by 7.5-cm glass stacking bowls containing dechlorinated tap water and labeled with collection dates. I fed and kept small crayfish alive for up to 3 months in the laboratory. Techniques I used in their culture were those of Black and Huner (1979). Mortality within groups was minimal, and eventually I necropsied all surviving specimens when each had grown to about 25 mm in length. By early December, some crayfish in the field, as well as some reared in the laboratory, had grown larger and, if infected, harbored worms mature (oviferous) enough to be apparent at necropsy.

Beginning in December, I removed the paired antennal glands from 465 *P. clarkii,* dissected them under a stereomicroscope, and examined them for presence of worms. I prepared a representative voucher specimen of *A. filiformis* for deposit in the United States National Parasite Collection (USNPC 089114). Infections with *A. filiformis* first appeared in mid October (Fig. 1). Prevalence of infection increased steadily, and by early April, 100% of the sampled population was infected. Worms harbored by individual hosts seemed to be at or near the same stage of development, suggesting that individual infections were acquired during a brief period of time rather than through an accumulative process.

Although several species of aquatic mollusks occurred at the study site, I made no attempt to collect and screen them for larval trematode infections. However, the pattern of seasonal prevalence (Fig. 1) suggests that cercariae began leaving mollusks between early and mid October. By early April, the process of infecting young crayfish was complete. Thus, infections among the *P. clarkii* population apparently were acquired over a 5-month period.

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DIETS OF NEWLY METAMORPHOSED AMPHIBIANS IN WEST TEXAS PLAYAS

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ABSTRACT—Although amphibians are the dominant vertebrate inhabiting playa wetlands during spring and summer in the Southern Great Plains, little is known about their diet and role in playa trophic structure. Because new metamorphs are more numerous than other terrestrial life stages of amphibians, we describe the diets of recently (<2 weeks) metamorphosed Great Plains toad (*Bufo cognatus*), barred tiger salamander (*Ambystoma tigrinum*), and New Mexico spadefoot (*Spea multiplicata*). Cultivation has greatly altered most playa watersheds (>95%); therefore, we also examined this influence on diets of Great Plains toad metamorphs. Diets of all 3 species were dominated by coleopteran taxa, and diversity of prey taxa did not vary among species. Amount of specific prey consumed varied among species, with Great Plains toads preying more on scarab beetles and formicid ants than New Mexico spadefoots and tiger salamanders. New Mexico spadefoot metamorphs consumed more chrysomelid and elaterid beetles than tiger salamanders or Great Plains toads. Given the high numerical abundance of metamorphs, they likely have a strong influence on secondary production in playas. Great Plains toad metamorphs in playas with grassland watersheds had a much more diverse diet than those using playas with cultivated watersheds. Conservation of amphibians in the Southern Great Plains should focus on preserving playas with native grassland watersheds or restoring those with cultivated watersheds.

RESUMEN—Los anfibios son los vertebrados más abundantes durante la primavera y el verano en los lagos playa de las Grandes Planicies Sureñas. Sin embargo, poca información existe sobre su dieta y posición en la estructura trófica. Porque los recién metamorfoseados son más abundantes que los otros estadios terrestres de anfibios, describimos las dietas de animales recientemente metamorfoseados (<2 semanas) de las especies del sapo de las Grandes Planicies (*Bufo cognatus*), la salamandra tigre (*Ambystoma tigrinum*), y el sapo montícula de espuela (S*pea multiplicata*). El cultivo de la tierra ha alterado de gran manera el hábitat de la mayoría de los lagos playa (>95%), por lo que también examinamos el efecto de este factor sobre las dietas de metamorfoseados de *B. cognatus*. La presa principal de las tres especies fue coleóptera y no hubo diferencias entre especies en la diversidad de presas. La cantidad de presas específicas consumidas sí varió. *Bufo cognatus* consumió más escarabajos escárabos y hormigas formícidas que *S. multiplicata* y *A. tigrinum*. Los recién metamorfoseados de *S. multiplicata* consumieron más escarabajos crisomélidos y elatéridos que *A. tigrinum* o *B. cognatus*. Debido a la gran cantidad de metamorfoseados, hay una alta posibilidad que ellos tengan una influencia fuerte sobre la producción secundaria en los lagos playa. Metamorfoseados de *B. cognatus* que residen en lagos playa con cuenca pastizal tuvieron una dieta más diversa que los en lagos playa con cuenca de cultivos. Esfuerzos para la conservación de anfibios en las Grandes Planicies Sureñas deben enfocarse en la preservación de lagos playa con cuencas de pastizales nativas o en la restauración de los que han sido alterados.

Playa wetlands are the primary wetland habitat for amphibians in the Southern Great Plains (Anderson et al., 1999*a*). Playas are shallow (generally <2 m), depressional wetlands that only receive water from precipitation or runoff and lose water only through evaporation, transpiration, and recharge (Smith, 2003). There are approximately 25,000 to 30,000 playas in the region (Osterkamp and Wood, 1987), although they only occupy about 2% of the extensively cultivated landscape (Haukos and Smith, 1994). Given the semi-arid climate of the region, water availability in playas for successful reproduction of amphibians is highly variable on a seasonal and annual basis (Bolen et al., 1989). Cultivation of the watershed surrounding playas has further influenced the availability of water in playas by increasing sedimentation and altering hydroperiods (Luo et al., 1997). These influences on hydroperiod can affect population and community attributes of the entire amphibian assemblage (Skelly, 1997; Gray, 2002).

Although amphibians are the most numerous vertebrate group inhabiting wet playas of the Southern Great Plains during spring and summer (Smith, 2003), their importance in playa trophic structure is unknown. Great Plains toad (*Bufo cognatus*), New Mexico spadefoot (*Spea multiplicata*), and barred tiger salamander (*Ambystoma tigrinum*) are typically dominant (Anderson et al., 1999*a*; Gray, 2002). Information on the diets of these species is necessary to better understand amphibian life history, the importance of amphibians in playa wetland trophic structure, and the potential influence of landscape modification on amphibian population and community structure (e.g., Toft, 1981; Beebee, 1996; Anderson et al., 1999*b*).

The objectives of this study were to describe and compare the diets of recently emerged sympatric barred tiger salamander, Great Plains toad, and New Mexico spadefoot metamorphs in playa wetlands from West Texas, and to examine potential influence of anthropogenic landuse on diets of metamorphs of the Great Plains toad. Moreover, we selected new metamorphs because they emerge in large numbers (e.g., >10,000/night/6-ha playa; Gray, 2002) and are more numerous than adults, potentially intensifying competitive relationships among species at this life stage (Werner and Gilliam, 1984; Flowers and Graves, 1995). Because the historical landscape of the Southern Great Plains was primarily shortgrass prairie (Haukos and Smith, 1997)

TABLE 1—Aggregate proportional mass and familial diversity and richness of invertebrates in stomachs of metamorph Great Plains toad (GPT; n = 17 stomachs), New Mexico spadefoot (NSF; n = 13), and barred tiger salamander (BTS; n = 21) at 4 cropland playas on the Southern High Plains, Texas, 1999.

Order and indices	Family	GPT			NSF			BTS		
		Mean[a]		*SE*	Mean[a]		*SE*	Mean[a]		*SE*
Arachnidae	unknown	0.047	A	0.041	0.160	A	0.091	0.143	A	0.072
Coleoptera	Carabidae	0.006	A	0.006	0.051	A	0.041	0.184	A	0.075
	Chrysomelidae	0	A	0	0.013	B	0.007	0	A	0
	Cleridae	0	A	0	0.004	A	0.004	0	A	0
	Curculionidae	0.014	A	0.014	0	A	0	0.014	A	0.014
	Dytiscidae	0	A	0	0.019	A	0.019	0	A	0
	Elateridae	0	A	0	0.157	B	0.099	0	A	0
	Histeridae	0	A	0	0.009	A	0.009	0	A	0
	Scarabaeidae	0.383	A	0.102	0.034	B	0.034	0	B	0
	Staphylinidae	0.057	A	0.036	0.023	A	0.018	0	A	0
	unknown	0	A	0	0.077	A	0.077	0	A	0
Collembola	unknown	0	A	0	0.043	A	0.037	0	A	0
Diptera	Tephritidae	0.018	A	0.013	0	A	0	0	A	0
Hemiptera	Lygaeidae	0.001	A	0.001	0	A	0	0	A	0
	Miridae	0.037	A	0.037	0.089	A	0.075	0.013	A	0.013
	unknown	0	A	0	0.008	A	0.008	0	A	0
Homoptera	Aleyrodidae	0.045	A	0.045	0	A	0	0	A	0
	Cicadellidae	0	A	0	0.001	A	0.001	0.003	A	0.003
	Psyllidae	0.003	A	0.003	0	A	0	0	A	0
Hymenoptera	Formicidae	0.017	A	0.008	0.007	B	0.007	0.005	B	0.005
Lepidoptera	unknown	0.058	A	0.058	0	A	0	0	A	0
Orthoptera	Acrididae	0	A	0	0.007	A	0.007	0.178	A	0.081
	Gryllidae	0	A	0	0	A	0	0.087	A	0.060
Unknown	unknown	0.313	A	0.095	0.292	A	0.118	0.202	A	0.082
Vegetation		0	A	0	0	A	0	0.122	A	0.063
Diversity[b]		0.461	A	0.101	0.509	A	0.176	0.262	A	0.074
Richness		2.41	A	0.322	2.85	A	0.062	1.667	A	0.187

[a] Means within rows followed by unlike uppercase letters are different ($P \leq 0.05$) by an overall Kruskal-Wallis nonparametric test and subsequent pairwise Bonferroni-corrected Wilcoxon tests (Conover, 1980:216, 229).

[b] Diversity calculated using the Shannon's Index.

and is now largely cultivated, we selected Great Plains toad metamorphs from playas with native grassland and those with cultivated watersheds to compare their diets.

The study was conducted in 8 playas in Castro, Hale, and Floyd counties, Texas. These 3 counties contain more than 2,500 playa wetlands (Haukos and Smith, 1994). Playas in this region are lined with the hydric soil, Randall clay (Allen et al., 1972), are nearly circular in shape, and range in size from <1 ha to 200 ha. The majority of precipitation for this region falls between May and September, peaking in May and again in September, and averages 48 to 50 cm (National Oceanic and Atmospheric Administration, 2001).

We collected all 3 species in June 1999 from 4 playas with cropland watersheds (Table 1; Great Plains toad = 17, New Mexico spadefoot = 13, barred tiger salamander = 21) and Great Plains toads (n = 47) from an additional 4 playas with native grassland watersheds. All individuals were collected within 2 weeks of metamorphosis with drift fences and pitfall traps placed around playas (Gray, 2002). Metamorphs were euthanized in MS 222 (Texas Tech University Animal Welfare Protocol Permit 99843) and preserved in 70% ethanol.

We removed stomachs in the laboratory and separated contents by invertebrate family (Borror et al., 1989; Pennak, 1989), vegetation, or unknown material (e.g., detritus). Items were

TABLE 2—Familial diversity and richness and total dry mass (g) in stomachs of metamorph Great Plains toads between individuals at cropland and grassland playas using snout–vent length (SVL) as a covariate, Southern High Plains, Texas, 1999.

	Landuse				*P*-value	
	Cropland		Grassland			
Variable	Mean[a,b]	*SE*	Mean	*SE*	Landuse	SVL[d]
Diversity[c]	0.046	0.101	0.882	0.066	0.017	0.903
Richness	2.412	0.322	4.255	0.296	0.019	0.589
Mass	0.009	0.002	0.047	0.008	0.705	0.009

[a] $n = 17$ (cropland) and 47 (grassland) stomachs for diversity and richness; $n = 17$ and 53 stomachs for mass; empty stomachs were deleted from the analyses for the diet composition variables.

[b] Mean and *SE* of richness and mass were back-transformed from natural-logs.

[c] Diversity was calculated using Shannon's Index.

[d] Covariate.

then dried to a constant mass at 60°C. We then calculated aggregate percent mass for all diet items (Litvaitis et al., 1994). Under this procedure, each individual amphibian is given equal importance. We also calculated the diversity of items in the diet, by invertebrate family, using Shannon's diversity index (Magurran, 1988).

We compared percent mass of individual invertebrate taxa, richness, and diversity of diet items among amphibian species using separate Kruskal-Wallis tests (Conover, 1980). If the Kruskal-Wallis test was significant ($P < 0.05$), we compared percent mass of taxa, richness, and diversity between species using a Bonferroni-corrected Wilcoxon test for each Kruskal-Wallis test (Conover, 1980). Therefore, there were 3 possible pairwise comparisons for each significant Kruskal-Wallis test. Because amphibian consumption of one invertebrate category can influence consumption of another, invertebrate categories are not necessarily independent of each other.

To compare diets (i.e., mass, diversity, richness) of Great Plains toad metamorphs between landuses, we used an analysis of covariance, with body size as the covariate because body size is influenced by landuse (Gray, 2002). Body size can influence prey selection (e.g., mass, taxa, diversity) in terrestrial amphibians (Boice and Williams, 1971; Duellman and Trueb, 1994:230); thus, it is a possible continuous nuisance variable (i.e., covariate) of landuse main effect responses. Because snout-vent length was correlated with diversity ($r = 0.26$, $P = 0.03$), richness ($r = 0.35$, $P = 0.004$), and mass ($r = 0.43$, $P < 0.001$) in diets of the toads, we used it as a covariate to correct for this influence in the analysis. Although Great Plains toad metamorphs were of similar post-emergence age, they were larger in playas with grassland watersheds (mean = 38.2 mm, *SE* = 0.9) than those surrounded by cropland (mean = 24.5 mm, *SE* = 2.5). Richness and mass data were natural-log transformed to meet standard normal assumptions.

Richness and diversity ($\chi_2^2 = 2.76, 3.56$; $P > 0.17$) of invertebrate taxa consumed by metamorphs did not differ among barred tiger salamander, Great Plains toad, and New Mexico spadefoot (Table 1). The diet of all 3 amphibian species was dominated by coleopteran taxa. New Mexico spadefoots consumed more chrysomelids and elaterids than tiger salamanders and Great Plains toads ($\chi_2^2 = 9.12, 9.13$; $P < 0.01$). Great Plains toads consumed more scarab beetles and formicid ants ($\chi_2^2 = 6.59, 18.42$; $P < 0.04$) than tiger salamanders and New Mexico spadefoots (Table 1).

In the analysis of covariance, Great Plains toad metamorphs had a much more diverse ($F_{1,67} = 5.78, 6.01$; $P \leq 0.019$) diet in playas with grassland watersheds than in playas with cropland watersheds (Table 2). The relative amount of food consumed by Great Plains toads in cropland playas did not differ from those in grassland playas ($F_{1,67} = 0.14$, $P = 0.705$) (Table 2).

Similar to breeding adult anurans in the playas of the Southern High Plains (Anderson et al., 1999*b*), the diets of recently emerging metamorphs of barred tiger salamander, Great Plains toad, and Mew Mexico spadefoot were dominated by coleopterans. This likely reflects widespread availability of coleopterans in the landscape and their nocturnal activity, which coincides with newly metamorphosed amphibian nocturnal foraging. Scarabs, staphylinids, and curculionids were prominent in the diets of metamorphs. Unlike what Anderson et al. (1999*b*) found for adults, we found little variation in diet diversity among Great Plains toad, barred tiger salamander, and New Mexico spadefoot metamorphs. Possibly there is less variation in mouth/gape size and, therefore, in size of prey that can be consumed (e.g., Sites, 1978) among metamorphs than adults. However, we lack prey availability data to directly test this hypothesis.

Stebbins and Cohen (1995) suggested that, in amphibians, intraspecific competition for food was more likely than was interspecific competition. Support for this hypothesis is based on the variety of specific habitat preferences, temporal variability in feeding times, and foods consumed (Burton, 1976; Fraser, 1976; Toft, 1981). Anderson et al. (1999*b*) cited interspecific differences in adult diet richness as support for this idea. We, however, found little difference in diet diversity among species in the metamorph stage. Further, all 3 species emerge from their aquatic larval stages at similar times (Gray, 2002), they all feed nocturnally, and they all use the same habitat (playa wetland margins). This suggests that interspecific competition at the metamorph life stage is more intense than at later stages. Moreover, the much higher numbers of metamorphs than adults might increase interspecific and intraspecific competition at this life stage.

Because new metamorphs of New Mexico spadefoot, barred tiger salamander, and Great Plains toad emerge from their aquatic playa life stage in such large numbers, their influence on the invertebrate community in the dry portions of the playa wetland and immediate shoreline is likely substantial. Playas are virtually the only nonagricultural habitat in the region; playas are farmed to the immediate margin of the wetland (Haukos and Smith, 1994). Therefore, given their abundance, dominant vertebrate status in playas (Smith, 2003), and diet, amphibians likely play a significant role in the trophic structure of this environment. Amphibians are seldom considered significant in the trophic structure of most wetlands (Mitsch and Gosselink, 2000).

Because the vast majority (>95%) of playas exist in a highly cultivated landscape (Haukos and Smith, 1994), the diets of amphibians in croplands likely reflect current diets for the majority of new metamorph amphibians throughout the region. There are relatively few playas remaining with native grassland watersheds, and as reflected in the diets of Great Plains toad metamorphs, cultivation seems to have influenced the diets of amphibians inhabiting most playas.

Great Plains toad diets were more diverse at grassland than cropland playas. Because we partitioned variation in diets associated with body size, Great Plains toads consumed a greater diversity of invertebrate prey at grassland playas. Presumably, this was a consequence of prey availability. Cultivation of the watershed and insecticide use could influence prey available to new metamorphs (Freemark and Boutin, 1995). In addition, watershed cultivation greatly alters playa flora and potentially alters invertebrate communities (Smith and Haukos, 2002).

The smaller body size of Great Plains toads in playas in cultivated landscapes than in those with native grassland watersheds also influenced the amount of food consumed. Great Plains toad metamorphs in grassland landscapes consumed greater mass of invertebrates than in cropland playas. Consumption of greater food quantities might afford individuals in grassland playas better physiological condition, which might increase probability of survival and reproduction.

Hydroperiods in playas with cultivated watersheds are often shorter than in playas with native grassland watersheds, primarily as a result of soil erosion (Luo et al., 1999), potentially changing much of the biotic interactions within the wetland (e.g., Skelly, 1997). For example, there might be less food available to amphibian larvae in playas with cropland watersheds, which could influence larval growth, causing metamorphs to be smaller (Wilbur, 1977; Newman, 1994; Wallis, 1998), subsequently influencing the diversity of prey that metamorphs can consume due to gape limitations. It also is possible that shorter hydroperiods might cause metamorphs to emerge at a smaller size to reduce the risk of desiccation (Newman, 1989; Denver et al., 1998). Regardless of the reason, the smaller body size might influence amphibian ability to capture and consume some prey (Newman, 1999), and the smaller body size of amphibians in playas with cropland watersheds is retained through all post-metamorphic life stages (Gray, 2002), potentially influencing fitness (Smith, 1987; Morey and Reznick, 2001).

Because playa wetlands are the primary habitat for amphibians in the Southern Great Plains, efforts aimed at conserving amphibians should focus on playa preservation. Further, effort should first focus on conserving those few remaining playas with intact native grassland watersheds and restoring hydroperiod to those with cultivated watersheds (Smith and Haukos, 2002). We also urge caution in the use of insecticides surrounding playas because their use not only affects the prey base for terrestrial amphibians directly, but insecticides can alter larval amphibian foraging in the aquatic environment (Semlitsch et al., 1995).

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GENUS *SYRRHOPHUS* (ANURA: LEPTODACTYLIDAE) IN LOUISIANA

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ABSTRACT—The genus *Syrrhophus* is recorded for the first time from Louisiana due to the discovery of a population of *Syrrhophus cystignathoides* in Shreveport. The frogs have been documented during 4 years. Calling males and a female with large yolked eggs indicated that this species was reproducing and surviving.

RESUMEN—El género *Syrrhophus* es registrado por primera vez en Louisiana debido al descubrimiento de una población de *Syrrhophus cystignathoides* en Shreveport. Las ranas han sido documentadas durante 4 años. El encuentro de machos cantando y una hembra con huevos grandes con yema indica que la especie estuvo reproduciéndose y sobreviviendo.