The Invertebrate Prey of the Northern Leopard Frog, *Rana pipiens*, in a Northeastern Ohio Population[1]

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ABSTRACT. **The purpose of this investigation was to determine the feeding habits of the northern leopard frog, *Rana pipiens*, in northeastern Ohio. To accomplish this we examined the stomach contents of 13 adults and 19 juveniles collected from a restored wetland in Summit County, Ohio during the summers of 1996 and 1997. The adult and juvenile frogs ingested 142 invertebrates representing 2 phyla, 3 classes, 12 orders, and 34 families. Adult and juvenile frogs consumed both diurnal and nocturnal prey belonging primarily to the insect orders Coleoptera, Hemiptera, and Hymenoptera. Although juvenile frogs consumed more individual prey items than adults ($t = 2.196$, $p < 0.05$), neither age cohort specialized on active or inactive prey ($X^2 = 3.84$, $p < 0.05$). Approximately 67% of all prey consumed consisted of fossorial or crawling organisms. Our data suggest that *R. pipiens* is an efficient predator that maximizes prey diversity by employing more than one feeding strategy.**

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INTRODUCTION

The feeding habits of *Rana pipiens* are poorly understood (Rittschof 1975). Past investigations have indicated that the species feeds on a wide variety of invertebrate prey (Knowlton 1944, Kilby 1945, Linzey 1967, Rittschof 1975) which exhibit diverse methods of locomotion. Rittschof (1975) noted that the prey most commonly consumed were slow moving individuals of the orders Coleoptera, Lepidoptera and Orthoptera, but he did not determine if adult and juvenile *R. pipiens* feed on significantly different types of prey. In Michigan populations, recently transformed juveniles ingested ants (Hymenoptera: Formicidae); the ants were never found in the stomachs of adult frogs (Rittschof 1975). Whether this reflects a true feeding preference by juveniles, or is simply a result of local prey availability, is unknown. Stomach content analyses revealed the presence of both diurnal and nocturnal prey suggesting that *Rana pipiens* feeds during both day and night (Hine and others 1981, Rittschof 1975). The primary purpose of our investigation is to document the prey consumption of adult and juvenile *R. pipiens* from a restored wetland in northeastern Ohio. We note differences in the prey consumed by adult and juvenile frogs and compare the relative activity levels of the ingested prey types to determine if either age cohort specializes on active or inactive prey.

MATERIALS AND METHODS

We analyzed the stomach contents of 13 adult and 19 juvenile *R. pipiens* collected from a restored wetland in Barberton, OH (Coventry Township, Summit County). Juveniles were collected from habitats with standing water in July, 1997, approximately one month after metamorphosis. Adults were captured in the drier grasslands adjacent to the wetland between July and August, 1996 and 1997. Juveniles were sacrificed, their stomachs removed intact, and individually preserved in 70% ethanol. We flushed the stomachs of adults by inserting a pipette into the upper esophagus and forcing approximately 35 ml of water through the tube into the stomach. This procedure was repeated a minimum of four times or until the stomach contents were retrieved. The stomachs of three adults sacrificed following this procedure did not contain additional materials, indicating the effectiveness of this technique. All other adults were later released unharmed. A dissecting microscope was used to identify the invertebrate prey to family, or the lowest taxon possible.

We classified the collected invertebrates as either active or inactive prey based on the natural history information available for each family (Borror and others 1981). We then used a contingency Chi-square test (Zar 1983) to determine if adult and juvenile *R. pipiens* consume different proportions of active and inactive prey. The mean numbers of prey items consumed by adult and juvenile frogs were compared with a two-tailed *t* test.

RESULTS

Adult and juvenile *R. pipiens* ingested 142 invertebrates representing 2 phyla, 3 classes, 12 orders, and at least 34 families (Table 1). Many stomachs contained portions of recently shed skin or unidentified plant material and other debris, probably inadvertently ingested as the frogs captured prey. Both diurnal and nocturnal prey were consumed by adult and juvenile frogs. Approximately 67% of all prey consumed consisted of fossorial or crawling organisms. Saltatory and flying insects were ingested less frequently (Table 1). Juvenile frogs consumed a greater diversity of taxonomic prey including invertebrates from 17 families of insects and one class (Gastropoda) not consumed by adults. The mean numbers of invertebrates consumed by adults and juveniles were 3.2 (± 2.4), and 5.4 (± 2.9), respectively. Juveniles consumed a significantly larger number of prey items than adults ($t = 2.196$, $p < 0.05$). Our Chi-square calculation ($X^2 = 3.84$, $p < 0.05$) suggests

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TABLE 1

Mobility pattern and activity level of the invertebrate prey of Rana pipiens.

Taxa	Number	Mobility Pattern				Activity Level	
		Crawlers/Fossorial	Saltatory	Fliers	Sit & Wait	Active	Inactive
Coleoptera	39						
Carabidae [AJ]	14	+				+	
Chrysomelidae [J]	5	+					+
Curculionidae [AJ]	4	+					+
Scarabaeidae [AJ]	4	+				+	
Lampyridae [J]	2			+		+	
Elateridae [J]	1	+					+
Staphylinidae [J]	1	+				+	
Coccinellidae [J]	1	+				+	
unknown	7						
Arachnida	23						
Lycosidae [AJ]	13	+				+	
Thomosidae [A]	2				+		+
unknown	8						
Hemiptera	15						
Pentatomidae [AJ]	5	+					+
Lygaeidae [J]	5	+					+
Reduviidae [A]	1				+		+
unknown	4						
Hymenoptera	13						
Braconidae [J]	3			+		+	
Formicidae [J]	3	+				+	
Sphecidae [A]	2			+		+	
Ichneumonidae [AJ]	2			+		+	
Chalcidoidae [J]	1			+		+	
unknown	2						
Homoptera	13						
Cercopidae [J]	5		+				+
Aphidae [J]	1				+		+
Corimelaenidae [J]	1	+					+
Dictyopharidae [J]	1		+				+
unknown	5						
Gastropoda	10						
snails [J]	8	+					+
slugs [J]	2	+					+
Orthoptera	10						
Gryllidae [AJ]	6		+			+	
Acrididae [AJ]	3		+			+	
Tettigoniidae [AJ]	1		+			+	
Lepidoptera	7						
Noctuidae [A]	2	+					+
unknown	5						
Diptera	6						
Tipulidae [AJ]	3			+		+	
Tabanidae [AJ]	1			+		+	
Chironomidae [AJ]	1			+		+	
Calyptrate mucoid [J]	1			+		+	
Megaloptera	1						
Sialidae [AJ]	1	+					+
Collembola	1						
Sminthuridae [J]	1		+			+	
Thysanura	1						
Thripidae [J]	1				+		+

+ = Is characteristic of taxon. [A] = Taxon consumed only by adults. [J] = Taxon consumed only by juveniles. [AJ] = Taxon consumed by adults and juveniles.

that neither adult nor juvenile *R. pipiens* specialize on active or inactive prey.

DISCUSSION

Our findings support the hypothesis that *R. pipiens* is a generalist which feeds on both diurnal and nocturnal prey. This opportunistic feeding behavior may increase the diversity and overall number of prey items consumed (Rittschof 1975). Similar to past investigations, (Knowlton 1944, Linzey 1967, Rittschof 1975) our study indicates that the most commonly consumed prey were crawling or fossorial insects primarily of the order Coleoptera (Table 1). Linzey (1967) noted that these invertebrates may be a particularly abundant and reliable food source in most habitats. The fact that flying insects were ingested less frequently in our study, as in past investigations (Rittschof 1975), may reflect the difficulty involved in the successful capture of these invertebrates.

Although juveniles in our sample consumed a greater diversity and number of taxonomic prey, it remains unclear if they are actually more active foragers than the adults. This disparity may simply reflect the local diversity and abundance levels of the invertebrate community in the moister habitats from which juveniles were collected in this wetland. For example, prey items such as snails and slugs, consumed only by juveniles, are often tied to moist habitats and therefore may have been unavailable as prey to adults in the drier grasslands. Juveniles also consumed larger numbers of relatively few families including wolf spiders (Lycosidae), ground beetles (Carabidae), and snails. Whether juveniles actually prefer these families over other prey, or if the families in question were simply more abundant in this region of the wetland remains unclear.

Sit-and-wait predators, such as *R. pipiens* (Rittschof 1975), normally consume more active than inactive prey (Huey and Pianka 1981). Our data, however, deviate from these expected results as neither adult nor juvenile frogs consumed statistically larger proportions of active invertebrate taxa. Our unexpected results may have resulted from an erroneous assumption that *R. pipiens* is strictly a sit-and-wait predator. *Rana pipiens* is known to make frequent and often extensive excursions in response to environmental stimuli such as precipitation and drops in barometric pressure (Dole 1965, 1971), which may allow the frogs to relocate to areas rich with invertebrate prey (Merrell 1977). Frequent dispersal could therefore enable *R. pipiens* to encounter a greater diversity of invertebrates including less active, and perhaps, less abundant prey that they would normally not encounter. In summary, we believe our data support the notion that *R. pipiens* is a highly efficient predator that maximizes prey diversity by employing more than one foraging strategy.

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