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Diet of *Agonostomus monticola* (Pisces: Mugilidae) in the Río Ayuquila, Sierra de Manantlán Biosphere Reserve, México

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Abstract: We quantified the diet of Agonostomus monticola during the wet and dry seasons of 1990 in a 15 km reach of the Río Ayuquila, a Pacific tributary of west-central México. The species consumed 32 animal and 9 plant families, with aquatic insects (mainly Diptera, Ephemeroptera, and Trichoptera) and algae (mainly Chlorophyta) as primary prey. Animal material dominated the diet in the wet season but was only slightly more important than plant material in the dry season. Animal material increased in importance with fish size for specimens 151-300 mm total length. Río Ayuquila A. monticola ate fewer shrimp, Odonate insects, fish, and fruit than other studied populations. The broad diet of A. monticola suggests that it is an opportunistic feeder

Key words: Agonostomus monticola, Mugilidae, México, Sierra de Manantlán, food habits, insects, algae.

Agonostomus monticola (Mugilidae) is an important food fish in the rivers of the Sierra de Manantlán Biosphere Reserve, west-central México, as well as in many other parts of tropical America (Lyons and Navarro-Pérez 1990, Santana-C. et al. 1990). However, A. monticola populations in the Manantlán reserve and elsewhere are declining, and additional information on the species life history and ecology is needed to aid in conservation. In this paper we characterize the diet of A. monticola, known locally as the "trucha de tierra caliente", in the Río Ayuquila, the largest river in the Manantlán reserve. A companion study (Navarro-Pérez 1992) examined other aspects of the biology of A. monticola in the Río Ayuquila.

Some data on the feeding of A. monticola are available from Costa Rica (Winemiller 1983, Bussing 1987), Honduras (Cruz 1987), Trinidad (Phillip 1993), and the United States (Loftus et al. 1984). Agonostomus monticola has been characterized as either an insectivore (Winemiller 1983, Cruz 1987) or an omnivore, feeding on both algae and aquatic invertebrates (Loftus et al. 1984, Bussing 1987, Phillip 1993). However, sample sizes were small (< 5 stomachs) for all but the Cruz (1987) and Phillip (1993) studies. Moreover, published data may not be completely applicable to Mexican populations, as what is currently referred to as A. monticola could represent a complex of at least two species (Miller 1995). Populations in the Manantlán reserve may be both taxonomically and ecologically different from previously studied populations, and specific data from reserve populations are needed.

Study area: All data were collected from the Río Ayuquila, which forms the

northeastern boundary of the Sierra de Manantlán Biosphere Reserve (RBSM) in the state of Jalisco. The Río Ayuquila originates about 100 km north of the reserve and flows along the reserve for about 40 km before joining with the Río Tuxcacuesco to form the Río Armería, which flows approximately another 150 km before emptying into the Pacific Ocean. The river in the reserve experiences a tropical climate, with a mean annual air temperature of 28°C and a water temperature of 26°C (Torres-Navarro 1994). There is a wet season from May through October, and a dry season from November through April, with almost no rain from February through April. The study area encompasses 15 km of the river between the villages of Guamuchil (104° 01' W 19° 35' N) and Ventanas (104° 06' W 19° 41' N). The river here has a mean width of 31 m and a mean thalweg depth of 1.1 m, with numerous pools and rapids. Substrate is mainly boulder and rubble, with some sand and gravel.

Field sampling: We sampled for nine months in 1990, four in the dry season (November, February, March, and April) and five in the wet season (May, July, August, September, and October). Each month, digestive tracts of freshly captured A. monticola were obtained from local fishermen. They fished between 06:00 and 22:00 hours and captured fish by cast net in the dry season and hooks with worms in the wet season. Digestive tracts were removed from captured fish and immediately preserved in 5% formalin for later examination in the laboratory (Korschgen 1987). Total length and weight were recorded from captured fish.

Laboratory analyses: All food organisms were identified (Alvarez del Villar 1970, Barnes 1977, Wiggins 1977, Merrit and Cummins 1978, Hurlbert et al. 1981, Ortega 1984 y Burch 1987) to family and counted and weighed, and then their volume was estimated by water displacement. For each food item up to five diet indices were calculated (Hyslop 1980): percentage number (N; number of individuals of food item divided by total individuals of all food items), percentage dry weight (W), percentage volume (V), frequency of occurrence (F; number of stomachs with item divided by total number of stomachs examined), and index of relative importance (IRI = [N + V] X F). Index values were compared between length groups and season with analysis of variance and Duncan Multiple Range tests ($P > 0.05$).

A total of 140 specimens of A. monticola were examined during the study. These fish ranged from 92-428 mm total length, with a mean total length of 211 mm and weight of 128 g. Digestive tracts were obtained from 135 specimens. The digestive tract consisted of mouth, esophagus, stomach, two pyloric cacae, intestine, and anus. The inside wall of the stomach typically had thick, parallel folds, although in a few cases these folds were irregular or absent. One of the pyloric cecae was always longer than the other, and both were usually lined with thin irregular folds.

Of the 135 stomachs examined, 125 contained food (93%). We encountered 32 animal and 9 plant families in stomachs, which we aggregated into 8 taxonomic groups: nematodes (1 family), molluscs (2), crustaceans (2), arachnids (1), insects (25), fish (1), algae (7), and other plants (2) (Table 1). Some material could not be identified to family. On average, about five different families were encountered in each stomach with food.

The diet of A. monticola differed significantly between seasons. In the wet season (43 stomachs), animal material was significantly greater than plant material in N (73%), V (55%), W (61%), and IRI (78%). In the dry season (92 stomachs), animal material was equal to plant material in N (50%), V (48%), and W (49%), but greater in IRI (61%). Insects were the most frequently encountered food items in both seasons, with F of 52% in the dry and 42% in the wet season (Fig. 1). The most common families were Chironomidae and Simulidae (Diptera), Baetidae and Siphlonuridae (Ephemeroptera), and Hydroptilidae and Hydropsychidae

(Trichoptera). Algae had the second highest F values at 24% in the dry and 22% in the wet season. The most common families were Chaetophoraceae, Cladophoraceae, and Rhodomelaceae (Chlorophyta). In the dry season, the third highest F was for molluscs (10%; Hydrobiidae and Corbiculidae) and the fourth was for unidentified animal material (7%). However in the wet season, unidentified animal material was third (21%) and Nematodes were fourth (4%; Lumbricidae).

Diet was significantly different among size classes of A. monticola, with larger individuals eating relatively more animal material. We established eight 50 mm total length classes between 51 and 450 mm. However, sample sizes were sufficient for analysis only in the three size classes from 151 to 300 mm. For the 151-200 mm group (46 stomachs), plant material was greater by N (51%), V (80%), and W (78%). In the 201-250 mm group (63 stomachs), animal material was greater by N (55%) but plant material was greater by V (56%) and W (58%). In the 251-300 mm group (14 stomachs), animal material was greater by N (77%), V (58%), and W (62%).

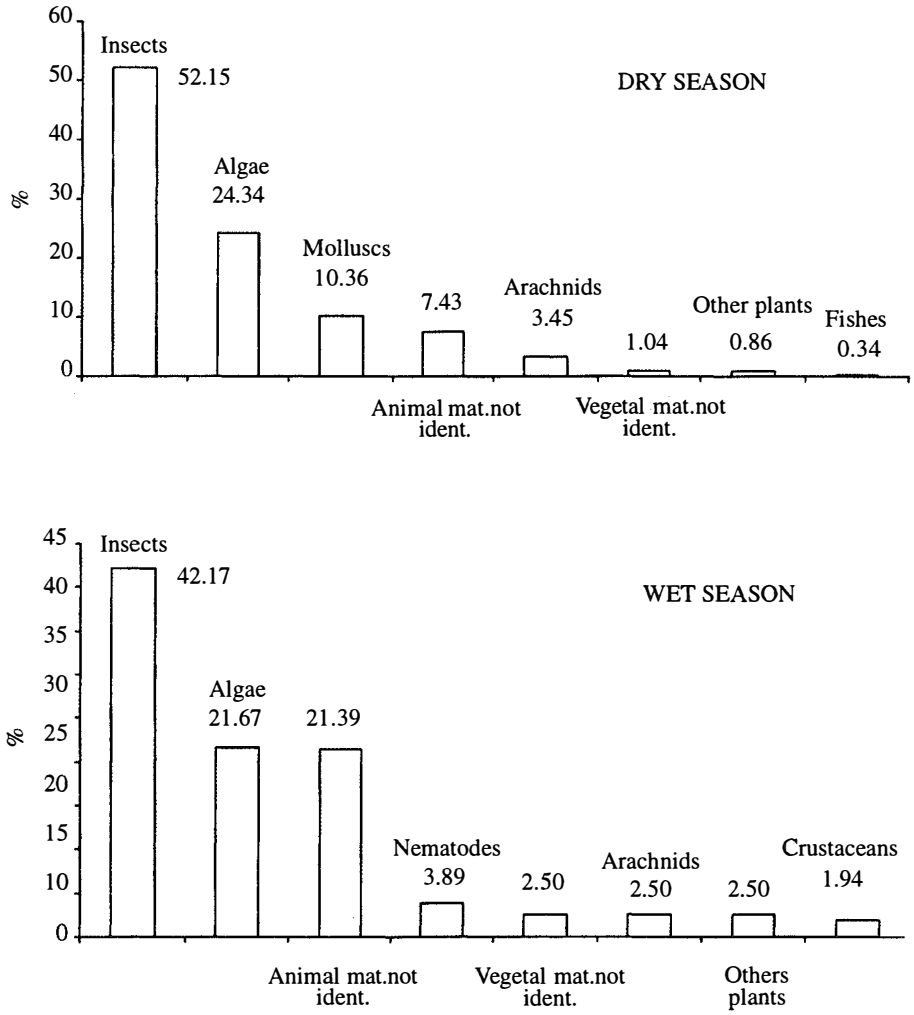

Fig. 1: Frequency of occurrence of different food items of *A. montico la.*

In the Río Ayuquila, A. monticola feeded somewhat more on animal than plant material. This finding was consistent with results from previous studies (Loftus et al. 1984, Bussing 1987, Phillip 1993). In the Río Ayuquila, the species consumed a wide range of organisms, with aquatic insects and algae dominating. The importance of algae in the diet was lowest in the wet season, when scouring flows and high turbidity after rainstorms likely reduce the amount of algae available for consumption. Phillip (1993) also found algae to be less common in the diet in the wet than the dry season in Trinidad.

The diet of Río Ayuquila A. monticola was different in several ways from the diets of the two other populations that had been well studied. Cruz (1987) characterized A. monticola from the Río Plátano on the Atlantic slope of Honduras as primarily insectivorous. He examined many more small (< 100 mm) specimens than we did, but for his largest size category (110-215 mm standard length), he found plant material to have a V of only 9% compared to 56-80% for this size category in the Río Ayuquila. His A. monticola also consumed substantial amounts of shrimp (Crustacea; V = 20%), fish (Characidae; 18%), and Odonate insects (17%). These taxa occurred in the Río Ayuquila (Navarro- Pérez 1987, Lyons and Navarro-Pérez 1990) but were absent or infrequent in the diet of A. monticola there (F < 2%). In the Shark River, Trinidad, Phillip (1993) found the most frequently encountered diet items in the wet season to be insects (F = 52%), shrimp (35%), fruit (32%), and algae (15%). In the dry season the diet shifted to algae (66%), insects (24%), fruits (18%), and shrimp (13%). We found fruits to be infrequent in the diet of A. monticola in both the wet (3%) and dry season (1%).

The food habits of A. monticola in the Río Ayuquila allows exploitation of a wide range of food resources and should minimize the effects of shortages of a preferred item or competition with other species (Phillip 1993). A. monticola appears to be an opportunistic feeder, and this should suggests the lack of strong habitat specificity, which has been confirmed by Navarro-Pérez (1992), who found the mullet in a wide range of habitats in the Río Ayuquila. The ability to use a wide range of food resources and habitats should make A. monticola relatively tolerant of environmental variation.

TABLE 1

Food items found in stomach of A. monticola *during different sampling months*

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
PLANT MATERIAL												
Algae:												
Chlorophyta												
Cladophoraceae		X	X	X	X		X			X		
Rhodomelaceae		X		X	X		X			X	X	
Chaetophoraceae		X		X						X		
Trentepholiaceae		X		X	X							
Ulvaceae		X										
Cyanophyta												
Nostocaceae		X										
Crysophyta												
Crysophyta*			X	X						X		
Others plants:												
Acuatic fanerogama												
Podostemaceae		X					X					
Superior plant												
Leguminosae		X					X					

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
ANIMAL MATERIAL												
Crustaceans:												
Decapoda												
Potamonidae								X				
Atydae									X			
Molluscs: Gastropoda												
Mesogastropoda												
Hydrobiidae		X		X								
Corbiculidae												
Corbicula		X		X								
Nematodes: Oligochaeta												
Haplotaxia												
Lumbricidae							X					
Arachnids: Acarida												
Prostigmata												
Unionicolidae		X		X	X					X		
Fishes: Teleostomi												
Cyprinodontiformes												
Goodeidae				X								
Insects:												
Diptera												
Chironomidae		X		X	X		X			X	X	
Simuliidae		X		X	X		X			X	X	
Muscidae				X						X		
Culicidae				X								
Stratiomyidae							X					
Ephemeroptera												
Baetidae		X		X	X		X			X	X	
Siphlonuridae		X		X	X		X			X		
Leptophlebiidae				X			X			X		
Heptageniidae										X		
Trichoptera												
Hydroptilidae		X	X	X	X		X			X		
Hydropsychidae		X		X	X		X		X	X		
Limnephilidae				X								
Glossosomatidae							X					
Coleoptera												
Psephenidae				X			X			X		
Elmidae				X	X		X					
Haliplidae				X								
Carabidae		X										
Odonata												
Calopterygidae				X					X			
Aeshnidae									X			
Libellulidae									X			
Lepidoptera												
Pyralidae		X		X	X		X					
Megaloptera												
Corydalidae							X		X			
Orthoptera												
Tetrigidae		X										
Hymenoptera												
Scelionidae		X		X								
Homoptera												
Delphacidae		X										

*Could not be identified to a family.

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RESUMEN

Se cuantificó la dieta del pez Agonostomus monticola en 1990 en México. La dieta es oportunista e incluyó 32 familias de animales y nueve de plantas, pero dominó el alimento de origen animal, especialmente en individuos de 151-300 mm de longitud.

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