 | 26.0 | 15.3 |
| Evening | 15 June 1973 | 28.3 | 16.1 |
| 3 | | | |
| Morning | 1 July 1973 | 27.5 | 16.3 |
| Evening | 30 June 1973 | 25.8 | 14.7 |
| 4 | | | |
| Morning | 30 July 1973 | 26.5 | -- |
| Evening | 30 July 1973 | 31.4 | 24.1 |

TABLE 2. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 1. (Morning, 16 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus | 32.0 | 0.0 | 14.5 | -- | 0.0 | 1.00 | -- |
| Amphipods | 2.0 | 13.0 | 6.9 | 8.0 | 0.1 | .97 | .98 |
| Polychaetes | 29.0 | 20.0 | 22.3 | 26.1 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 31.0 | 0.0 | 14.1 | 16.5 | 12.0 | .08 | .16 |
| Bivalves | 0.0 | 2.5 | 1.1 | 1.3 | 0.2 | .69 | .73 |
| Brachyuran larva | 14.0 | 50.0 | 29.1 | 34.0 | 0.1 | .99 | .99 |
| *Hippolyte sp.* | 15.0 | 0.0 | 6.8 | 8.0 | 18.7 | -.47 | -.40 |
| *Argulus sp.* | 0.0 | 1.0 | 0.5 | 0.5 | 0.0 | 1.00 | 1.00 |
| Insects | 0.0 | 6.0 | 2.7 | 3.2 | 0.9 | .50 | .56 |
| Calanoid Copepods | 0.0 | 2.5 | 1.1 | 1.3 | 66.9 | -.97 | -.96 |
| Harpacticoid Copepods | 0.0 | 1.8 | 0.8 | 0.9 | 0.0 | 1.00 | 1.00 |
| Nauplii | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 | 1.00 | 1.00 |
| Fishes | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | -1.00 | -1.00 |

Numerical values given in amphipod units
RFI = Regurgitated Food Items

TABLE 3. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 1. (Evening, 14 June 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 14.0 | 0.0 | 12.6 | -- | 0.0 | 1.00 | -- |
| Detritus | 56.0 | 0.0 | 50.4 | -- | 0.0 | 1.00 | -- |
| Amphipods | 14.8 | 2.5 | 15.6 | 42.2 | 67.9 | -.63 | -.23 |
| Polychaetes | 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | -1.00 | -1.00 |
| *Tubifex sp.* | 18.0 | 0.0 | 16.2 | 43.8 | 5.0 | .53 | .80 |
| Chaetognaths | 2.8 | 0.0 | 2.5 | 6.8 | 0.0 | 1.00 | 1.00 |
| Mysids | 0.0 | 3.0 | 2.7 | 7.3 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 3.8 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | -1.00 | -1.00 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 8.3 | -1.00 | -1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 4.5 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 4. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 2. (Morning, 30 June 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 1.0 | 0.0 | 0.4 | -- | 0.0 | 1.00 | -- |
| Amphipods | 17.0 | 30.5 | 18.5 | 18.7 | 9.8 | .27 | .31 |
| Polychaetes | 7.0 | 1.0 | 3.1 | 3.1 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 18.0 | 0.0 | 7.0 | 7.0 | 47.7 | -.76 | -.76 |
| *Polysiphonia sp.* | 1.0 | 0.0 | 0.4 | -- | 0.0 | 1.00 | -- |
| Insects | 2.0 | 0.0 | 0.8 | 0.8 | 16.1 | -.91 | -.91 |
| Eggs | 69.0 | 52.0 | 47.3 | 47.4 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.0 | 1.0 | 0.4 | 0.4 | 18.4 | -.96 | -.96 |
| Brachyuran larva | 52.5 | 2.0 | 21.3 | 21.4 | 0.0 | 1.00 | 1.00 |
| Harpacticoid Copepods | 0.0 | 2.0 | 0.8 | 0.8 | 0.0 | 1.00 | 1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | -1.00 | -1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 5.7 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 5. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 2. (Evening, 15 June 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 43.8 | 0.0 | 30.2 | -- | 0.0 | 1.00 | -- |
| Detritus | 15.6 | 0.0 | 10.8 | -- | 0.0 | 1.00 | -- |
| Amphipods | 38.8 | 0.0 | 26.9 | 51.2 | 26.9 | 0.00 | .31 |
| Polychaetes | 0.0 | 0.0 | 0.0 | 0.0 | 5.8 | -1.00 | -1.00 |
| *Palaemonetes pugio* | 8.0 | 0.0 | 5.5 | 10.6 | 8.1 | -.19 | .13 |
| *Polysiphonia sp.* | 9.5 | 0.0 | 6.6 | -- | 0.0 | 1.00 | -- |
| Insects | 7.0 | 0.0 | 4.8 | 9.2 | 0.0 | 1.00 | 1.00 |
| *Tubifex sp.* | 2.0 | 0.0 | 1.4 | 2.6 | 0.0 | 1.00 | 1.00 |
| Eggs | 5.0 | 0.0 | 3.5 | 6.6 | 0.0 | 1.00 | 1.00 |
| *Callinectes sapides* | 4.0 | 0.0 | 2.8 | 5.3 | 0.0 | 1.00 | 1.00 |
| Mysids | 0.0 | 0.0 | 0.0 | 0.0 | 22.4 | -1.00 | -1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 8.1 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 6. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 3. (Morning, 1 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 6.5 | 0.0 | 4.2 | -- | 0.0 | 1.00 | -- |
| Amphipods | 60.0 | 2.0 | 40.3 | 42.5 | 44.3 | -.05 | -.03 |
| Polychaetes | 64.5 | 10.0 | 48.4 | 50.5 | 3.6 | .86 | .87 |
| Insects | 0.0 | 11.0 | 7.2 | 7.5 | 7.3 | .00 | .00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 8.5 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | -1.00 | -1.00 |
| Barnacles | 0.0 | 0.0 | 0.0 | 0.0 | 14.5 | -1.00 | -1.00 |
| *Hippolyte sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 14.5 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 7. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 3. (Evening, 30 June 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 31.0 | 0.0 | 7.8 | -- | 0.0 | 1.00 | -- |
| Detritus | 7.0 | 0.0 | 1.8 | -- | 0.0 | 1.00 | -- |
| Amphipods | 30.5 | 0.0 | 7.6 | 8.5 | 26.8 | -.56 | -.52 |
| Polychaetes | 93.0 | 172.0 | 66.4 | 74.0 | 0.0 | 1.00 | 1.00 |
| Insects | 39.0 | 5.5 | 11.1 | 12.4 | 12.5 | -.05 | 0.00 |
| Eggs | 3.0 | 0.0 | 0.8 | 0.8 | 0.0 | 1.00 | 1.00 |
| Fish | 0.0 | 12.0 | 3.0 | 3.4 | 0.0 | 1.00 | 1.00 |
| *Argulus sp.* | 3.0 | 0.0 | 0.8 | 0.8 | 0.0 | 1.00 | 1.00 |
| *Polysiphonia sp.* | 3.0 | 0.0 | 0.8 | -- | 0.0 | 1.00 | -- |
| *Palaemonetes pugio* | 0.0 | 0.0 | 0.0 | 0.0 | 45.1 | -1.00 | -1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 10.5 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 5.5 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 8. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 4. (Morning, 30 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 5.0 | 0.0 | 7.0 | -- | 0.0 | 1.00 | -- |
| Detritus | 4.0 | 0.0 | 5.6 | -- | 0.0 | 1.00 | -- |
| Amphipods | 0.0 | 0.0 | 0.0 | 0.0 | 15.6 | -1.00 | -1.00 |
| Polychaetes | 9.0 | 0.0 | 12.7 | 14.5 | 0.0 | 1.00 | 1.00 |
| Fishes | 47.0 | 0.0 | 66.2 | 75.7 | 25.5 | .44 | .50 |
| Insects | 0.5 | 0.0 | 0.7 | 0.8 | 4.3 | -.72 | -.69 |
| *Palaemonetes pugio* | 3.0 | 0.0 | 4.2 | 4.8 | 0.0 | 1.00 | 1.00 |
| Isopods | 1.5 | 0.0 | 2.1 | 2.4 | 0.0 | 1.00 | 1.00 |
| *Argulus sp.* | 0.0 | 1.0 | 1.4 | 1.6 | 0.0 | 1.00 | 1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 11.3 | -1.00 | -1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 36.9 | -1.00 | -1.00 |
| Eggs | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 9. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at Station 4. (Evening, 30 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 11.5 | 0.0 | 10.9 | -- | 0.0 | 1.00 | -- |
| Detritus | 7.3 | 0.0 | 6.9 | -- | 0.0 | 1.00 | -- |
| Amphipods | 5.0 | 3.0 | 7.6 | 9.1 | 0.0 | 1.00 | 1.00 |
| Polychaetes | 17.5 | 25.0 | 39.7 | 48.3 | 20.0 | .33 | .41 |
| Fishes | 17.0 | 0.0 | 16.1 | 19.5 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 13.0 | 0.0 | 12.3 | 14.9 | 0.0 | 1.00 | 1.00 |
| Insects | 0.0 | 5.0 | 4.7 | 5.7 | 20.0 | -.62 | -.56 |
| Zoea | 0.0 | 2.0 | 1.9 | 2.3 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 17.5 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 7.7 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 10. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at all stations combined. (Mornings)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 12.5 | 0.0 | 1.6 | -- | 0.0 | 1.00 | -- |
| Detritus | 32.0 | 0.0 | 4.5 | -- | 0.0 | 1.00 | -- |
| Amphipods | 79.0 | 45.5 | 17.5 | 18.7 | 17.4 | .00 | .04 |
| Polychaetes | 109.5 | 44.5 | 21.7 | 23.1 | 0.9 | .92 | .92 |
| Eggs | 69.0 | 52.0 | 17.0 | 18.2 | 1.1 | .88 | .89 |
| Fishes | 47.0 | 0.0 | 6.7 | 7.1 | 6.6 | .00 | .04 |
| Insects | 2.5 | 17.0 | 2.7 | 2.9 | 7.2 | -.45 | -.43 |
| Brachyuran larva | 66.5 | 52.0 | 16.7 | 17.8 | 2.8 | .71 | .73 |
| *Palaemonetes pugio* | 52.0 | 0.0 | 7.3 | 7.8 | 14.9 | -.34 | -.31 |
| *Polysiphonia sp.* | 1.0 | 0.0 | 0.1 | -- | 0.0 | 1.00 | -- |
| *Argulus sp.* | 0.0 | 2.0 | 0.3 | 0.3 | 0.0 | 1.00 | 1.00 |
| *Hippolyte sp.* | 15.0 | 0.0 | 2.1 | 2.3 | 8.3 | -.60 | -.57 |
| Calanoid Copepods | 0.0 | 3.5 | 0.5 | 0.5 | 32.7 | -.97 | -.97 |
| Bivalves | 0.0 | 2.5 | 0.4 | 0.4 | 2.0 | -.67 | -.67 |
| Harpacticoid Copepods | 0.0 | 3.8 | 0.5 | 0.5 | 0.0 | 1.00 | 1.00 |
| Zoea and Nauplii | 0.0 | 0.3 | .0 | .0 | 0.0 | 1.00 | 1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | -1.00 | -1.00 |
| Isopods | 1.5 | 0.0 | 0.2 | 0.2 | 0.9 | -.64 | -.64 |
| Barnacles | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 11. Food, plankton, and electivity co-efficient values for *Fundulus heteroclitus* collected at all stations combined. (Evenings)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 100.2 | 0.0 | 13.3 | -- | 0.0 | 1.00 | -- |
| Detritus | 85.9 | 0.0 | 11.4 | -- | 0.0 | 1.00 | -- |
| Amphipods | 81.1 | 5.0 | 11.5 | 15.6 | 30.4 | -.45 | -.32 |
| Polychaetes | 110.0 | 197.0 | 40.8 | 55.5 | 8.3 | .66 | .74 |
| Eggs | 8.0 | 0.0 | 1.1 | 1.5 | 0.0 | 1.00 | 1.00 |
| Fishes | 28.0 | 12.0 | 5.3 | 7.3 | 6.5 | -.10 | .05 |
| Insects | 46.0 | 10.5 | 7.6 | 10.2 | 10.2 | -.15 | 0.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 3.2 | -1.00 | -1.00 |
| *Tubifex sp.* | 20.0 | 0.0 | 2.7 | 3.6 | 1.2 | .38 | .50 |
| *Palaemonetes pugio* | 21.0 | 0.0 | 2.8 | 3.8 | 13.3 | -.65 | -.56 |
| *Callinectes sapides* | 4.0 | 0.0 | 0.5 | 0.7 | 0.0 | 1.00 | 1.00 |
| *Polysiphonia sp.* | 12.5 | 0.0 | 1.7 | -- | 0.0 | 1.00 | -- |
| *Argulus sp.* | 3.0 | 0.0 | 0.4 | 0.5 | 0.0 | 1.00 | 1.00 |
| Mysids | 0.0 | 3.0 | 0.4 | 0.5 | 5.6 | -.87 | -.84 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 8.9 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 9.1 | -1.00 | -1.00 |
| Zoea and Nauplii | 0.0 | 2.0 | 0.2 | 0.3 | 0.0 | 1.00 | 1.00 |
| Chaetognaths | 2.8 | 0.0 | 0.4 | 0.5 | 0.0 | 1.00 | 1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 12. Food, plankton, and electivity co-efficient values for all *Fundulus heteroclitus* collected.

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 112.8 | 0.0 | 8.2 | -- | 0.0 | 1.00 | -- |
| Detritus | 121.9 | 0.0 | 8.9 | -- | 0.0 | 1.00 | -- |
| Amphipods | 168.1 | 51.0 | 16.0 | 19.5 | 23.9 | -.20 | -.10 |
| Polychaetes | 131.0 | 228.0 | 26.2 | 32.0 | 4.6 | .70 | .75 |
| Eggs | 77.0 | 52.0 | 9.4 | 11.5 | 0.5 | .90 | .92 |
| Fishes | 75.0 | 12.0 | 6.3 | 7.8 | 6.6 | -.02 | .08 |
| Insects | 48.5 | 27.5 | 5.5 | 6.8 | 8.7 | -.23 | -.12 |
| Brachyuran larva | 66.5 | 52.0 | 8.6 | 10.5 | 3.0 | .48 | .56 |
| *Tubifex sp.* | 20.0 | 0.0 | 1.5 | 1.8 | 0.6 | .43 | .50 |
| *Palaemonetes pugio* | 73.0 | 0.0 | 5.3 | 6.5 | 14.1 | -.45 | -.37 |
| *Callinectes sapides* | 4.0 | 0.0 | 0.3 | 0.4 | 0.0 | 1.00 | 1.00 |
| *Polysiphonia sp.* | 13.5 | 0.0 | 1.0 | -- | 0.0 | 1.00 | -- |
| *Argulus sp.* | 3.0 | 2.0 | 0.4 | 0.4 | 0.0 | 1.00 | 1.00 |
| *Hippolyte sp.* | 15.0 | 0.0 | 1.1 | 1.3 | 4.2 | -.58 | -.53 |
| Mysids | 0.0 | 3.0 | 0.2 | 0.2 | 2.8 | -.87 | -.81 |
| Calanoid Copepods | 0.0 | 3.5 | 0.3 | 0.3 | 21.3 | -.97 | -.97 |
| Bivalves | 0.0 | 2.5 | 0.2 | 0.2 | 5.9 | -.93 | -.93 |
| Harpacticoid Copepods | 0.0 | 3.8 | 0.3 | 0.3 | 0.0 | 1.00 | 1.00 |
| Zoea and Nauplii | 0.0 | 2.3 | 0.2 | 0.2 | 0.0 | 1.00 | 1.00 |
| Chaetognaths | 2.8 | 0.0 | 0.2 | 0.2 | 0.6 | -.50 | -.50 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | -1.00 | -1.00 |
| Barnacles | 0.0 | 0.0 | 0.0 | 0.0 | 1.6 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 13. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at Station 1. (Morning, 16 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus | 7.0 | 0.0 | 14.3 | -- | 0.0 | 1.00 | -- |
| Amphipods | 5.0 | 0.0 | 10.2 | 11.9 | 0.1 | .98 | .98 |
| Polychaetes | 26.0 | 0.0 | 53.1 | 61.9 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.0 | 11.0 | 22.4 | 26.2 | 66.9 | -.50 | -.44 |
| *Palaemonetes pugio* | 0.0 | 0.0 | 0.0 | 0.0 | 12.0 | -1.00 | -1.00 |
| *Hippolyte sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 18.7 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | -1.00 | -1.00 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | -1.00 | -1.00 |
| Fishes | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items

TABLE 14. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at Station 1. (Evening, 14 June 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 22.0 | 0.0 | 45.8 | -- | 0.0 | 1.00 | -- |
| Detritus | 4.8 | 0.0 | 10.0 | -- | 0.0 | 1.00 | -- |
| Amphipods | 12.5 | 0.5 | 27.1 | 61.3 | 67.9 | -.43 | -.05 |
| Polychaetes | 4.0 | 0.0 | 8.3 | 18.9 | 7.5 | .05 | .42 |
| Calanoid Copepods | 0.2 | 0.0 | 0.4 | 0.9 | 3.8 | -.81 | -.62 |
| Bivalves | 1.0 | 0.0 | 2.1 | 4.7 | 1.5 | .17 | .52 |
| Mysids | 0.0 | 3.0 | 6.3 | 14.2 | 0.0 | 1.00 | 1.00 |
| *Tubifex sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | -1.00 | -1.00 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 8.3 | -1.00 | -1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 4.5 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 15. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at Station 3. (Morning, 1 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus | 0.5 | 0.0 | 0.5 | -- | 0.0 | 1.00 | -- |
| Amphipods | 0.0 | 4.5 | 4.3 | 4.3 | 44.3 | -.93 | -.93 |
| Polychaetes | 80.0 | 5.0 | 80.5 | 80.9 | 3.6 | .91 | .91 |
| Insects | 10.0 | 0.0 | 9.5 | 9.5 | 7.3 | .13 | .13 |
| Calanoid Copepods | 0.0 | 0.5 | 0.5 | 0.5 | 8.3 | -.89 | -.89 |
| Harpacticoid Copepods | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 1.00 | 1.00 |
| *Polysiphonia sp.* | 0.0 | 5.0 | 4.7 | -- | 0.0 | 1.00 | -- |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | -1.00 | -1.00 |
| Barnacles | 0.0 | 0.0 | 0.0 | 0.0 | 14.5 | -1.00 | -1.00 |
| *Hippolyte sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 14.5 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items

TABLE 16. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at Station 3. (Evening, 30 June 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Amphipods | 20.0 | 0.0 | 16.3 | 16.3 | 26.8 | -.24 | -.24 |
| Polychaetes | 82.0 | 10.0 | 75.1 | 75.1 | 0.0 | 1.00 | 1.00 |
| Insects | 5.0 | 0.0 | 4.1 | 4.1 | 12.5 | -.51 | -.51 |
| Brachyuran larva | 0.0 | 2.0 | 1.6 | 1.6 | 5.5 | -.55 | -.55 |
| Bivalves | 3.0 | 0.5 | 2.8 | 2.8 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 0.0 | 0.0 | 0.0 | 0.0 | 45.1 | -1.00 | -1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 10.1 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items

TABLE 17. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at Station 4. (Morning, 30 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 1.0 | 0.0 | 6.0 | -- | 0.0 | 1.00 | -- |
| Detritus | 5.8 | 0.0 | 34.3 | -- | 0.0 | 1.00 | -- |
| Amphipods | 0.0 | 2.0 | 11.9 | 20.0 | 15.6 | -.13 | .12 |
| Polychaetes | 8.0 | 0.0 | 47.8 | 80.0 | 0.0 | 1.00 | 1.00 |
| Fishes | 0.0 | 0.0 | 0.0 | 0.0 | 25.5 | -1.00 | -1.00 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 11.3 | -1.00 | -1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 36.9 | -1.00 | -1.00 |
| Eggs | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 18. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at Station 4. (Evening, 30 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 2.0 | 0.0 | 3.5 | -- | 0.0 | 1.00 | -- |
| Detritus | 13.8 | 0.0 | 24.0 | -- | 0.0 | 1.00 | -- |
| Polychaetes | 6.0 | 2.0 | 13.9 | 19.2 | 20.0 | -.18 | -.02 |
| Fishes | 0.0 | 30.0 | 52.2 | 71.9 | 0.0 | 1.00 | 1.00 |
| Insects | 0.0 | 1.0 | 1.7 | 2.4 | 20.0 | -.84 | -.79 |
| Harpacticoid Copepods | 0.2 | 0.0 | 0.3 | 0.5 | 0.0 | 1.00 | 1.00 |
| Bivalves | 2.5 | 0.0 | 4.3 | 6.0 | 35.0 | -.78 | -.71 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 17.5 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 19. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at all stations. (Mornings)

| ORGANISMS | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 1.0 | 0.0 | 0.7 | -- | 0.0 | 1.00 | -- |
| Detritus | 13.5 | 0.0 | 7.8 | -- | 0.0 | 1.00 | -- |
| Amphipods | 5.0 | 6.5 | 6.7 | 7.6 | 20.0 | -.50 | -.45 |
| Polychaetes | 114.0 | 5.0 | 69.4 | 78.2 | 1.2 | .97 | .97 |
| Fishes | 0.0 | 0.0 | 0.0 | 0.0 | 8.9 | -1.00 | -1.00 |
| Insects | 10.0 | 0.0 | 5.8 | 6.6 | 4.2 | .16 | .22 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 3.8 | -1.00 | -1.00 |
| *Polysiphonia sp.* | 0.0 | 5.0 | 2.9 | -- | 0.0 | 1.00 | -- |
| Calanoid Copepods | 0.0 | 11.5 | 6.7 | 7.6 | 37.4 | -.70 | -.67 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | -1.00 | -1.00 |
| Harpacticoid Copepods | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 | -1.00 | -1.00 |
| *Hippolyte sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 11.0 | -1.00 | -1.00 |
| Barnacles | 0.0 | 0.0 | 0.0 | 0.0 | 4.6 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | -1.00 | -1.00 |
| Eggs | 0.0 | 0.0 | 0.0 | 0.0 | 1.6 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 20. Food, plankton, and electivity co-efficient values for *Fundulus majalis* collected at all stations. (Evenings)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 24.0 | 0.0 | 10.7 | -- | 0.0 | 1.00 | -- |
| Detritus | 21.6 | 0.0 | 9.6 | -- | 0.0 | 1.00 | -- |
| Amphipods | 32.5 | 0.5 | 14.8 | 18.3 | 31.2 | -.36 | -.26 |
| Polychaetes | 92.0 | 12.0 | 46.6 | 57.6 | 9.2 | .67 | .72 |
| Fishes | 0.0 | 30.0 | 13.4 | 16.6 | 0.0 | 1.00 | 1.00 |
| Insects | 5.0 | 1.0 | 2.7 | 3.3 | 13.6 | -.67 | -.61 |
| Brachyuran larva | 0.0 | 2.0 | 0.7 | 1.0 | 4.3 | -.72 | -.62 |
| Mysids | 0.0 | 0.3 | 0.2 | 0.2 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.2 | 0.0 | 0.1 | 0.1 | 10.5 | -.98 | -.98 |
| Bivalves | 3.5 | 0.5 | 1.8 | 2.2 | 12.2 | -.74 | -.69 |
| Harpacticoid Copepods | 0.2 | 0.0 | 0.1 | 0.1 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 0.0 | 0.0 | 0.0 | 0.0 | 15.0 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | -1.00 | -1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | -1.00 | -1.00 |
| *Tubifex sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 21. Food, plankton, and electivity co-efficient values for all *Fundulus majalis* collected.

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| PDAM | 25.0 | 0.0 | 6.3 | -- | 0.0 | 1.00 | -- |
| Detritus | 31.4 | 0.0 | 7.9 | -- | 0.0 | 1.00 | -- |
| Amphipods | 37.5 | 7.0 | 11.2 | 13.2 | 25.8 | -.40 | -.32 |
| Polychaetes | 206.0 | 17.0 | 55.9 | 66.1 | 5.2 | .83 | .85 |
| Fishes | 0.0 | 30.0 | 7.5 | 8.9 | 4.4 | .26 | .34 |
| Insects | 15.0 | 1.0 | 4.0 | 4.7 | 8.9 | -.38 | -.31 |
| Brachyuran larva | 0.0 | 2.0 | 0.5 | 0.6 | 4.1 | -.71 | -.68 |
| *Polysiphonia sp.* | 0.0 | 5.0 | 1.3 | -- | 0.0 | 1.00 | -- |
| Mysids | 0.0 | 3.0 | 0.8 | 0.9 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.2 | 11.5 | 2.9 | 3.4 | 23.9 | -.78 | -.75 |
| Bivalves | 6.5 | 0.5 | 1.8 | 2.1 | 7.1 | -.60 | -.54 |
| Harpacticoid Copepods | 0.3 | 0.0 | 0.1 | 0.1 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 0.0 | 0.0 | 0.0 | 0.0 | 9.5 | -1.00 | -1.00 |
| *Hippolyte sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 5.5 | -1.00 | -1.00 |
| Barnacles | 0.0 | 0.0 | 0.0 | 0.0 | 2.4 | -1.00 | -1.00 |
| Isopods | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | -1.00 | -1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | -1.00 | -1.00 |
| Eggs | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | -1.00 | -1.00 |
| *Tubifex sp.* | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
PDAM = Partially Digested Animal Matter

TABLE 22. Food, plankton, and electivity co-efficient values for *Cyprinodon variegatus* collected at Station 2. (Morning, 30 June 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus | -- | 0.0 | 100.0 | -- | 0.0 | 1.00 | -- |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items

TABLE 23. Food, plankton, and electivity co-efficient values for *Cyprinodon variegatus* collected at Station 4. (Morning, 30 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus | 32.0 | 0.0 | 86.5 | -- | 0.0 | 1.00 | -- |
| Bivalves | 0.0 | 2.0 | 5.4 | 40.0 | 2.1 | .44 | .90 |
| Amphipods | 0.0 | 1.0 | 2.7 | 20.0 | 15.6 | -.70 | .12 |
| Calanoid Copepods | 0.0 | 1.0 | 2.7 | 20.0 | 36.9 | -.86 | -.30 |
| *Argulus sp.* | 0.0 | 1.0 | 2.7 | 20.0 | 0.0 | 1.00 | 1.00 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 11.3 | -1.00 | -1.00 |
| Fishes | 0.0 | 0.0 | 0.0 | 0.0 | 25.5 | -1.00 | -1.00 |
| Eggs | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items

TABLE 25. Food, plankton, and electivity co-efficient values for *Cyprinodon variegatus* collected at all stations. (Mornings)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus* | 70.6 | 0.0 | 93.2 | -- | 0.0 | 1.00 | -- |
| Amphipods | 0.0 | 1.0 | 1.3 | 20.0 | 12.7 | -.81 | .22 |
| *Palaemonetes pugio* | 0.0 | 0.0 | 0.0 | 0.0 | 23.8 | -1.00 | -1.00 |
| Fishes | 0.0 | 0.0 | 0.0 | 0.0 | 12.8 | -1.00 | -1.00 |
| Bivalves | 0.0 | 2.0 | 2.7 | 40.0 | 2.2 | .10 | .90 |
| *Argulus sp.* | 0.0 | 1.0 | 1.3 | 20.0 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.0 | 1.0 | 1.3 | 20.0 | 27.6 | -.91 | -.16 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 10.2 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 5.6 | -1.00 | -1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 2.9 | -1.00 | -1.00 |
| Eggs | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
* = estimated value which includes Station 2

TABLE 26. Food, plankton, and electivity co-efficient values for *Cyprinodon variegatus* collected at all stations. (Evenings)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus | 60.0 | 0.0 | 58.3 | -- | 0.0 | 1.00 | -- |
| Polychaetes | 0.0 | 1.0 | 1.0 | 2.3 | 20.0 | -.90 | -.79 |
| *Palaemonetes pugio* | 0.0 | 20.0 | 19.4 | 46.5 | 0.0 | 1.00 | 1.00 |
| Fishes | 0.0 | 22.0 | 21.4 | 51.2 | 0.0 | 1.00 | 1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | -1.00 | -1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 17.5 | -1.00 | -1.00 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items

TABLE 27. Food, plankton, and electivity co-efficient values for all *Cyprinodon variegatus* collected.

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus* | 250.0 | 0.0 | 81.6 | -- | 0.0 | 1.00 | -- |
| Amphipods | 0.0 | 1.0 | 0.9 | 2.1 | 8.5 | -.81 | -.60 |
| Polychaetes | 0.0 | 1.0 | 0.9 | 2.1 | 6.7 | -.91 | -.52 |
| *Palaemonetes pugio* | 0.0 | 20.0 | 6.5 | 41.7 | 15.9 | -.42 | .45 |
| Fishes | 0.0 | 22.0 | 7.1 | 45.8 | 8.5 | -.09 | .68 |
| Bivalves | 0.0 | 2.0 | 1.8 | 4.2 | 13.1 | -.76 | -.51 |
| *Argulus sp.* | 0.0 | 1.0 | 0.9 | 2.1 | 0.0 | 1.00 | 1.00 |
| Calanoid Copepods | 0.0 | 1.0 | 0.9 | 2.1 | 24.3 | -.93 | -.84 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 13.5 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 6.3 | -1.00 | -1.00 |
| Spiders | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | -1.00 | -1.00 |
| Eggs | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items
* = estimated value which includes Station 2

TABLE 24. Food, plankton, and electivity co-efficient values for *Cyprinodon variegatus* collected at Station 4. (Evening, 30 July 1973)

| ORGANISM | FOOD | | | | ENVIRONMENT | ELECTIVITIES | |
|---|---|---|---|---|---|---|---|
| | stomach | RFI | %Σ | adj. %Σ | %Σ | E | adj. E |
| Detritus | 60.0 | 0.0 | 58.3 | -- | 0.0 | 1.00 | -- |
| Polychaetes | 0.0 | 1.0 | 1.0 | 2.3 | 20.0 | -.90 | -.79 |
| Fishes | 0.0 | 22.0 | 21.4 | 51.2 | 0.0 | 1.00 | 1.00 |
| *Palaemonetes pugio* | 0.0 | 20.0 | 19.4 | 46.5 | 0.0 | 1.00 | 1.00 |
| Insects | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | -1.00 | -1.00 |
| Bivalves | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | -1.00 | -1.00 |
| Calanoid Copepods | 0.0 | 0.0 | 0.0 | 0.0 | 17.5 | -1.00 | -1.00 |
| Brachyuran larva | 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | -1.00 | -1.00 |

Numerical food values given in amphipod units
RFI = Regurgitated Food Items

Figure 1. Sampling site locations. Approximate latitude 76° 5.55' W, approximate longitude 36° 54.5' N.

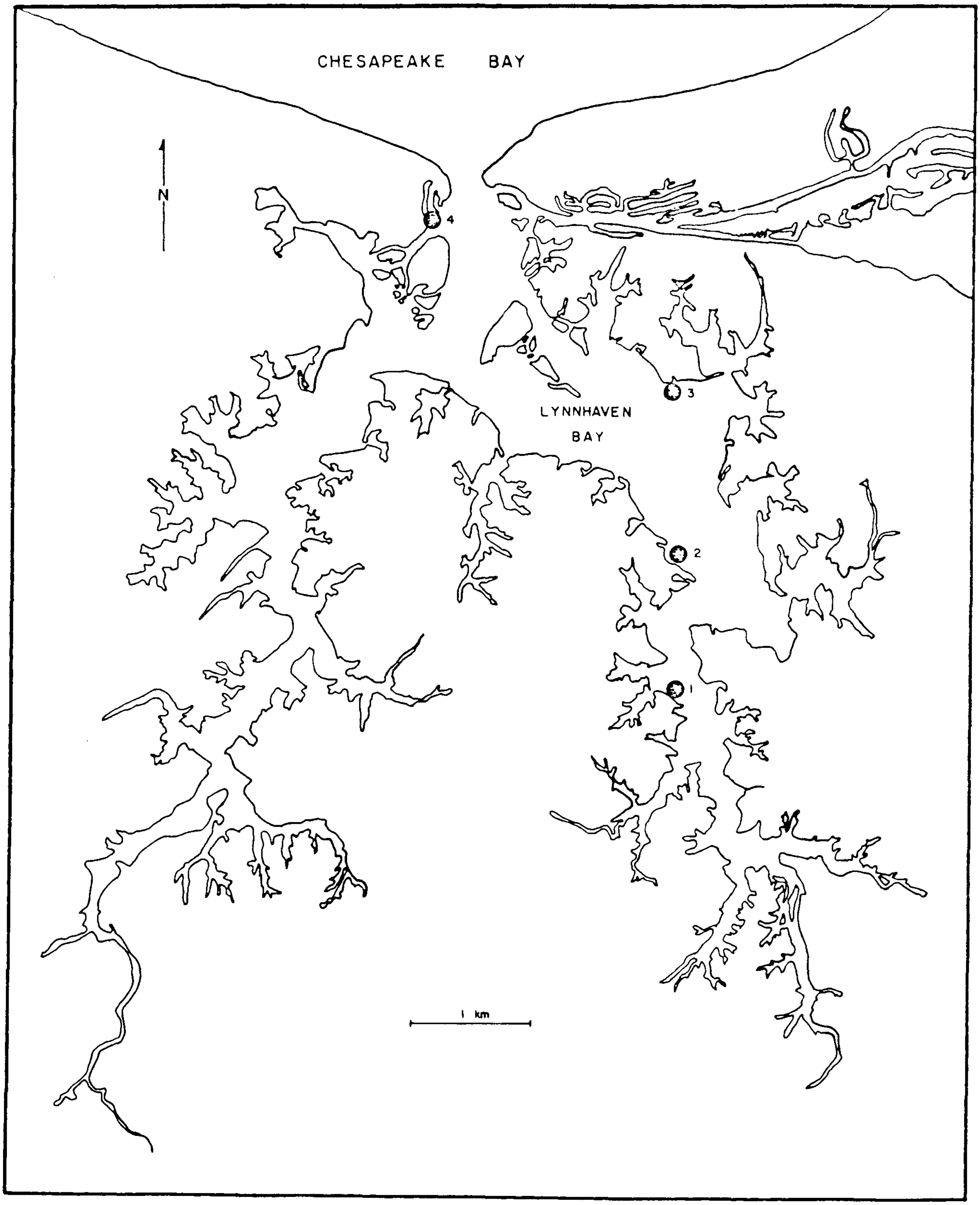
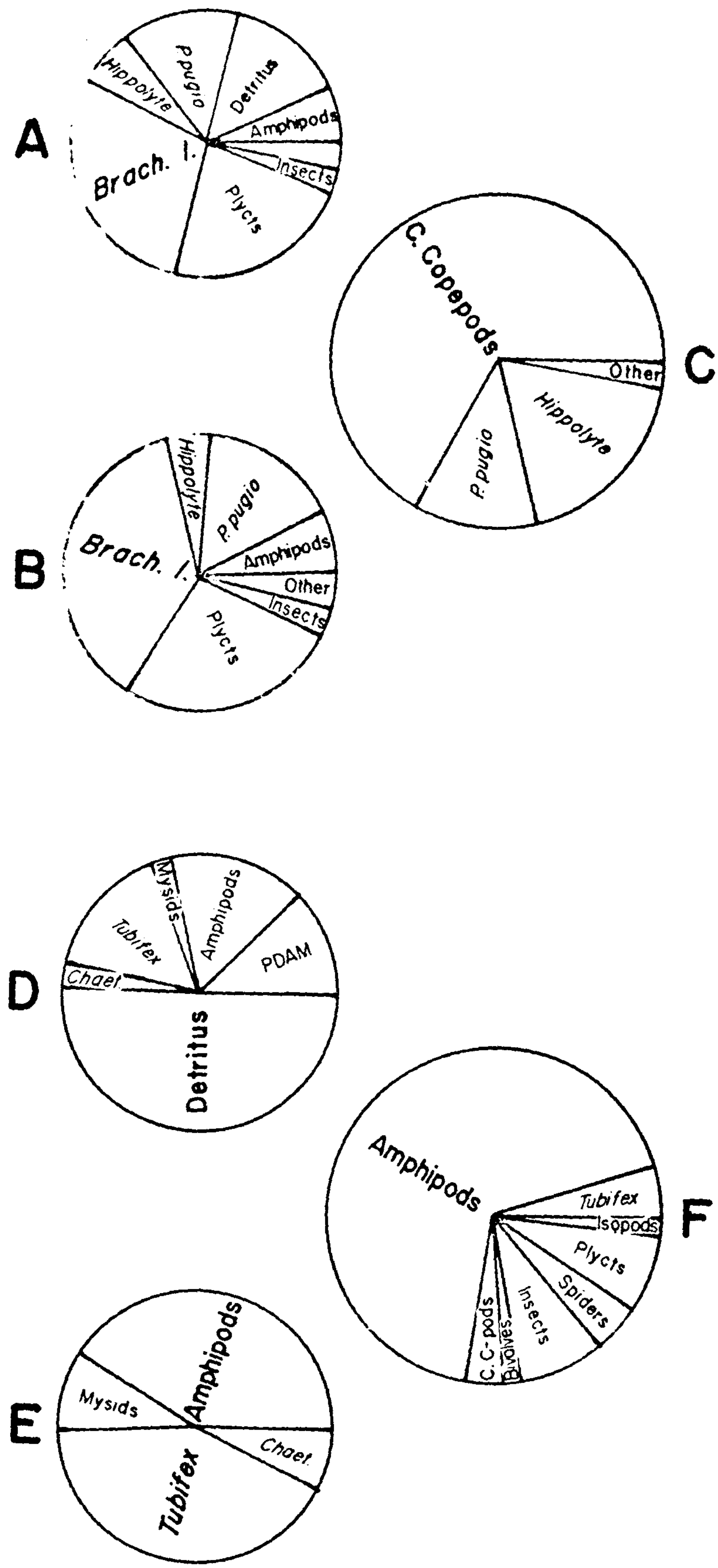
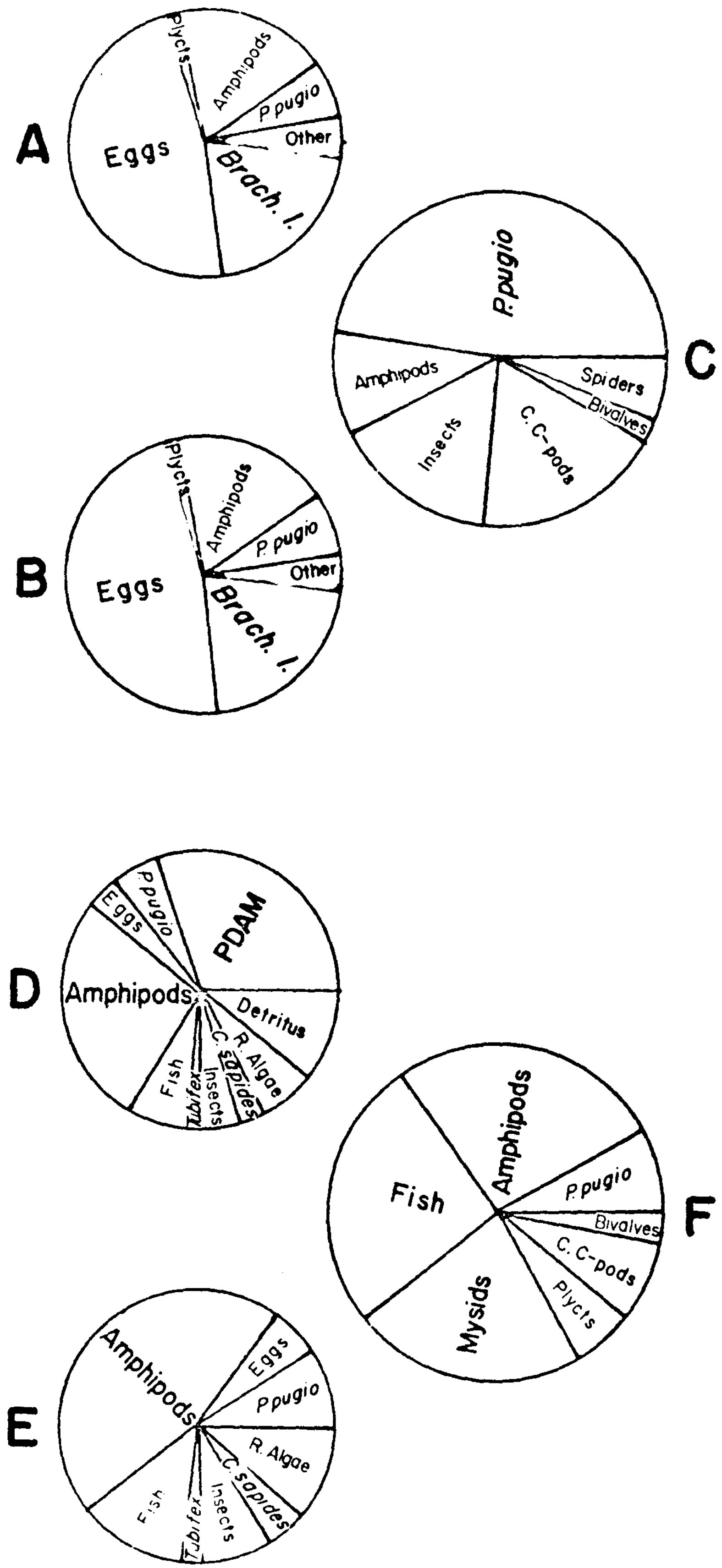

CHESAPEAKE BAY
N
4
3
LYNNHAVEN
BAY
2
1
1 km

Figure 2. Ration, adjusted ration, and available food for *Fundulus heteroclitus* collected at Station 1. (Morning: 16 July 1973, Evening: 14 June 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening



A
Hippolyte
P. pugio
Detritus
Amphipods
Brach. l.
Insects
Plycts
B
Hippolyte
P. pugio
Brach. l.
Amphipods
Other
Insects
Plycts
C
C. Copepods
Other
Hippolyte
P. pugio
D
Mysids
Tubifex
Amphipods
PDAM
Chaet.
Detritus
E
Amphipods
Mysids
Chaet.
Tubifex
F
Amphipods
Tubifex
Isopods
Plycts
Spiders
Insects
C. C-pods
Bivalves

Figure 3. Ration, adjusted ration, and available food for *Fundulus heteroclitus* collected at Station 2. (Morning: 30 June 1973, Evening: 15 June 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening.



A
Plycts
Amphipods
P. pugio
Other
Eggs
Brach. l.
B
Plycts
Amphipods
P. pugio
Other
Eggs
Brach. l.
C
P. pugio
Amphipods
Spiders
Bivalves
Insects
C. C-pods
D
P. pugio
Eggs
PDAM
Amphipods
Detritus
R. Algae
C. sapides
Insects
Tubifex
Fish
E
Amphipods
Eggs
P. pugio
R. Algae
C. sapides
Insects
Tubifex
Fish
F
Amphipods
Fish
P. pugio
Bivalves
C. C-pods
Plycts
Mysids

Figure 4. Ration, adjusted ration, and available food for *Fundulus heteroclitus* collected at Station 3. (Morning: 1 July 1973, Evening: 30 June 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening.

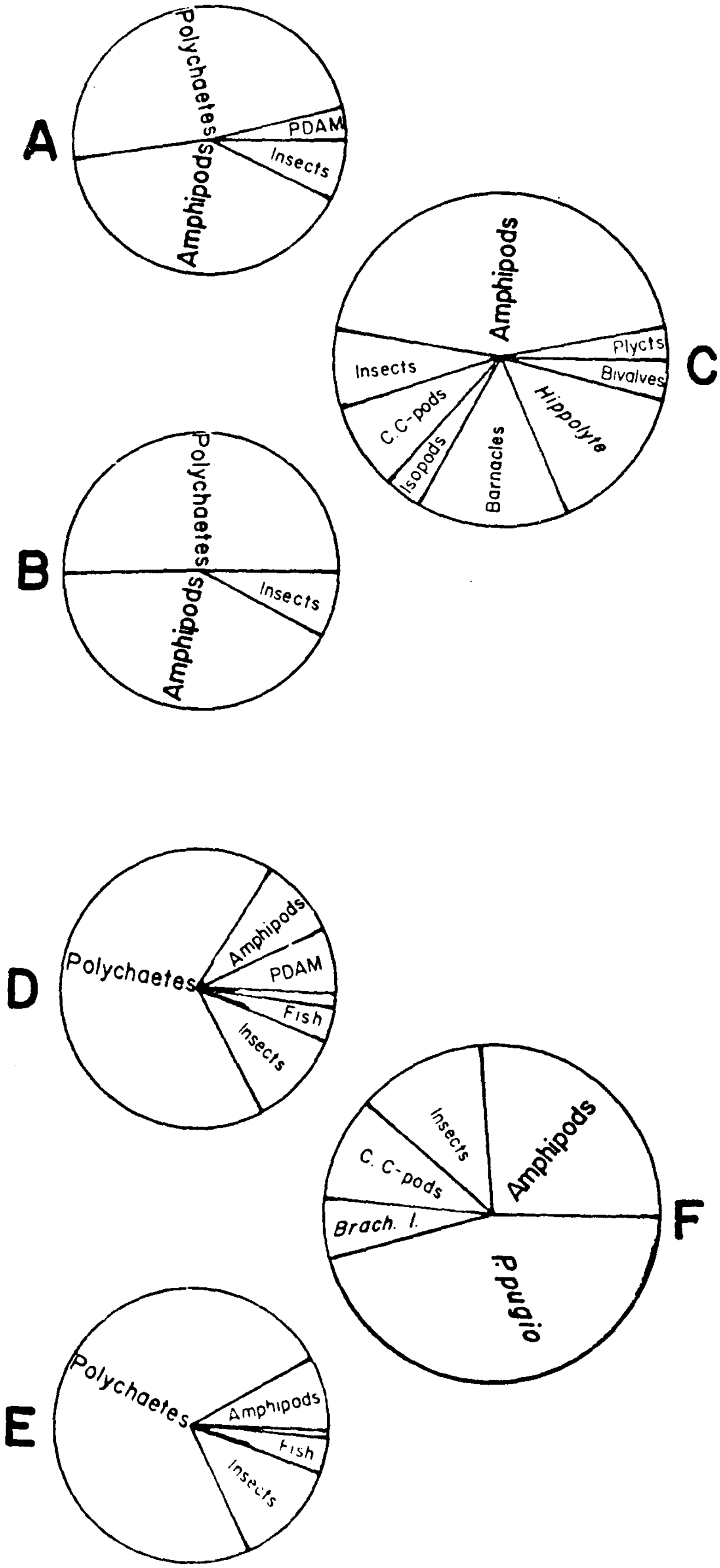

A
Polychaetes
PDAM
Insects
Amphipods
B
Polychaetes
Insects
Amphipods
C
Amphipods
Plycts
Bivalves
Hippolyte
Barnacles
Isopods
C.C-pods
Insects
D
Polychaetes
Amphipods
PDAM
Fish
Insects
E
Polychaetes
Amphipods
Fish
Insects
F
Insects
Amphipods
C. C-pods
Brach. l.
P.pugio

Figure 5. Ration, adjusted ration, and available food for *Fundulus heteroclitus* collected at Station 4. (Morning: 30 July 1973, Evening: 30 July 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening.

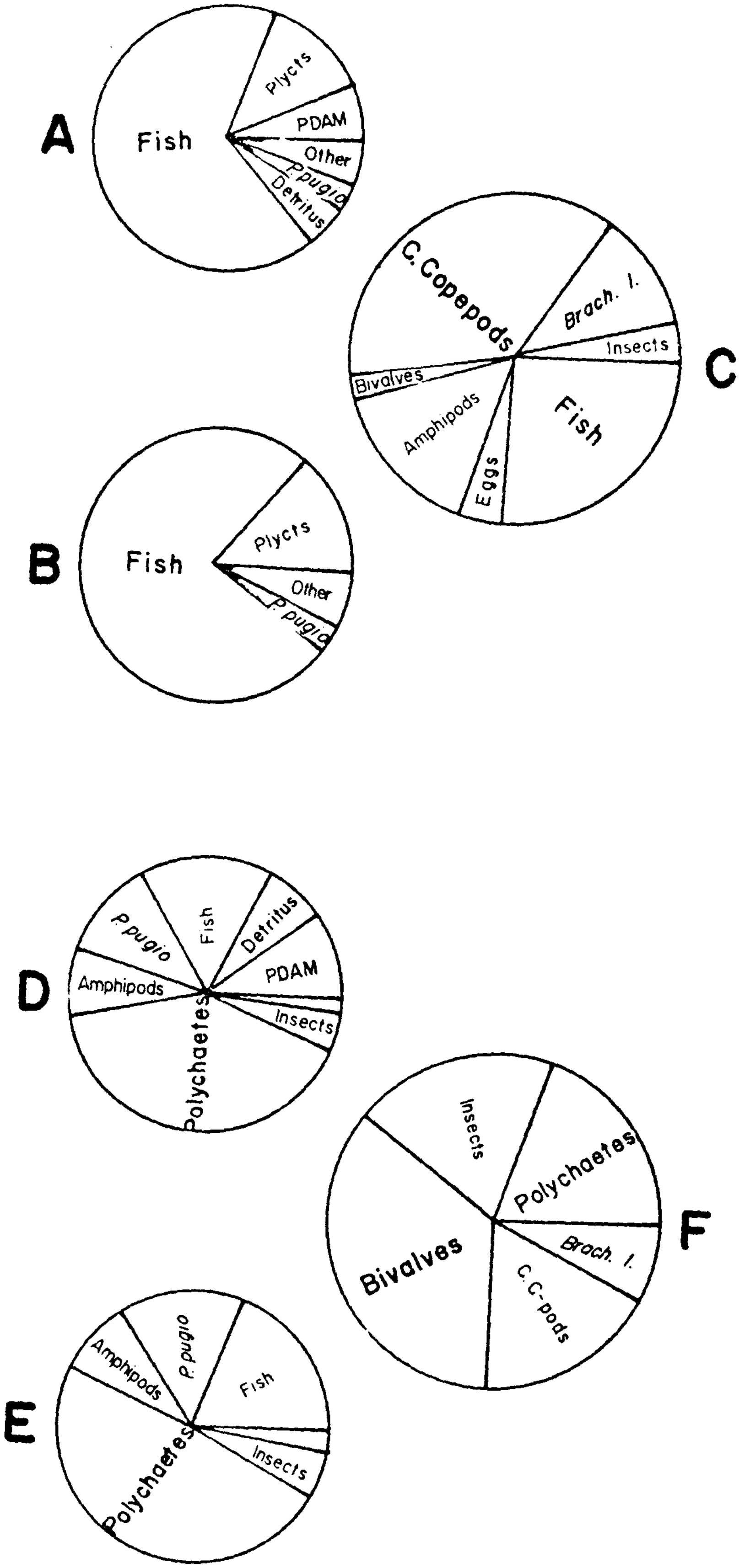

A
Fish
Plycts
PDAM
Other
P. pugio
Detritus
B
Fish
Plycts
Other
P. pugio
C
C. Copepods
Brach. l.
Insects
Fish
Eggs
Amphipods
Bivalves
D
Fish
Detritus
PDAM
Insects
Polychaetes
Amphipods
P. pugio
E
P. pugio
Fish
Insects
Polychaetes
Amphipods
F
Insects
Polychaetes
Brach. l.
C. C-pods
Bivalves

Figure 6. Ration, adjusted ration, and available food for *Fundulus heteroclitus* collected at all stations combined. A - Ration for mornings. B - Adjusted ration for mornings. C - Available food for mornings. D - Ration for evenings. E - Adjusted ration for evenings. F - Available food for evenings.

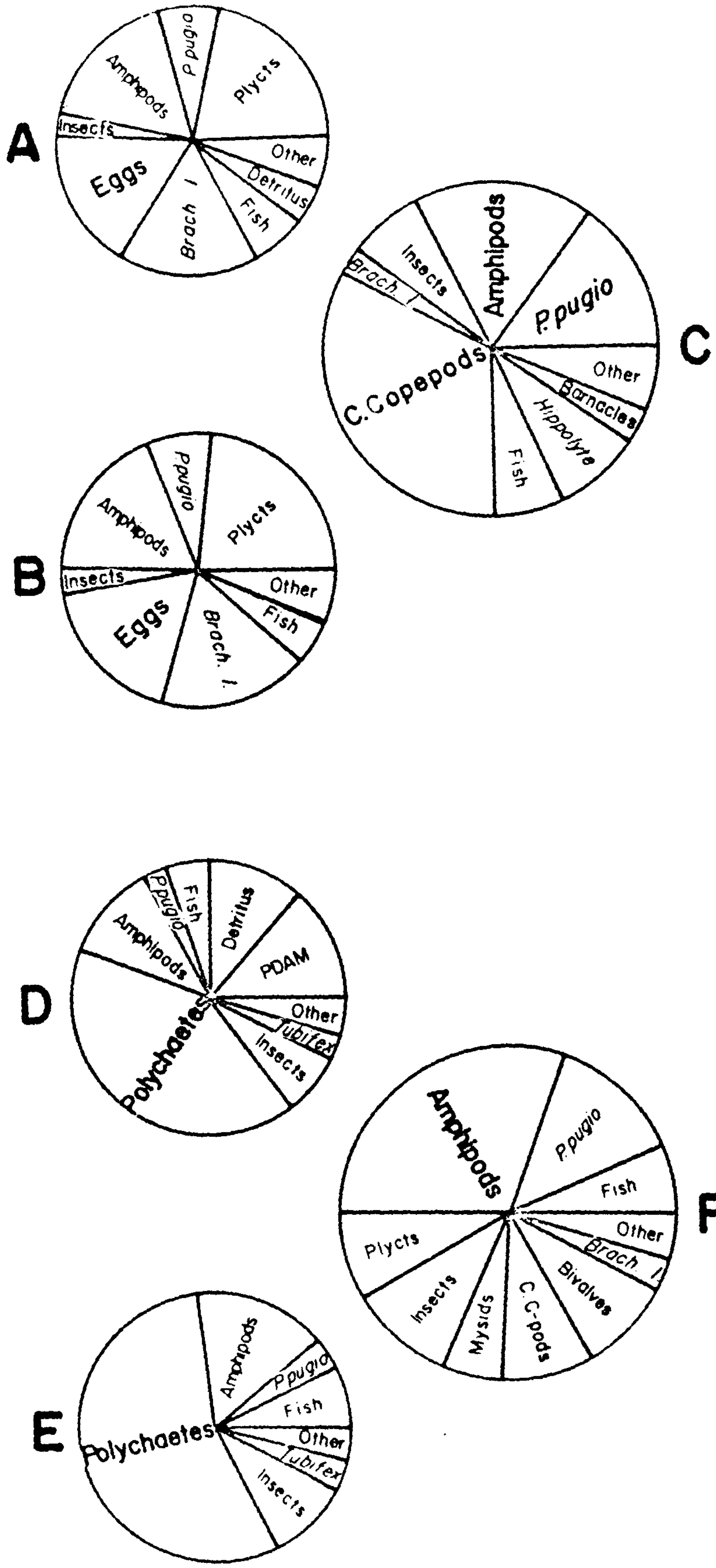

A
P. pugio
Plycts
Amphipods
Insects
Other
Detritus
Eggs
Brach. l
Fish
C
Amphipods
Insects
Brach. l
P. pugio
Other
Barnacles
Hippolyte
C. Copepods
Fish
B
Ppugio
Plycts
Amphipods
Insects
Other
Fish
Eggs
Broch. l.
D
Fish
P. pugio
Detritus
Amphipods
PDAM
Other
Tubifex
Insects
Polychaetes
F
Amphipods
P. pugio
Fish
Other
Brach. l
Plycts
Bivalves
Insects
Mysids
C. C-pods
E
Amphipods
P. pugio
Fish
Polychaetes
Other
Tubifex
Insects

Figure 7. Ration, adjusted ration, and available food for all *Fundulus heteroclitus* collected. A - Ration. B - Adjusted ration. C - Available food.

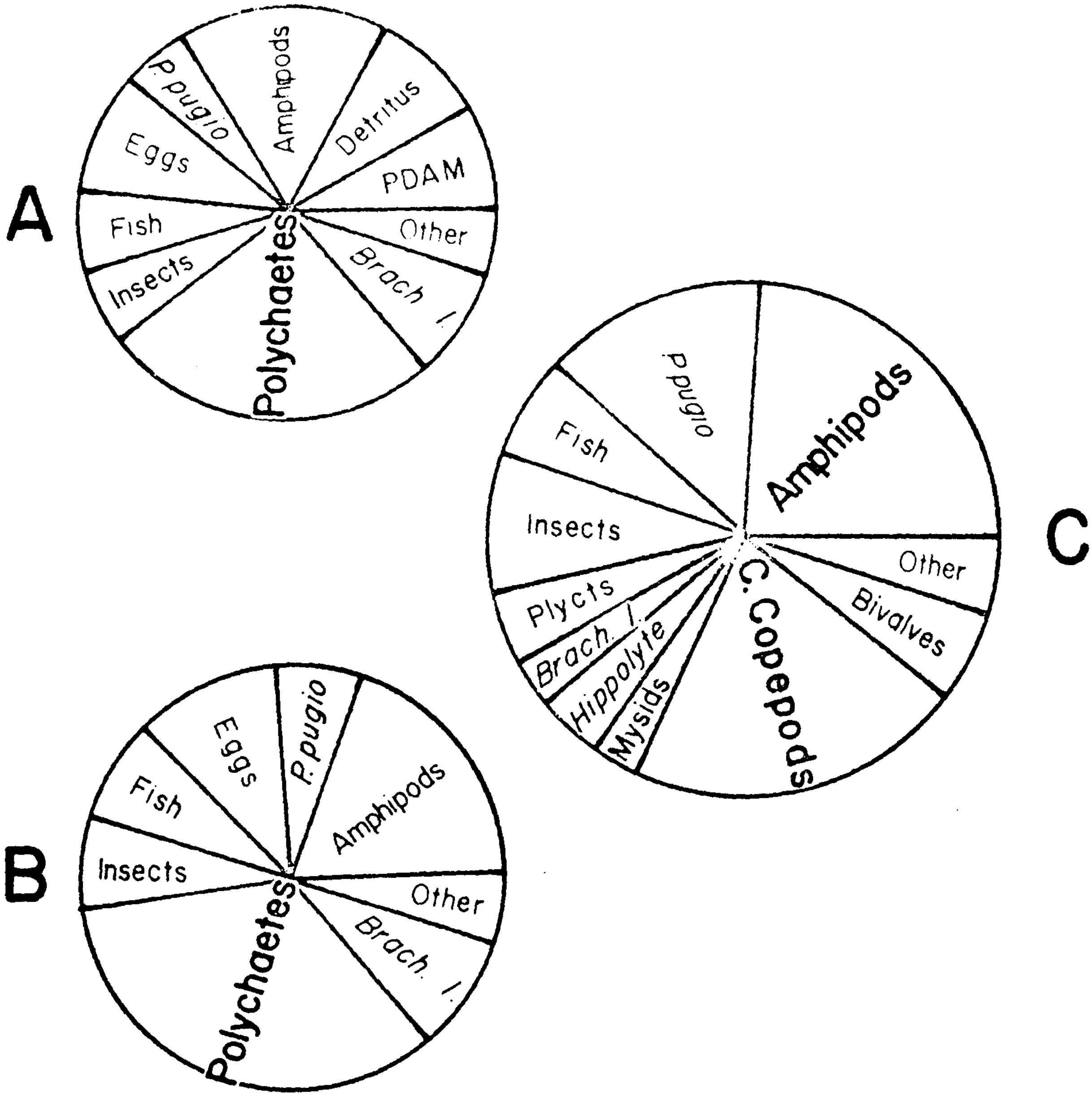
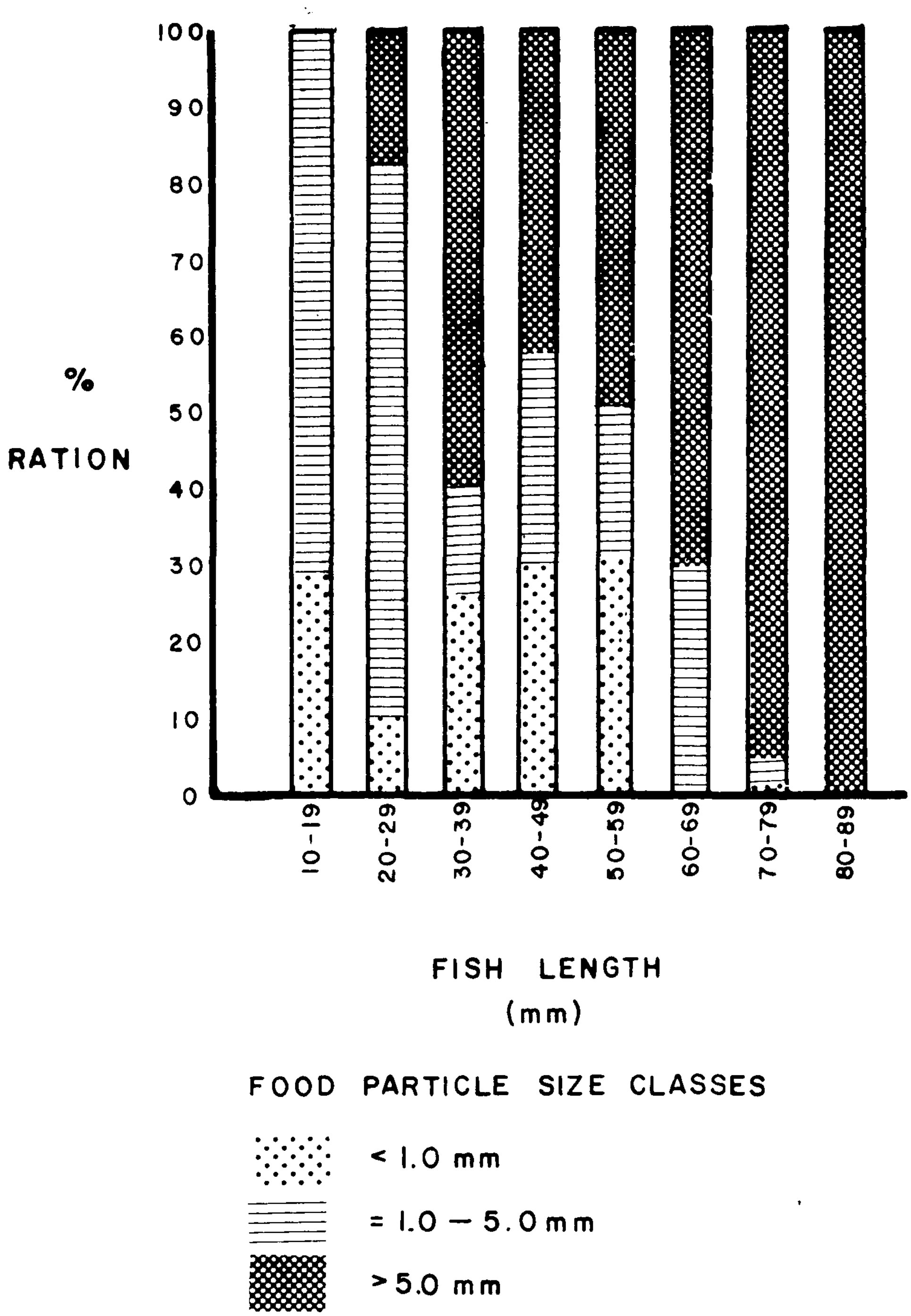

A
P. pugio
Amphipods
Detritus
Eggs
PDAM
Fish
Other
Insects
Brach. l.
Polychaetes
C
P. pugio
Amphipods
Fish
Insects
Other
Plycts
Bivalves
Brach. l.
Hippolyte
Mysids
C. Copepods
B
Eggs
P. pugio
Fish
Amphipods
Insects
Other
Brach. l.
Polychaetes

Figure 8. *Fundulus heteroclitus* -- standard length of fishes as compared to ingested food particle sizes.



100
90
80
70
60
50
40
30
20
10
0
%
RATION
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
FISH LENGTH
(mm)
FOOD PARTICLE SIZE CLASSES
< 1.0 mm
= 1.0 — 5.0 mm
> 5.0 mm

Table 9. Ration, adjusted ration, and available food for *Fundulus majalis* collected at Station 1. (Morning: 16 July 1973, Evening: 14 June 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening.

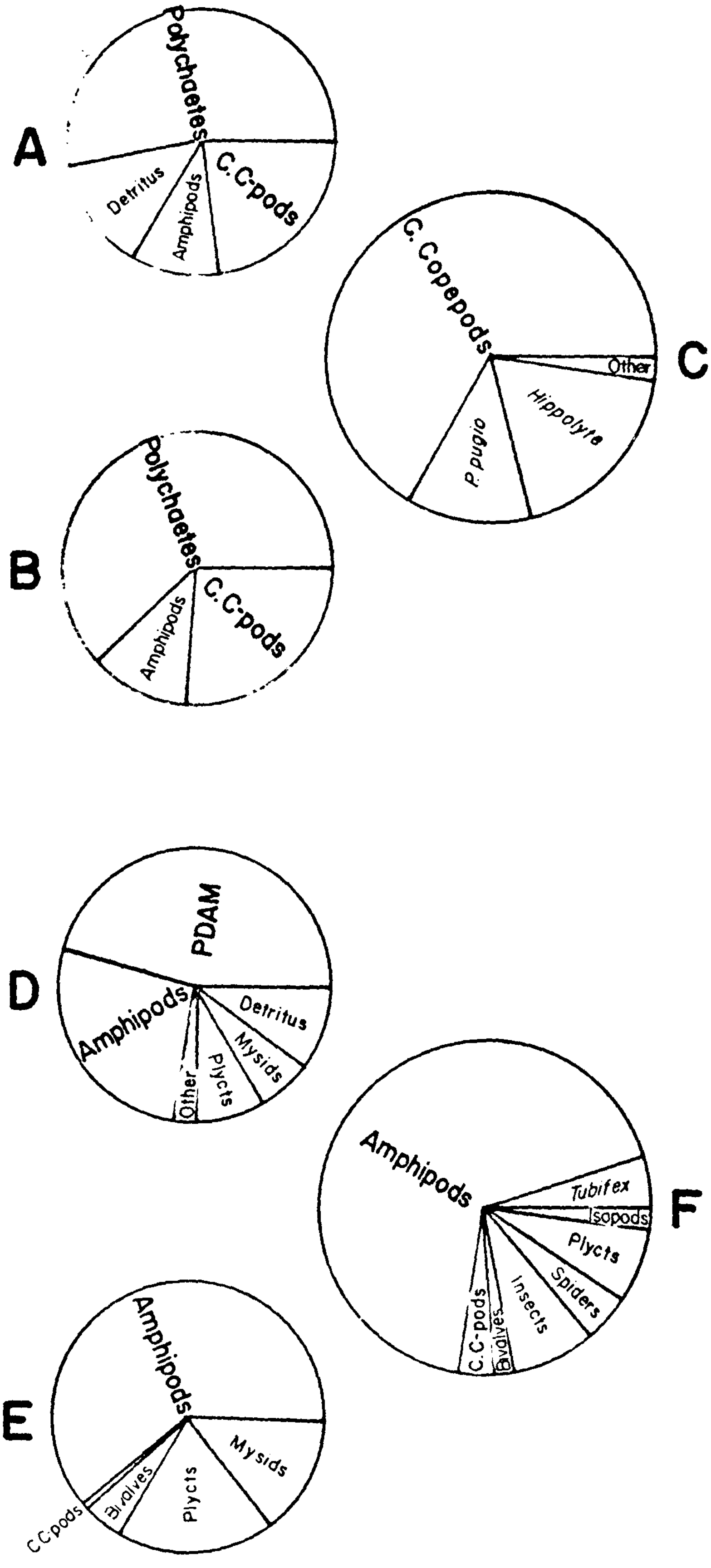

A
Polychaetes
Detritus
Amphipods
C.C-pods
B
Polychaetes
Amphipods
C.C-pods
C
C. Copepods
Other
Hippolyte
P. pugio
D
PDAM
Amphipods
Detritus
Mysids
Plycts
Other
E
Amphipods
Mysids
Plycts
Bivalves
CC-pods
F
Amphipods
Tubifex
Isopods
Plycts
Spiders
Insects
Bivalves
C.C-pods

Figure 10. Ration, adjusted ration, and available food for *Fundulus majalis* collected at Station 3. (Morning: 1 July 1973, Evening: 30 June 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening.

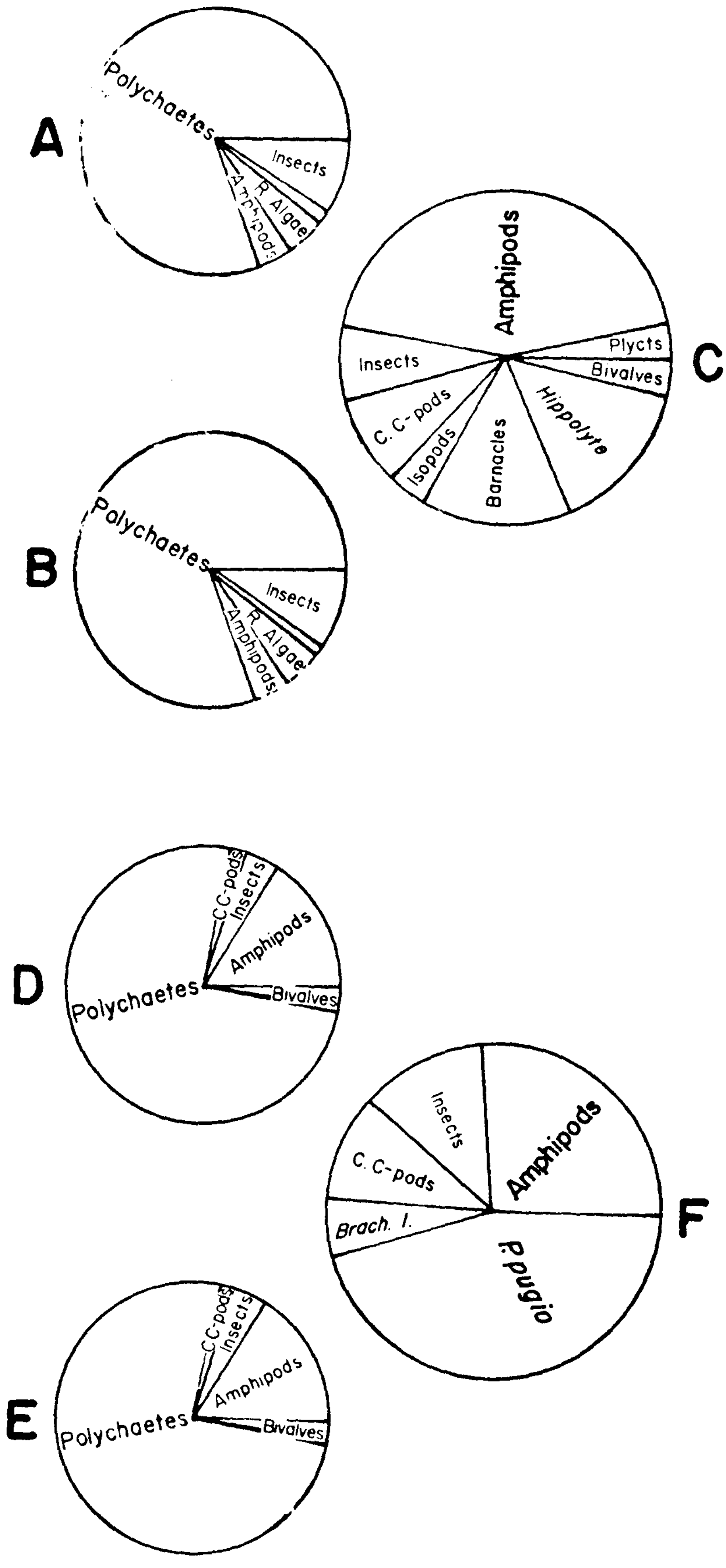

A
Polychaetes
Insects
R. Algae
Amphipods
B
Polychaetes
Insects
R. Algae
Amphipods
C
Amphipods
Plycts
Bivalves
Hippolyte
Barnacles
Isopods
C. C-pods
Insects
D
Polychaetes
C.C-pods
Insects
Amphipods
Bivalves
E
Polychaetes
C.C-pods
Insects
Amphipods
Bivalves
F
Amphipods
Insects
C. C-pods
Brach. l.
P. pugio

Figure 11. Ration, adjusted ration, and available food for *Fundulus majalis* collected at Station 4. (Morning: 30 July 1973, Evening: 30 July 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening

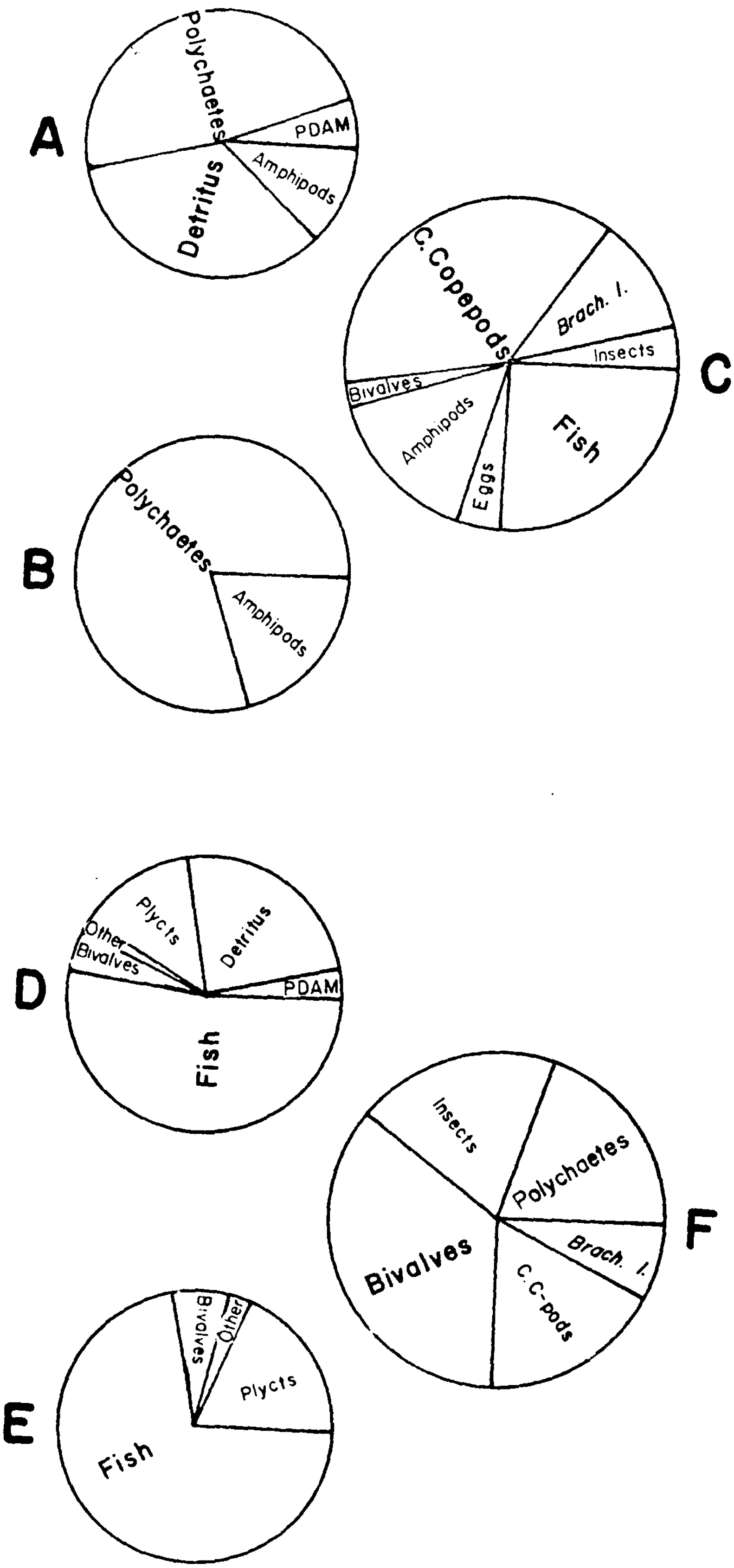
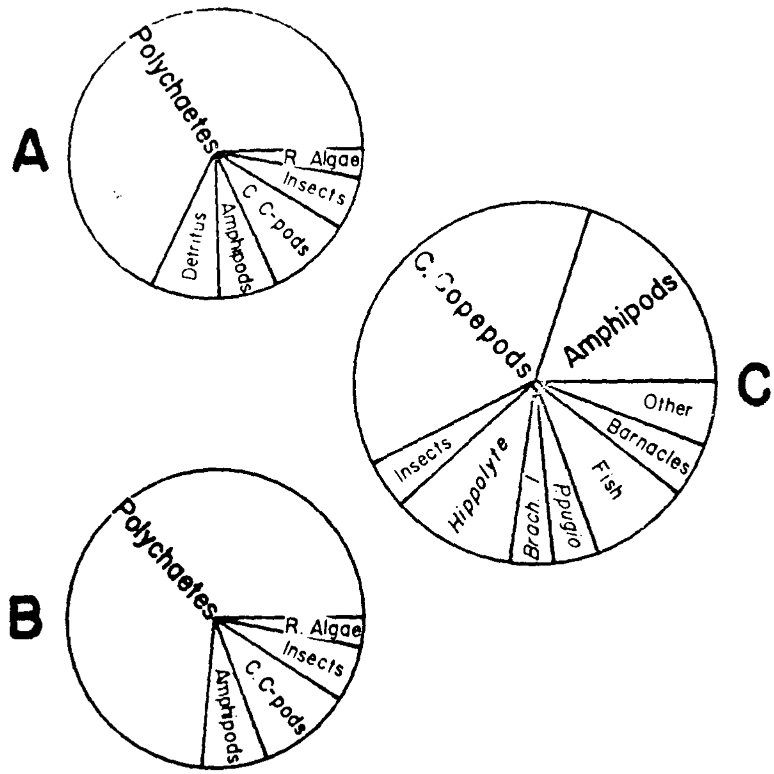

A
Polychaetes
PDAM
Amphipods
Detritus
C
C.Copepods
Brach. l.
Insects
Fish
Eggs
Amphipods
Bivalves
B
Polychaetes
Amphipods
D
Plycts
Detritus
Other
Bivalves
PDAM
Fish
F
Insects
Polychaetes
Brach. l.
C.C-pods
Bivalves
E
Bivalves
Other
Plycts
Fish

Figure 12. Ration, adjusted ration, and available food for *Fundulus majalis* collected at all stations combined. A - Ration for mornings. B - Adjusted ration for mornings. C - Available food for mornings. D - Ration for evenings. E - Adjusted ration for evenings. F - Available food for evenings.


A
Polychaetes
R. Algae
Insects
C. C-pods
Amphipods
Detritus
B
Polychaetes
R. Algae
Insects
C.C-pods
Amphipods
C
Copepods
Amphipods
Other
Barnacles
Fish
P.pugio
Brach.
Hippolyte
Insects

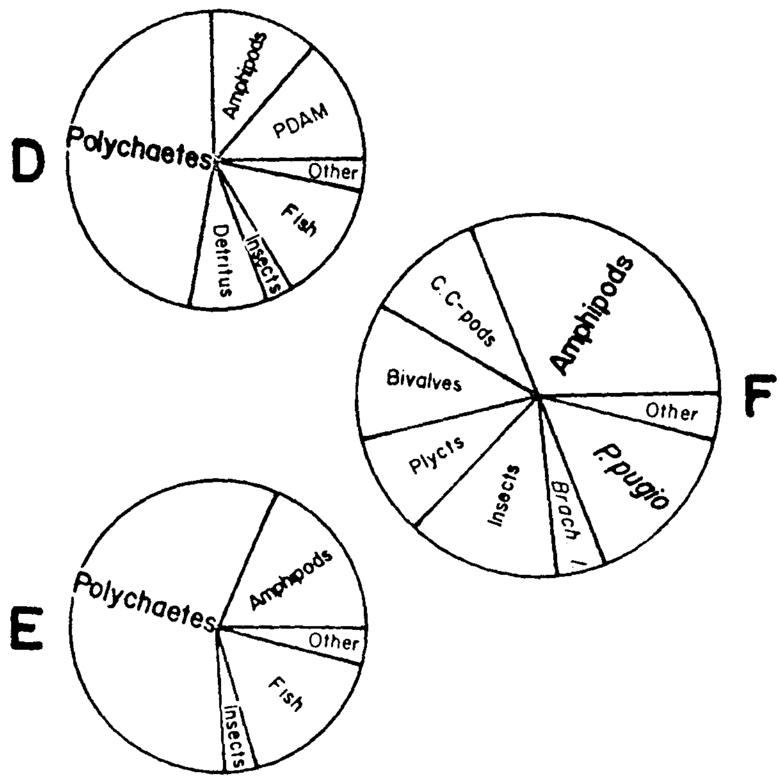

D
Polychaetes
Amphipods
PDAM
Other
Fish
Insects
Detritus
E
Polychaetes
Amphipods
Other
Fish
Insects
F
Amphipods
Other
P.pugio
Brach.
Insects
Plycts
Bivalves
C.C-pods

Figure 13. Ration, adjusted ration, and available food for all *Fundulus majalis* collected. A - Ration. B - Adjusted ration. C - Available food.

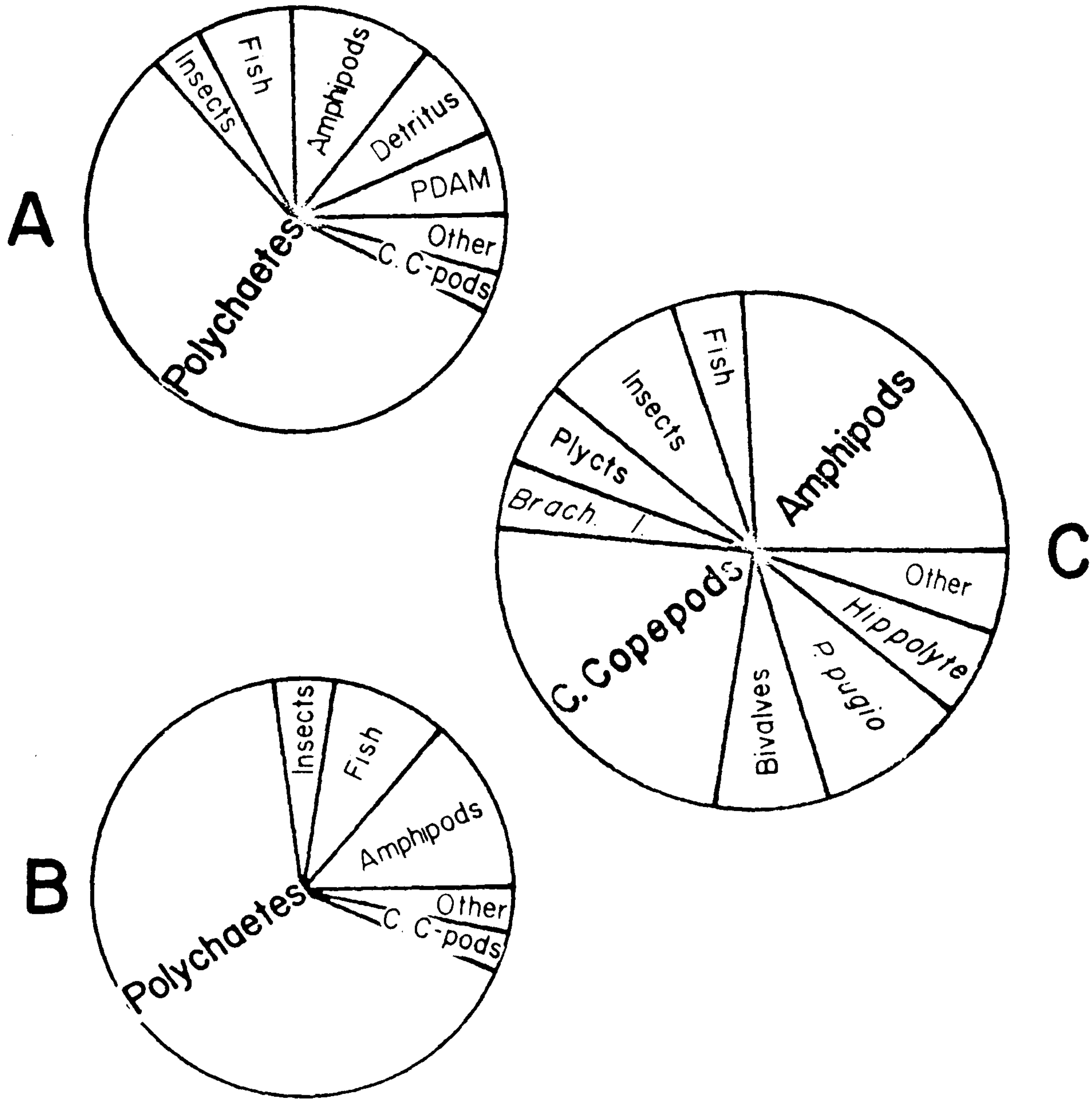

A
Insects
Fish
Amphipods
Detritus
PDAM
Other
C. C-pods
Polychaetes
B
Insects
Fish
Amphipods
Other
C. C-pods
Polychaetes
C
Fish
Insects
Amphipods
Plycts
Brach. l.
Other
Hippolyte
P. pugio
Bivalves
C. Copepods

Figure 14. Ration, adjusted ration, and available food of all *Fundulus heteroclitus* collected compared to the ration, adjusted ration, and available food of all *Fundulus majalis* collected. A - Ration of *F. heteroclitus*. B - Adjusted ration of *F. heteroclitus*. C - Available food for *F. heteroclitus*. D - Ration of *F. majalis*. E - Adjusted ration of *F. majalis*. F - Available for for *F. majalis*.

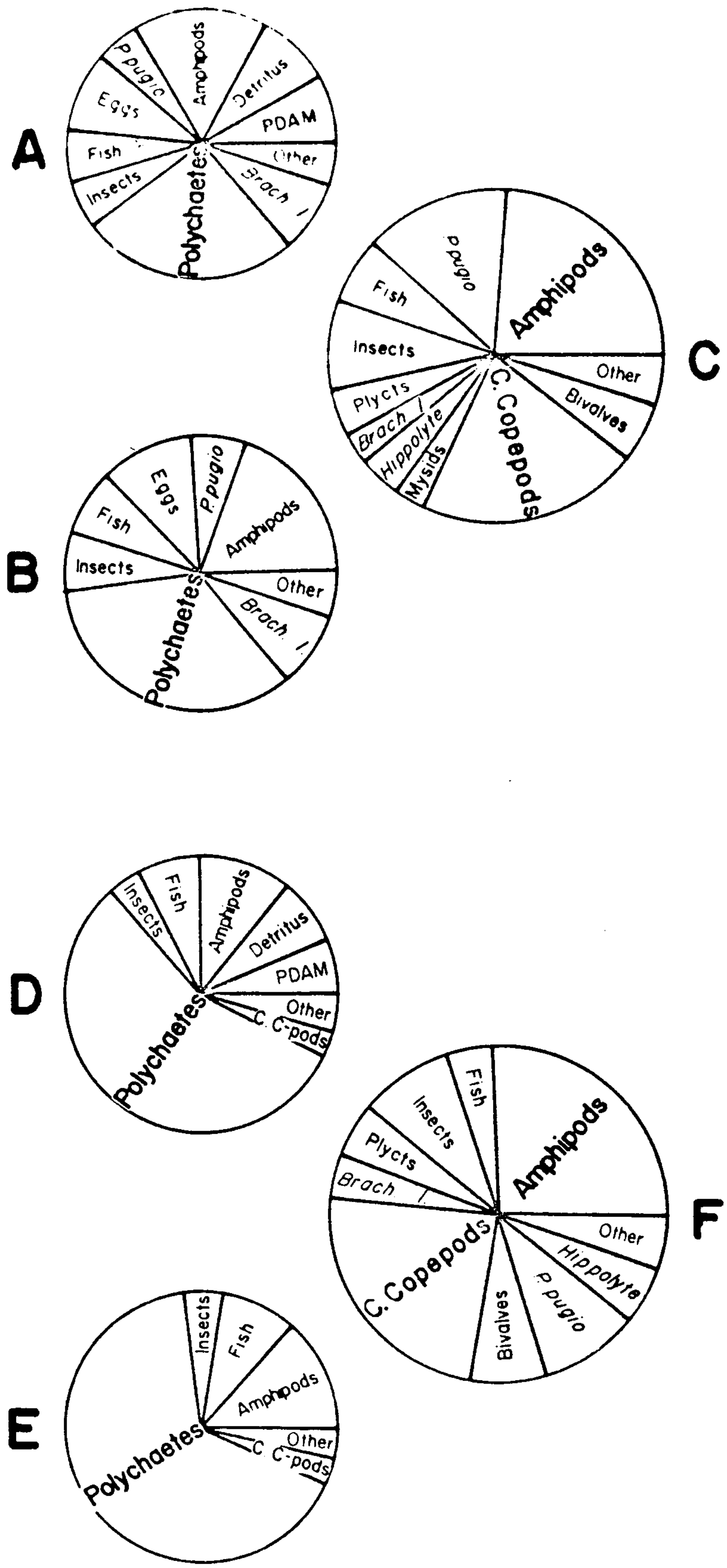

A
P. pugio
Amphipods
Detritus
PDAM
Other
Brach. l.
Polychaetes
Insects
Fish
Eggs
C
P. pugio
Amphipods
Other
Bivalves
C. Copepods
Mysids
Hippolyte
Brach. l.
Plycts
Insects
Fish
B
Eggs
P. pugio
Amphipods
Other
Brach. l.
Polychaetes
Insects
Fish
D
Fish
Amphipods
Detritus
PDAM
Other
C. C-pods
Polychaetes
Insects
F
Fish
Amphipods
Other
Hippolyte
P. pugio
Bivalves
C. Copepods
Brach. l.
Plycts
Insects
E
Insects
Fish
Amphipods
Other
C. C-pods
Polychaetes

Figure 15. Ration, adjusted ration, and available food for *Cyprinodon variegatus* collected at Station 2. (Morning only: 30 June 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning.

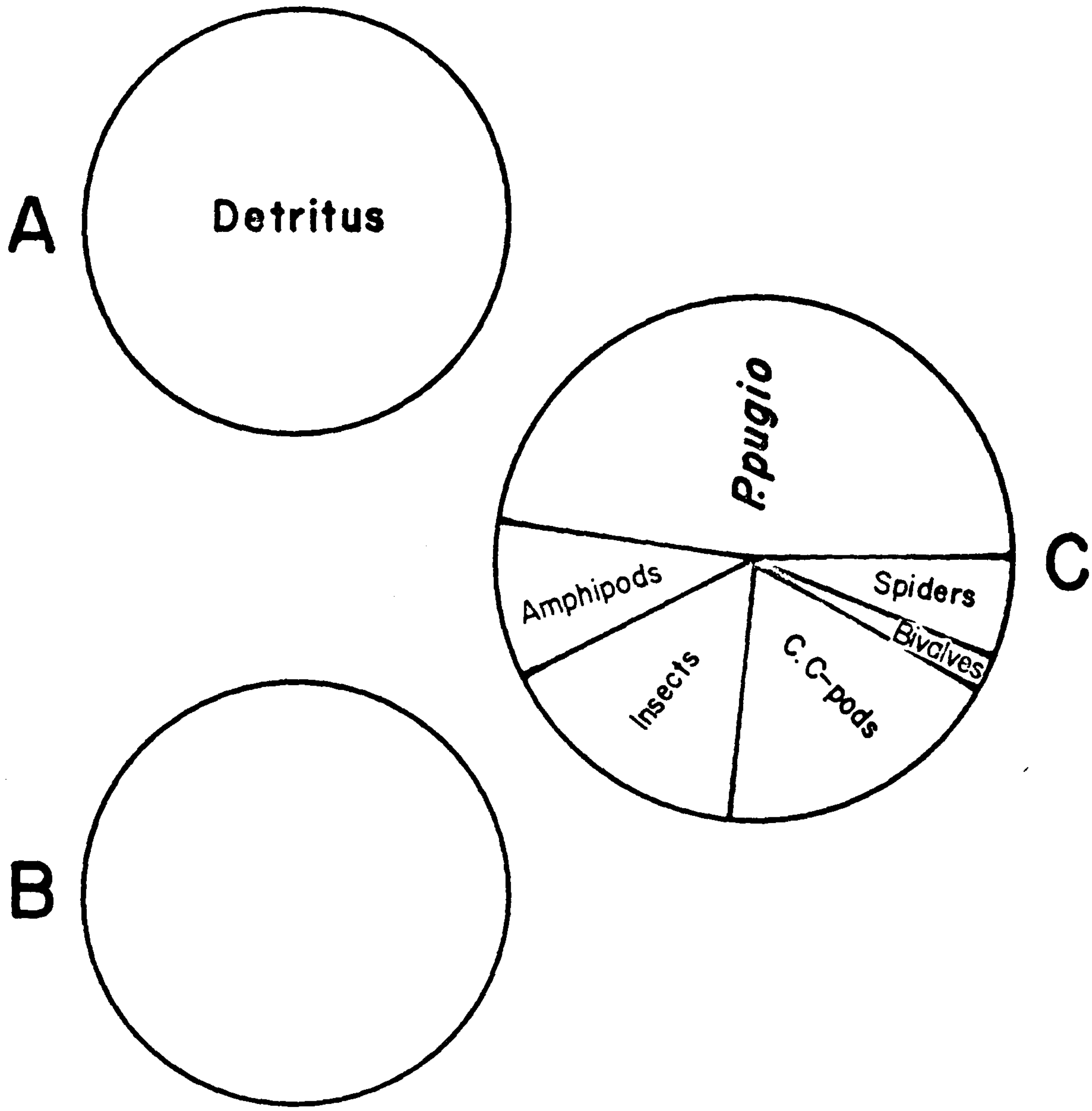

A
Detritus
B
P.pugio
Amphipods
Insects
C.C-pods
Bivalves
Spiders
C

Figure 16. Ration, adjusted ration, and available food for *Cyprinodon variegatus* collected at Station 4. (Morning: 30 July 1973, Evening: 30 July 1973) A - Ration for morning. B - Adjusted ration for morning. C - Available food for morning. D - Ration for evening. E - Adjusted ration for evening. F - Available food for evening.

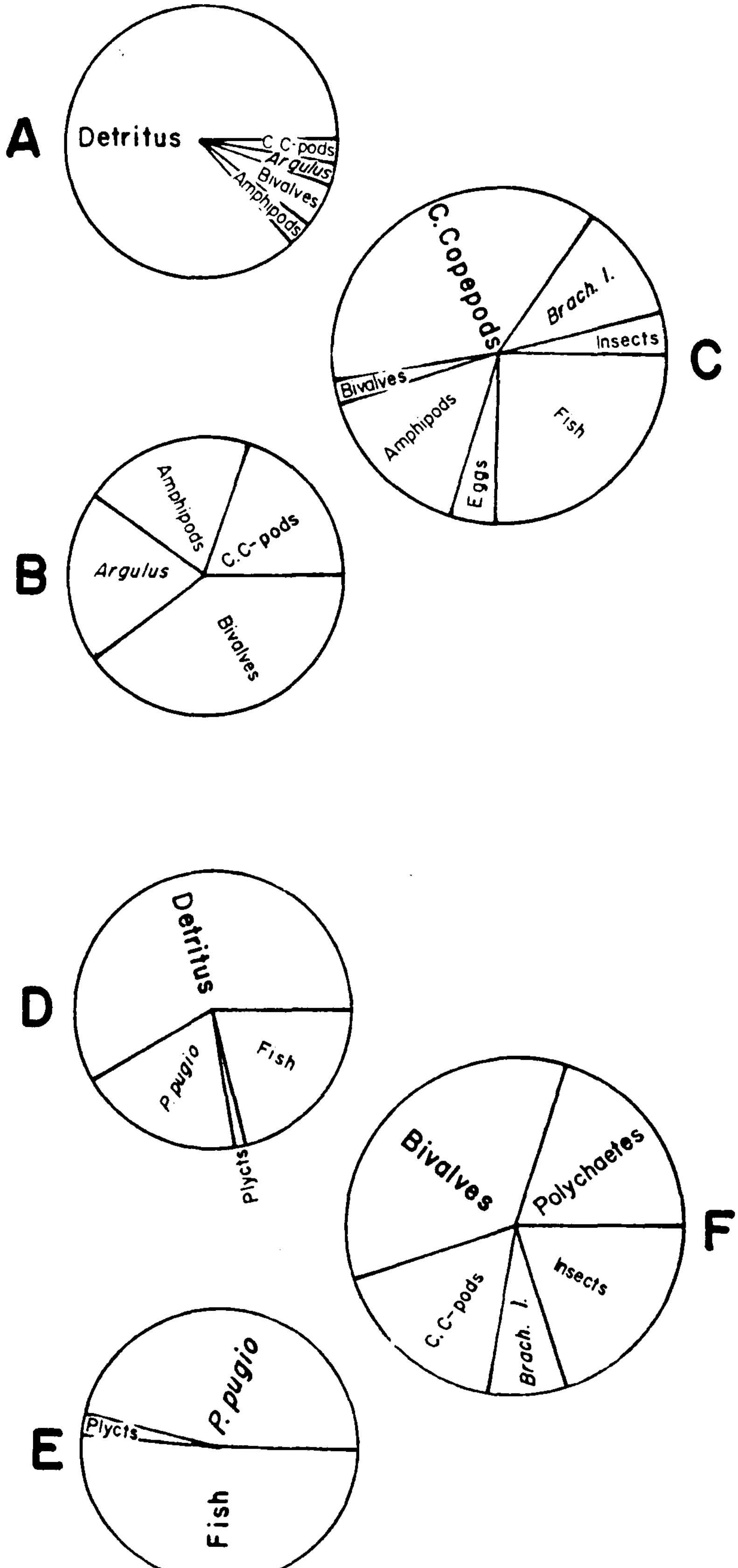

A
Detritus
C.C-pods
Argulus
Bivalves
Amphipods
B
Amphipods
C.C-pods
Argulus
Bivalves
C
C.Copepods
Brach. l.
Insects
Bivalves
Amphipods
Eggs
Fish
D
Detritus
P. pugio
Fish
Plycts
E
P. pugio
Plycts
Fish
F
Bivalves
Polychaetes
C.C-pods
Brach. l.
Insects

Figure 17. Ration, adjusted ration, and available food for *Cyprinodon variegatus* collected at all stations combined. A - Ration for mornings. B - Adjusted ration for mornings. C - Available food for mornings. D - Ration for evenings. E - Adjusted ration for evenings. F - Available food for evenings.

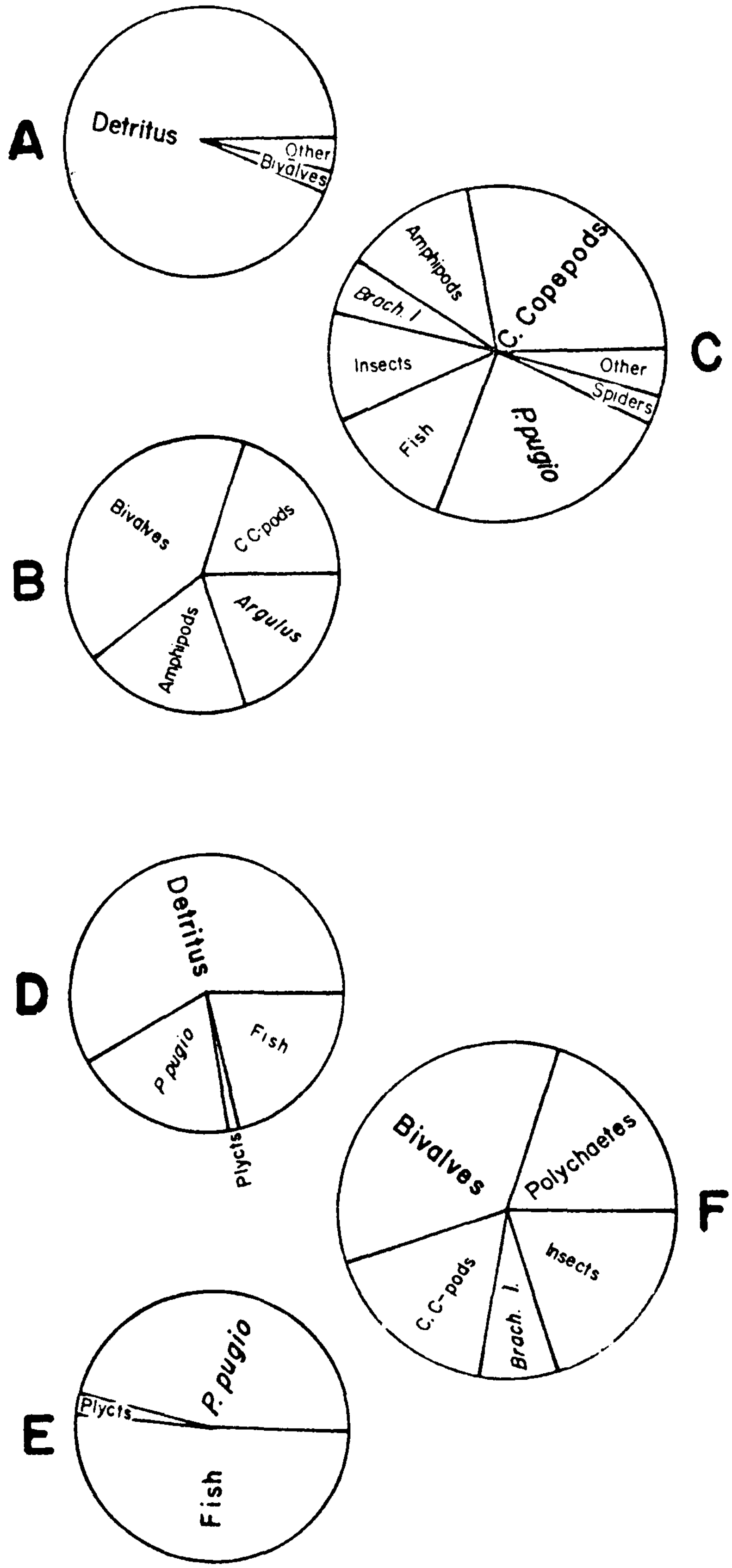
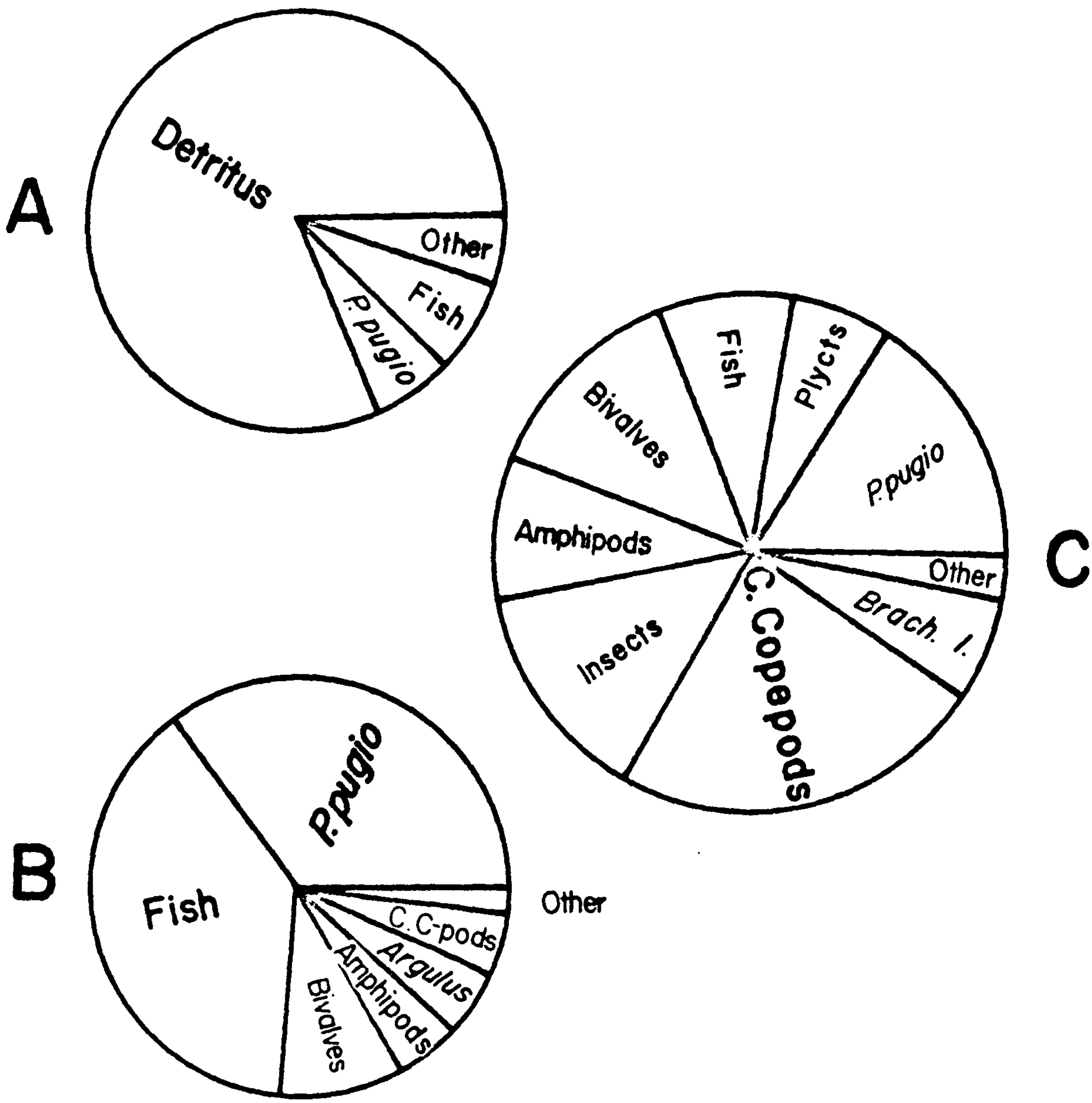

A
Detritus
Other
Bivalves
B
Bivalves
C.C-pods
Argulus
Amphipods
C
C. Copepods
Amphipods
Brach. l.
Insects
Fish
P. pugio
Spiders
Other
D
Detritus
Fish
P. pugio
Plycts
E
P. pugio
Plycts
Fish
F
Bivalves
Polychaetes
Insects
Brach. l.
C.C-pods

Figure 18. Ration, adjusted ration, and available food for all *Cyprinodon variegatus* collected. A - Ration. B - Adjusted ration. C - Available food.



A
Detritus
Other
Fish
P. pugio
B
P. pugio
Fish
Other
C. C-pods
Argulus
Amphipods
Bivalves
C
Fish
Plycts
Bivalves
P. pugio
Amphipods
Other
Brach. l.
Insects
C. Copepods