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A Breeding Population of *Theraps underwoodi* (Teleostei: Cichlidae) on Ometepe Island, Nicaragua, and Implications for its Dispersal Mechanisms

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ABSTRACT.—We report a first record of a breeding population of tuba, *Theraps underwoodi* Regan 1908 (Cichlidae), in its natural environment, in the Buen Suceso River on Ometepe Island in Lake Nicaragua. This population was not expected in this location since it is separated by several kilometers from the nearest known habitat of this species. *Theraps underwoodi* is known to inhabit only lotic habitats, including the San Juan River through which Lake Nicaragua empties to the Caribbean; however, it had not been reported inside Lake Nicaragua. This population may exist due to juvenile dispersal promoted by floating "islands" or rafts of vegetation following prevailing westward winds toward Ometepe island derived from the San Juan River.

KEYWORDS.—Dispersal, conservation, floating islands, stream, freshwater fishes, biogeography.

In the tropics, the paucity of basic biogeographic and ecological information on freshwater fishes limits our capacity to protect threatened fish species and use the fishery resources profitably and sustainably. In spite of particularly high levels of endemism and conservation needs of freshwater fishes in the tropics, relatively little attention has been given to their systematics, distribution and ecology (Moyle and Leidy 1992). In turn, the increasing fragmentation of freshwater habitats by human use raises our need for information to guarantee protection to species which exhibit mechanisms of dispersal among relatively isolated populations.

The biogeography and systematics of Nicaraguan freshwater fishes have been studied (Astorqui 1974; Villa 1982; Bussing 1998), and recent additions and adjustments to records have been made for cichlids in crater lakes of the Pacific region (Waid et al. 1999; Stauffer and McKaye 2002). Cichlid systematics in Nicaragua is characterized by both allopatric and sympatric speciation, and several undescribed species remain as a monophyletic species flock (McKaye et al. 2002). However, a history of social conflict and lack of infrastructure in Nicaragua have limited the extent of scientific field work.

Theraps underwoodi (Regan 1908) (=*Cichlasoma tuba* =*Tomocichla tuba*), known locally as tuba, has been reported in the Atlantic drainage from the Escondido River, Nicaragua, southward into Panama, always in rivers and streams. In Costa Rica, it has been reported in some tributary streams that diverge into Lake Nicaragua, but it has not been reported in the lake itself. *Theraps underwoodi* feeds mostly on fruits, leaves and algae, although juveniles consume aquatic insects. It prefers temperatures from 23°C to 33°C and altitudes 0-540 meters above sea level. Nomenclature and systematics of *T. underwoodi* needs revision (Bussing 1998). Although, it inhabits the San Juan River, which drains into the Nicaraguan Great Lakes, it is not reported in Lake Nicaragua or any other lentic system. Here, we present a new biogeographical record for *T. underwoodi* which is likely the result of a dispersal mechanism for a fish species that, otherwise, would be unlikely to migrate between previously recognized, and herein newly reported, habitats. We comment upon the implications on our understanding of biogeography of freshwater fishes in Nicaragua and on the conservation of these fishes in their natural habitats.

On the southwestern side of Lake Nicaragua, the tenth-largest freshwater lake in the world (Fig. 1), Ometepe is the largest freshwater island in the world, resulting of

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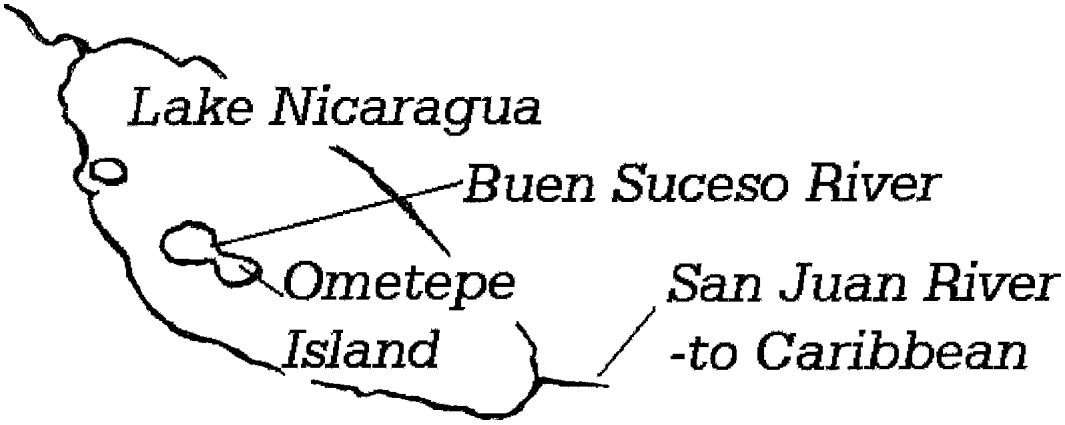

FIG. 1. Map of Lake Nicaragua with Ometepe Island.

two volcanoes dating from the modern geological epoch much more recent than the lake itself. On 20 December 2001, we snorkeled the Buen Suceso River from its mouth upriver approximately one kilometer. This river empties into Lake Nicaragua at the eastern shore of Ometepe Island, is approximately 1.5 meters deep at its confluence with Lake Nicaragua, and 8 meters wide at its widest point. The visibility is 1.5 meters or more throughout the area studied.

We sighted at least 100 adult and large juvenile tubas, including 5 breeding pairs with fry, along a 50 m stretch in the stream and located over gravel but near or under grassy overhangs in a shaded section of the stream. We found 40 free-swimming fry, with a female in one of the clutches in this location, and also non-breeding individuals were sighted at several points in the stream in fast-flowing riffles with gravelly substrate. We identified 22 fish species in this river. Several adults, including one female with brood of fry, were photographed and filmed by Ad Konings and Willem Heinz of Cichlid Press.

Theraps underwoodi occupies moderately to rapidly flowing rivers, and has not been reported by local fishermen nor caught in our more than hundred hours of experimental gill net sets in Lake Nicaragua (see McKaye et al. 1995) nor is it reported in the lake by any of the many studies (Astorqui 1974; Villa 1982; McKaye et al. 1995; Bussing 1998). The *T. underwoodi* population found on Ometepe Island is relatively isolated from other populations in rivers along the Lake Nicaragua shore to the east by at least 35 km and to the west by at least 18 km. It has not been reported in any river on the western shore of Lake Nicaragua, but eastward migration from those rivers to Ometepe Island, via floating vegetation rafts, would be less likely given that winds are prevailing year-round from the east or northeast. In November 1993, one of us (EPvdB) sighted 3 adult tubas on the shore of La Pelea island in the Isletas archipielago in northwestern Lake Nicaragua, which confirms that low-frequency events may lead to disperal in these fishes.

Theraps underwoodi may have colonized Ometepe Island by juveniles association with floating mats of vegetation. This mechanism of dispersal, for some cichlids, has been demonstrated on floating islands of vegetation over ranges of many kilometers in Lake Malawi (Oliver and McKaye 1982). We suspect that juveniles accompanied floating vegetation which broke off from extensive mats along the eastern shore of the lake, eventually coming shoreward near the Buen Suceso River on Ometepe Island, and pushed along by prevailing westward winds. Large mats of water hyacinth (*Eichhornia crassipes*) and other floating vegetation occasionally break off from the eastern shore of Lake Nicaragua and are blown westward by prevailing winds.

The occurrence of a population of *T. un-*

derwoordi on this small river demonstrates the importance of low-frequency events which may contribute to dispersal and gene flow among satellite populations, as well as species spreading following habitat disruptions or introductions. In addition, it demonstrates the relatively low level of basic ecological and distributional information in a country faced with increasingly complex conservation challenges. In Nicaragua, many of the Caribbean watershed drainages are facing new challenges from pesticides, sediment loads, and species introductions as development moves eastward, with some drainages already colonized by tilapias (*Oreochromis* spp.; see for instance Waid et al. 1999). We recommend population and ecological review of the freshwater fishes of Nicaragua, before additional disruption is done, to identify important populations and locations for protection.

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