PRELIMINARY FOOD STUDIES OF *CYPRINODON MACULARIUS* AND *CYPRINODON NEVADENSIS* (CYPRINODONTIDAE).—Endemic pupfishes (*Cyprinodon*) inhabiting isolated springs and streams in the southwestern United States and northern Mexico are being subjected to increasing environmental stress. Diversion of water for other uses, permanent alteration of habitats, and interspecific competition from introduced species have become serious problems (Pister, Trans. Am. Fish. Soc. 103:531–540, 1974). Any contributions to an understanding of the basic life history of pupfishes will be important to their management. This brief note presents some information on the food habits of two pupfish species.

Desert pupfish (*Cyprinodon macularius*) are found in shore pools of the Salton Sea, California. Amargosa pupfish (*Cyprinodon nevadensis amargosae*) inhabit the Amargosa River and several springs near Tecopa and Shoshone, CA, as well as some isolated pools at the southern tip of Death Valley Nat. Mon. The Saratoga Springs pupfish (*Cyprinodon nevadensis nevadensis*) is restricted to Saratoga Springs at the southern edge of the monument (Miller, Misc. Publ. Mus. Zool. Univ. Michigan 68:1–155, 1948).

Desert pupfish were collected from shore pools 4 km W North Shore, CA, and Amargosa pupfish from the Amargosa River at Tecopa, CA, by seining. Saratoga Springs pupfish were taken from the main spring pool by unbaited traps left in place for 5 min. All specimens were immediately preserved in 10% formalin; no regurgitation was noted upon preservation. Both adults and juveniles were used for food analysis in approximate proportion to their frequency in the samples.

Contents of the entire gut were used, since *Cyprinodon* does not have a distinctly recognizable stomach. Food materials were categorically separated into algae, vascular plants, inorganic detritus, organic detritus, and animals. Three criteria were used to discern the relative importance of each food: (1) frequency of occurrence, (2) numbers method (animals only), and (3) a modified points method (Hynes, J. Anim. Ecol. 19:36–58, 1950; Naiman, Trans. Am. Fish. Soc. 104:536–538, 1975). A total of 223 fish was examined.

Cyprinodon macularius. On 20 Jun., animals comprised 56.5% of the gut volume, algae occupied 33.2%. On the morning of 4 Aug., animals (56%) still predominated, but the secondary item in the diet was detritus (43%). A collection was taken the next day, also in the early morning, about 50 m from the other in the same general type of habitat; but the diet differed considerably. These fish had fed predominantly on algae (54%) and animals (30%); no detritus was ingested. On 24 Oct., large amounts of sand (15%) and empty space (19%) were found, although detritus (33%) and animals (30%) still accounted for most of the diet.

A large proportion of the animal diet was chironomid larvae, dipteran pupae (mostly chironomids), and lepidopteran larvae (subfamily Nymphulinae: aquatic caterpillars) (Table 1). Ostracods were important on one date. Dipteran adults (mostly chironomids), large dipteran larvae (other than chironomids), and miscellaneous fishes (all other than *Cyprinodon*) were minor components of the diet. Animal food items were often mixed with algae or detritus. "Pit-digging," as a behaviorial feeding adaptation, is accomplished with the mouth, which may account in part for the diverse mixture of animal, detrital, and algal materials (Minckley and Arnold, J. Arizona Acad. Sci. 5:254–257, 1969).

Cyprinodon nevadensis amargosae. Detritus, containing numerous diatoms, made

TABLE 1

Composition of animal food items found in the guts of Cyprinodon macularius, C. nevadensis amargosae, *and* C. n. nevadensis. *Frequency of occurrence (% Freq.), percentage of total number of animals ingested (% Total), and sample size (n) are given for each date.*

Animal Food Item	*Cyprinodon macularius* 20 Jun 1970 n=30 % Freq.	% Total	4 Aug 1970 n=15 % Freq.	% Total	5 Aug 1970 n=30 % Freq.	% Total	24 Oct 1970 n=21 % Freq.	% Total	*Cyprinodon n. amargosae* 20 Oct 1970 n=30 % Freq.	% Total	21 Nov 1970 n=30 % Freq.	% Total	*Cyprinodon nevadensis nevadensis* 20 Oct 1970 n=30 % Freq.	% Total	21 Nov 1970 n=30 % Freq.	% Total	19 Mar 1971 n=7 % Freq.	% Total
Diptera adult	43.3	1.1	0	0	0	0	0	0	0	0	0	0	0	0	3.3	<0.1	0	0
Diptera pupae	63.3	13.2	80.0	6.4	36.7	16.7	4.8	<0.1	10.0	84.6	6.7	1.8	3.3	<0.1	0	0	0	0
Diptera larvae	13.3	0.2	0	0	10.0	2.6	0	0	0	0	0	0	0	0	0	0	0	0
Chironomid larvae	66.7	8.0	93.3	83.3	40.0	68.8	61.9	59.2	3.3	<0.1	13.3	4.6	3.3	<0.1	0	0	0	0
Lepidoptera larvae	13.3	0.3	53.3	10.0	0	0	42.9	40.8	0	0	0	0	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0	0	0	0	0	0	0	6.7	4.1	0	0	0	0
Odonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.3	<0.1	0	0
Notonectidae	10.0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostracods	70.0	76.7	0	0	0	0	0	0	3.3	<0.1	13.3	15.6	10.0	8.2	10.0	3.3	14.3	11.8
Copepods	0	0	0	0	0	0	0	0	0	0	13.3	78.0	13.3	17.5	0	0	0	0
Amphipods	0	0	0	0	0	0	0	0	0	0	0	0	13.3	45.4	46.7	32.9	42.9	41.2
Gastropods	0	0	0	0	0	0	0	0	0	0	0	0	23.3	22.7	53.3	63.8	42.9	23.5
Hydracarina	0	0	0	0	0	0	0	0	0	0	0	0	6.7	2.1	0	0	0	0
Invertebrate eggs	13.3	0.5	0	0	6.7	0.5	0	0	0	0	0	0	0	0	0	0	0	0
Cyprinodon eggs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28.6	23.5
Poecilia latipinna	0	0	0	0	13.3	5.6	0	0	0	0	0	0	0	0	0	0	0	0
Gillichthys mirabilis	0	0	0	0	10.0	3.7	0	0	0	0	0	0	0	0	0	0	0	0
Unknown fish	0	0	6.7	0.3	10.0	2.1	0	0	0	0	0	0	0	0	0	0	0	0
Unknown invertebrates	3.3	<0.1	0	0	0	0	4.8	<0.1	6.7	15.4	0	0	3.3	<0.1	0	0	0	0
TOTAL NUMBER INGESTED		3633		1243		1078		154		17		109		102		312		17

up a major portion of the gut volume (65% in Oct., 90% in Nov.). In Oct., a large proportion of the gut was empty, although no external evidence of starvation was noticeable. Algae, vascular plants, and animals were not important food items in either collection and little inorganic material was ingested.

Invertebrate diversity is low in the Amargosa River when compared to nearby springs (Naiman, unpubl.) and is reflected in the few taxa of invertebrates eaten (Table 1). In autumn, invertebrates were neither abundant nor an important food item, yet their frequency of occurrence was relatively high (22% in Oct., 42% in Nov.).

The Amargosa pupfish may be considered an omnivore, rather than a detritivore. Its selection of food in autumn appears dictated by biological and physico-chemical restrictions placed upon the food supply and its composition. Animal food items probably become more important in other seasons.

Cyprinodon nevadensis nevadensis. Detritus made up the bulk of the gut volumes: 41% in Oct., 44% in Nov., and 83% in Mar.; however, algae also contributed significantly (17%, 18%, and 17%, respectively). Vascular plants, primarily *Ceratophyllum demersum* (8 to 13%) and *Tamarix* flower buds (19% in Oct.), and animals (3 to 20%) were minor food items. Empty space and inorganic materials were not important elements. Small gastropods (hydrobiid snails), amphipods, and ostracods were numerous, while other invertebrates were uncommon (Table 1).

The Saratoga Springs pupfish appears more diversified in its feeding habits than the Amargosa pupfish, but this may only be a reflection of the habitat. Large beds of *Ceratophyllum* and filamentous algae in Saratoga Springs provide a greater number of microhabitats which support a greater diversity of invertebrates. Animals were mixed with detritus and *Ceratophyllum* or were eaten in groups. The appearance of invertebrates in the gut and the spatial arrangement relative to detritus and plant materials suggest that invertebrates were the primary target, with other materials accidentally ingested. Algae and *Ceratophyllum* in the hindgut were not completely digested, whereas all invertebrates were attacked by digestive enzymes.

Food habits reported here appear to have been dictated by environmental constraints upon the food supply. Pupfish actively select mosquito larvae and other small invertebrates when placed in artificial outdoor pools; when such items become scarce, they will begin extensive bottom foraging (Naiman 1975).

Algae ingested by pupfish appeared to be viable, even if taken from the hindgut. The lack of algal digestion has also been noted in the Red River pupfish (*C. rubrofluviatilis*) and the sheepshead minnow (*C. variegatus*) (Martin, Southwest. Nat. 14:351–375, 1970). Breder (Zoologica 18:58–88, 1934) reported, however, that *C. baconi* subsisted largely on a diet of the red alga *Batophora*. The role of the Cyanophyta and other algae as nutrition in the diet of *Cyprinodon macularius* and *C. nevadensis* is not clearly understood, and is in need of further investigation.

Diatoms found in the Amargosa pupfish were digested relatively quickly; frustules were all that remained in the hindgut. Arnold (Unpubl. Ph.D. dissert., Arizona State Univ., 138 pp., 1972) attempted to determine if *Cyprinodon bifasciatus* from the Bolson of Cuatro Cienegas in Coahuila, Mexico, was able to digest diatoms by comparing oils from the plants to stored fats in the visceral masses of the fish by thin-field chromatography. Her results appear to substantiate digestion of diatoms by that fish.

Both *Cyprinodon macularius* and *C. nevadensis* are omnivorous feeders. This is substantiated by the results of this and other studies (Cox, J. Arizona Acad. Sci. 7:25–27, 1972; Leser and Deacon, unpubl., Final Rep. Res., Nat. Park Serv., Contr. 14-10–0434–1989, 1968). Desert pupfish show spatial and temporal changes in the number and species of animals eaten and in the percentage of each food category eaten. Amargosa pupfish will select invertebrates when they are available, but will eat detritus at other times. Saratoga Springs pupfish ingest a wide variety of foods in their relatively diverse habitat.

In general, when invertebrates are available they are the primary target of foraging pupfish. As invertebrates become less available, either through cropping or other factors, pupfish begin to ingest other food items in larger amounts. Algae, exclusive of diatoms, and vascular plants do not appear to be nutritionally important to either species, but still may be a functional part of the diet. Invertebrates, detritus, and diatoms probably provide most food energy, and are ingested in various proportions dependent upon local conditions.

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ADDITONAL RECORDS OF SOME MEXICAN BATS.—During the last few years a series of bats has been incorporated in the Collection of Mammals of the Instituto de Biologia (IB) of the National Autonomous University of México. Some of them are of special interest because they represent significant extension of known geographic ranges; others close gaps in known geographic distribution or otherwise complement published information. Measurements are given in mm, capitalized color-names are those of Ridgway (Color standards and color nomenclature, Washington, 43 pp., 1912).

Enchisthenes hartii (Thomas 1892). A female (13211) was caught 28 km (by road) N Tecpan de Galeana, Guerrero, 350 m. This specimen was caught in a mist-net set along a shallow riverbed adjacent to a hill approximately 200 m high. Numerous wild figs, macahuite, and zapotillo trees along the stream provided a darkened area beneath the canopy. Other bats netted in the same nets were *Pteronotus parnelli, Glossophaga soricina, Sturnira lilium, Artibeus jamaicensis, A. lituratus* and *Desmodus rotundus.*

As this species has been recorded before on the Pacific Slope in the states of Jalisco (de la Torre, Fieldiana, Zool. 37:695–701, 1955; Villa-R., Los murciélagos de México. Instit. Biol. Nac. Autón. México, 491 pp., 1967; Goodwin, Bull. Am. Mus. Nat. Hist. 141:1–269, 1969; and Watkins, Jones, and Genoways, Spec. Publ. Mus. Texas Tech Univ. 1:1–44, 1972), Oaxaca (Goodwin 1969), and Chiapas (Baker, Southwest. Nat. 12:407–428, 1967; Baker, Webb, and Stern, An. Instit. Biol. Univ. Nac. Autón. México 42, Ser. Zool. 1:77–85, 1971), its existence in Guerrero was to be expected.

Hylonycteris underwoodi minor Phillips and Jones 1971. A female (13587) was netted 30 km (by road) SE Tepic, Nayarit, 1250 m, at the bottom of a ravine. The mist-net was set over a pool in the flowing stream. The surrounding