1977

Ecology of the Pirate Perch

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pdm
ECOLOGY OF THE

PIRATE PERCH

(TITLE)

BY

Leslie D Frankland

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

M.S. in Zoology

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1977

YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
THIS PART OF THE GRADUATE DEGREE CITED ABOVE

5 May, 1977

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ADVISER

5 May, 1977

DATE

DEPARTMENT HEAD
The pirate perch, Aphredoderus sayanus, (Gilliams), the only living species of the family Aphredoderidae, ranges throughout the Mississippi Valley and the Atlantic Coastal Plain in low gradient streams, swamps, oxbows and other backwaters. External characters of the pirate perch have been described in detail by Eddy and Surber (1943), Troutman (1957) and Pflieger (1975). Literature printed on the pirate perch is limited with many parts of its life history still undescribed.

Food habits of the pirate perch have been alluded to but not closely documented. Abbot (1861) was first to describe its food habits by noting the consumption of small fish overnight by pirate perch from his aquarium. Studies by Becker (1923) and Flemer and Woolcott (1966) describe the pirate perch as predaceous, feeding almost entirely upon small, aquatic insects and amphipods. Clark (1949) describes its food as small aquatic insects, but also includes small fish among the pirate perch's diet. Feeding behavior and activity patterns have recently been studied by Parker and Simco (1975) and Bartone (1973).

A review of the literature on pirate perch reveals very little about its age and growth relationships. Hall and Jenkins (1954) examined scales from 82 pirate perch collected in Sub Prison Lake, Oklahoma. Swingle (1965) aged 44 pirate perch from Alabama, but considered his age regression as invalid. Growth studies have been carried out by Mansueti (1963), who compared growth stages to anal vent locations and anal spine numbers. Hogue, et.al. (1976) have described morphological changes during growth of post-larval pirate perch.

Movement of the vent from the anal to the jugular or thoracic position is well documented (Jordan 1878, Jordan and Evermann 1896, Forbes and Richardson 1920, Hall and Jenkins 1954, and Mansueti 1963). Variations
in vent location have given rise to several nominal species and genera (Jordan and Gilbert, 1882 and Nelson, 1876). An indepth morphological study of vent movements and anatomical changes was conducted by Mansueti (1963). She noted that variations existed in the rate of vent movement and suggested that additional data were needed to establish the relationship between vent movement and age, seasons, reproductive status and spatial distribution.

This study was conducted to examine in detail the following specific areas of the pirate perch's ecology: food habits, age, growth, sexual maturation and anal vent migration.

METHODS

Pirate perch were collected with common minnow seines of 6.35 mm mesh size. The collection period extended from April through September of 1974 and February through March of 1976. Specimens were placed in straight formalin for killing, then transferred to 10% formalin for preservation. Stomachs were removed in the laboratory and their contents classified according to Pennak (1953). Numbers of organisms were recorded for each pirate perch along with each category's percent of total numbers and frequency of occurrence as described in Lagler (1956). Feeding behavior was studied by direct observation of 20 pirate perch seined from Greasy Creek in Coles County, Illinois on March 1, 1976. Pirate perch were placed in a twenty-gallon aquarium which contained a substrate of muck and detritus taken from the collecting site. Amphipods and small decapods (crayfish) were placed in the aquarium periodically over a two-week period and responses were observed.

The pirate perch's ctenoid scales were removed from the area midway between the anterior region of the dorsal fin and the lateral line. The
scales were mounted in CMC9 mounting fluid on glass slides and examined at 100X under a phase contrast compound scope. Age was determined by counting annuli distinguished by a separation of circuli in the anterior field and a cutting across of circuli in the lateral field. Scale length and annuli length were determined with a micrometer. The scale and annuli lengths combined with total lengths were substituted in the formula \( \ln = (S_n/S) \times L \) for determination of pirate perch total lengths at the end of past growing seasons (Lagler 1956).

Regression lines were established from body growth to caudal fin growth relations by linear regression equations. With this regression line, total length could be converted to standard length for comparison with other studies. Sex and gonadal conditions were determined by internal examination of the gonads. Spawning times were established from these gonadal examinations and the first young of year collected.

Preserved pirate perch in collections from Illinois Natural History Survey, Urbana, Illinois, and Eastern Illinois University, Charleston, Illinois, were examined and measured with dial calipers. Measurements recorded in millimeters from preserved and collected specimens were as follows: total length, standard length, snout-vent length and isthmus knob-vent length. Graphs were constructed of isthmus-vent lengths compared to the months collected to show seasonal variations. Photographs of vent locations and isthmus knobs were taken of pirate perch collected in the same area during March and July.

DESCRIPTION OF STUDY AREA

Specimens collected for this study were seined from Village and West Village in Edwards County and from Greasy Creek in Coles County, Illinois (Figure 1). Streams and ditches were of low gradients with little
water flow. Ditch bottoms contained large amounts of muck and detritus making seining very difficult. During summer months aquatic vegetation would clog the streams and choke out the sun's rays. Fish collected with pirate perch are listed in Table 1.

**Table 1.** Fish collected with pirate perch from streams in Coles and Edwards Counties, Illinois.

<table>
<thead>
<tr>
<th>Species</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Erimyzon oblongus</em></td>
<td>Western creek chubsucker</td>
</tr>
<tr>
<td><em>Pimephales notatus</em></td>
<td>Blunt nose minnow</td>
</tr>
<tr>
<td><em>Semotilus atromaculatus</em></td>
<td>Creek chub</td>
</tr>
<tr>
<td><em>Notemigonus crysoleucus</em></td>
<td>Golden shiner</td>
</tr>
<tr>
<td><em>Notropis umbratilis</em></td>
<td>Redfin shiner</td>
</tr>
<tr>
<td><em>Notropis whippeli</em></td>
<td>Steel color shiner</td>
</tr>
<tr>
<td><em>Hybognathus nuchalis</em></td>
<td>Silvery minnow</td>
</tr>
<tr>
<td><em>Phenacobius mirabilis</em></td>
<td>Suckermouth minnow</td>
</tr>
<tr>
<td><em>Cyprinus carpio</em></td>
<td>Carp</td>
</tr>
<tr>
<td><em>Esox americanus</em></td>
<td>Grass pickerel</td>
</tr>
<tr>
<td><em>Ictalurus melas</em></td>
<td>Black bullhead</td>
</tr>
<tr>
<td><em>Ictalurus natalis</em></td>
<td>Yellow bullhead</td>
</tr>
<tr>
<td><em>Fundulus notatus</em></td>
<td>Blackstripe topminnow</td>
</tr>
<tr>
<td><em>Gambusia affinis</em></td>
<td>Mosquito fish</td>
</tr>
<tr>
<td><em>Lepomis macrochirus</em></td>
<td>Bluegill</td>
</tr>
<tr>
<td><em>Lepomis cyanellus</em></td>
<td>Green sunfish</td>
</tr>
<tr>
<td><em>Lepomis megalotis</em></td>
<td>Longear sunfish</td>
</tr>
<tr>
<td><em>Micropterus salmoides</em></td>
<td>Largemouth bass</td>
</tr>
<tr>
<td><em>Etheostoma nririm</em></td>
<td>Johnny darter</td>
</tr>
<tr>
<td><em>Etheostoma gracile</em></td>
<td>Slough darter</td>
</tr>
<tr>
<td><em>Percina maculata</em></td>
<td>Blackside darter</td>
</tr>
</tbody>
</table>

**RESULTS**

*Results and Feeding Habits*

Captive pirate perch were nonactive fish; they would lie motionless in different positions for hours. Their infrequent movements were rather sluggish, seeming only to drift to the bottom or nearby vegetation. Most remained in debris on the bottom or among vegetation, sometimes forming close groups of up to eight fish.
Figure 1. Greasy Creek, Coles County, Illinois, contained much habitat in which pirate perch were found.
Activity increased when food items were introduced in the aquarium. Pirate perch were never seen to rapidly pursue their intended prey but to slowly drift toward the moving organism. Feeding movements consisted of quick, sideways movements of the head accompanied with the flaring of the gills. The gill flaring seemed to form a vacuum drawing the prey and other debris into the mouth. Pirate perch would readily capture prey that moved, but would pass over prey that remained motionless.

Eighty-three of the 100 pirate perch stomachs examined contained food organisms. Eleven different types of organisms were present (Table 2). Chironomidae frequented more pirate perch stomachs (58%) and made up the greatest percent of total numbers (47%). Isopoda followed with a frequency of occurrence of 45% and 24% of total numbers (Table 2). The 1-20 mm and 21-40 mm size groups of pirate perch in Table 2 utilized the smaller prey (Copepoda and Cladocera) while the larger size groups, 41-60 mm and 61-80 mm, preyed more heavily on the larger food organisms (Hemiptera and Ephemeroptera).

**Age, Growth and Sexual Maturity**

One hundred pirate perch were collected from April through September of 1974 in Coles and Edwards Counties, and sixty more pirate perch were collected in February through March of 1976 in Coles County. The age distribution of pirate perch collected in 1974 is represented in Table 3 and the 1976 pirate perch in Table 4. In 1974, 76% of the pirate perch collected were one year or younger in age (Table 3) and in 1976, 67% of the pirate perch were found to be in the one year class (Table 4). The regression line established from the total and standard lengths was found to be $y = 1.2X + 6$ (Figure 2). Pirate perch were found to grow most rapidly during their first year of life, reaching 63% to 68% of their
Table 2. Frequency of occurrence, percent of total numbers and total numbers of food organisms present in four size groups of pirate perch collected in 1974 from Coles and Edwards Counties, N = number per group.

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Freq. Occ.</th>
<th>Fish Size Groups in mm SL</th>
<th>Percent Total Numbers</th>
<th>Total No. Organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N= 12</td>
<td>1-20 21-40 41-60 61-80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chironomidae</td>
<td>58</td>
<td>7 123 23 47 200</td>
<td>47</td>
<td>49</td>
</tr>
<tr>
<td>Isopoda</td>
<td>45</td>
<td>11 33 47 10 101</td>
<td>24</td>
<td>183</td>
</tr>
<tr>
<td>Copepoda</td>
<td>17</td>
<td>27 14 -- -- 41</td>
<td>10</td>
<td>110</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>14</td>
<td>-- -- 17 24 41</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>Amphipoda</td>
<td>10</td>
<td>-- 10 4 1 15</td>
<td>3</td>
<td>85</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>6</td>
<td>-- -- 5 -- 5</td>
<td>1</td>
<td>85</td>
</tr>
<tr>
<td>Odonata</td>
<td>5</td>
<td>-- 1 2 1 4</td>
<td>1</td>
<td>85</td>
</tr>
<tr>
<td>Cladocera</td>
<td>5</td>
<td>4 2 -- -- 6</td>
<td>1</td>
<td>85</td>
</tr>
<tr>
<td>Ostracoda</td>
<td>4</td>
<td>-- -- 8 -- 8</td>
<td>2</td>
<td>85</td>
</tr>
<tr>
<td>Ephemeroptera</td>
<td>2</td>
<td>-- -- 4 1 5</td>
<td>1</td>
<td>85</td>
</tr>
<tr>
<td>Fish</td>
<td>1</td>
<td>-- -- -- 1 1</td>
<td>25</td>
<td>85</td>
</tr>
<tr>
<td>Total No. Organisms</td>
<td>49</td>
<td>183</td>
<td>110</td>
<td>85</td>
</tr>
</tbody>
</table>
Table 3. Age groups and calculated total lengths of pirate perch collected from Coles and Edwards Counties, Illinois in 1974.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Average TL mm</th>
<th>Length Range</th>
<th>No.</th>
<th>Calculated TL at end of year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young of yr.</td>
<td>27.5</td>
<td>14.0-41.0</td>
<td>37</td>
<td>28.0</td>
</tr>
<tr>
<td>I</td>
<td>56.5</td>
<td>37.5-81.5</td>
<td>39</td>
<td>(\ldots)</td>
</tr>
<tr>
<td>II</td>
<td>77.1</td>
<td>62.0-98.0</td>
<td>24</td>
<td>(\ldots)</td>
</tr>
</tbody>
</table>

Average Length: 28.0, 39.6, 62.7

Table 4. Age groups and calculated total lengths of pirate perch collected from Coles County, Illinois in 1976.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Average TL mm</th>
<th>Length Range</th>
<th>No.</th>
<th>Calculated TL at end of year</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>62.7</td>
<td>52.0-87.8</td>
<td>40</td>
<td>60.4</td>
</tr>
<tr>
<td>II</td>
<td>91.4</td>
<td>79.5-105.2</td>
<td>8</td>
<td>66.1</td>
</tr>
<tr>
<td>III</td>
<td>95.8</td>
<td>83.4-117.3</td>
<td>10</td>
<td>46.4</td>
</tr>
<tr>
<td>IV</td>
<td>96.8</td>
<td>96.8</td>
<td>1</td>
<td>38.6</td>
</tr>
<tr>
<td>V</td>
<td>133.7</td>
<td>133.7</td>
<td>1</td>
<td>67.1</td>
</tr>
</tbody>
</table>

Average Length: 55.7, 81.5, 99.0, 110.2, 132.5
Figure 2. The regression line of total length (mm) to standard length (mm) of 160 pirate perch from Coles and Edwards Counties, Illinois.
total length. They reached 82% the second year and 89% the third year.

Examinations of gonads from pirate perch in age group one (Table 3) indicate that sexual maturity may be established at growing season one. However, all pirate perch of age group one did not contain mature gonads indicating that some do not reach sexual maturity until the end of the second year. A one year male 47 mm total length had milt and a one year female 49 mm total length contained ripe roe.

In 1974 the spawning season of pirate perch in Edwards County was established as the first two weeks of May. Females collected on April 23 showed extensive egg development, and females collected on May 5 exhibited egg movement into the duct. After May 5, no developed eggs were found in female pirate perch. Males collected during the last week of April and the first week of May contained milt in the urogenital duct. The first young of year pirate perch, which measured 14.4 mm TL, was collected on May 29.

Vent Variations

A total of 160 pirate perch were collected in Coles and Edwards Counties; an additional 421 Illinois pirate perch and 138 out-of-state pirate perch were obtained from preserved collections. Isthmus knob-vent lengths increased from April through the summer in the three size classes (Figure 3). Although the isthmus knob-vent length means in Figure 3 indicate a seasonal cycle, variations within each monthly sample have sufficient overlap to prevent significant findings (Figure 4). Isthmus knob size of spring collected pirate perch was found to be greater than summer collected pirate perch. Photographs of isthmus knob-vent lengths and isthmus knob size are shown in Figures 5 and 6.
Figure 3. Graphs of the mean isthmus-vent lengths (mm) of three size groups of pirate perch from Illinois and one size group from other states.
Figure 4. Seasonal comparisons of isthmus knob-vent lengths of pirate perch 37.5 mm TL and larger from Illinois. One standard deviation is represented by the range by the vertical lines. The means are shown by the line.
Figure 5. Ventral view of six pirate perch collected from Franklin County, Illinois. Sex, age and month collected are shown below each fish.

<table>
<thead>
<tr>
<th>Month</th>
<th>Sex</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>2</td>
</tr>
<tr>
<td>July</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The fish on the right was collected in July from the same locality.
Figure 6. Ventral view of isthmus knob difference among pirate perch.

The pirate perch on the left was collected in March, while the specimen on the right was collected in July in the same locality.

The pirate perch is a highly predacious fish, feeding entirely on small aquatic organisms. Feeding behavior studies by Parker and SimAnd (1975) delineated the findings of this study. They describe feeding behavior as a slow silent approach, but with quick turns of the head and a negative pressure aided by the gill cavities to suck in the prey.

They also found the pirate perch to be most active at night and restricted to bottom areas.

Chironomids were found in more pirate perch stomachs and made up greater numbers than any other organisms (Table 2). Decker (1923), Clark (1949), Rice (1942) and Flemer and Woolcott (1966) also found chironomids present in pirate perch stomachs. Flemer and Woolcott listed chironomids as the most frequent (88%) species in 52

fish stomachs.

Fish prey of a few select large individual pirate perch. Fish remains have been taken from pirate perch stomachs (Forbes and Richardson 1920 and Clark 1949). However, from this study and Flemer and Woolcott (1969), fish were found to make up only a very small percentage of the diet (Table 2).

Prey size was found to vary with pirate perch size (Table 2). As expected, small pirate perch utilized the smaller Cladocera and Copepoda, while larger pirate perch preyed more heavily on the larger Hemiptera and Ephemeroptera. Prey size selection is probably a result of food source availability, preferability and vulnerability to the pirate perch size.
DISCUSSION

Diet and Feeding Habits

The pirate perch is a highly predacious fish, feeding entirely on small aquatic organisms. Feeding behavior studies by Parker and Simco (1975) coincide with findings of this study. They describe feeding behavior as a slow indirect approach, but with quick turns of the head and a negative pressure formed by the gill cavities to suck in the prey. They also found the pirate perch to be most active at night and restricted to bottom areas.

Chironomids were found in more pirate perch stomachs and made up greater numbers than any other organisms (Table 2). Becker (1923), Clark (1949), Rice (1942) and Flemer and Woolcott (1966) also found chironomids present in pirate perch stomachs. Flemer and Woolcott (1969) listed chironomids as the most frequent (55%) and made up 53% of the total organisms. Forbes (1888) established the diet as mainly dipteran larvae.

Fish predation by pirate perch is insignificant and limited to only a few select large individual pirate perch. Fish remains have been taken from pirate perch stomachs (Forbes and Richardson 1920 and Clark 1949). However, from this study and Flemer and Woolcott (1969), fish were found to make up only a very small percentage of the diet (Table 2).

Prey size was found to vary with pirate perch size (Table 2). As expected, small pirate perch utilized the smaller Cladocera and Copepoda while larger pirate perch preyed more heavily on the larger Hemiptera and Ephemeroptera. Prey size selection is probably a result of food source availability, preferability and vulnerability to the pirate perch size.
Prey utilized by pirate perch consisted almost entirely of small aquatic insects and crustaceans which live within the muck and vegetation of the dimly-lit bottom. Observations from this study indicate sight is used in prey capture, but because of the murky waters and nocturnal habits, other senses must be used (Parker and Simco 1975). The well-developed lateral line and sensory pores of the head, as described by Moore and Burris (1956), are probably the main senses used in prey location and capture.

Age, Growth and Sexual Maturity

Pirate perch are reported as spring spawners (Abbott 1862 and Eddy and Underhill 1974). In Texas, Martin and Rubbs (1973) established spawning times as late February. Findings from this study and Forbes and Richardson (1920) indicate that pirate perch spawn in early May at the latitudes of Illinois. The age and size at sexual maturity in pirate perch have been shown by Mansueti (1963) from Hall and Jenkins (1953) as 55 mm total length and one year of age. Findings by this study indicate that sexual maturity is established in the 40 mm's and not the 50 mm's as thought by Mansueti.

Considerable length variations among different age groups are shown in Tables 3 and 4. Hall and Jenkins (1953) also had length variations and overlap among age groups of Oklahoma pirate perch. Differences in age size groups of 1974 (Table 3) and 1976 (Table 4) studies are probably results of variations in lengths of growing seasons and differences in geographical locations. Growth rates established in this study for the one-year class (63-68%), two-year class (82%), and three-year class (89%) are essentially the same as Hall and Jenkins
who found 66% for the one-year class, 83% for the two-year class and 87% for the three-year class.

Vent Variation

Studies of pirate perch have shown much variation in vent location (Jordan 1878 and Hall and Jenkins 1954). Mansueti (1963) stated that the variation of the vent location according to various fish size indicates a great variability in migration rate. Figures 3 and 5 show this variation, not of size groups, but of a seasonal cycle. Fish from these figures are considered to be at least one year of age and should show no juvenile forward movement of the vent. Variations of vent locations are definitely present and all results indicate some type of seasonal cycle.

Seasonal cycles are tied to spawning time and gonadal growth. The small isthmus-vent lengths are found when the pirate perch contains gonads in near spawning condition. Increased isthmus-vent lengths occur after the spawning season. The greatest isthmus-vent lengths occur during the summer months when gonads are at the least amount of development. With the decrease of isthmus-vent length during the fall, the gonads presumably are developing to the over-winter condition as shown in early February (Figure 3). The change in size of the isthmus-knob to vent is limited in anterior movement by the presence of thoracic muscles (isthmus knob). Posterior movement is limited by the complete ossification of the pelvic bones after the juvenile fish's intestine has passed through the foramen (Mansueti 1963).

Pirate perch estimated at two years and older show a seasonal variation of vent location, but not as pronounced as the one year class (Figure 3). The low numbers of two year olds examined does not allow
for significant speculations. However, decreases in variations may result from hardening of tissues linked with the anatomical processes of vent migration (Smith 1976).

The anterior position of the vent along with its variations could be most readily associated with its spawning habits. Eddy and Surber (1943) reported that little is known about the pirate perch's spawning habits except that it was reported to build a nest and guard the eggs. Pflieger (1975) postulates from the location of the vent on the throat that the pirate perch is actually a buccal incubator. This seems likely since the anterior position of the vent occurs in only two families of fish, Amblyopsidae and Aphredoderidae. The Amblyopsidae or the cave fishes and the pirate perch are relics of a past extensive fauna of the southern swamps (Jordan 1905). The closest living relatives of Aphredoderidae are considered by Rosen (1962) and Rosen and Patterson (1969) to be the Amblyopsidae. Members of this family are known buccal incubators, but just how the eggs become situated in the gill chambers is unknown (Weise 1957). An incidental observation by Martin and Hubbs (1973) showed that eggs expressed artificially from pirate perch tended to move along a groove into the gill chambers. This observation may explain the way eggs are introduced into gill chambers of the Aphredoderidae and Amblyopsidae. This may also explain why the vent is located closer to the isthmus knob during spawning season of the pirate perch. However, both females and males have the vent variation characteristic. The presence of the forward location of the male's vent cannot be explained without further information on spawning habits. Spawning behavior may require the male to place itself vent to vent on the female for fertilization to occur. Another explanation is that milt
may pass into the male's buccal area and then be expelled into the female's mouth. These are only speculations and can only be explained by more intensive studies. Another external change in morphology associated with seasonal conditions is the size of the isthmus knob. Figure 6 definitely shows a difference of knob size in March and July specimens. March specimens have an extended, swollen knob while July specimens have a knob which is not swollen. This swollen knob may be used in some type of spawning behavior ritual.

If the pirate perch is a buccal incubator, then it should be found with eggs in the gill chambers as in *Amblyopsis spelaea*. Eigenmann (1909) wrote that the female can readily be distinguished by the appearance of eggs through the opaque gill covers. Eigenmann also noted that eggs readily freed from the gill cavities continued to develop, uninterrupted. However, the gill cavity provided such a unique and self-regulated hatchery that the eggs remained in it. No eggs were found in the gill cavities of 719 pirate perch examined during this study. This indicates that the pirate perch may release the eggs as a type of species preservation. The released eggs could then develop naturally outside the gill chambers and ensure the survival of the species.
ACKNOWLEDGEMENTS

I would like to thank Dr. Phil Smith and Larry Page of the Illinois Natural History Survey for their loan of the specimens and help with vent variations. I would also like to thank Dr. Leonard Durham, Dr. E.O. Moll and Dr. R. Andrews of Eastern Illinois University for their help and suggestions throughout this study. Finally, I would like to thank my wife for her help in collecting specimens and typing this manuscript.
LITERATURE CITED


