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A Survey of Freshwater Fish Distribution in Tobago, West Indies

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ABSTRACT

The freshwater fish of Tobago were reported by a number of researchers between 1910 and 1998, with differing species richness and diversity being listed by each. Results of the recent survey reported here serve to update this baseline. Surveys were conducted at 81 sites in Tobago over the time period 2004-2015, with observations being conducted both nocturnally and diurnally. The most widespread species was *Sicydium punctatum* (Gobiidae). The species with the highest abundance was *Poecilia reticulata* (Poeciliidae), and the rarest species was *Gobiesox nudus* (Gobiesocidae). *Micropoecilia picta* (Poeciliidae), *Ctenogobius boleosoma* (Gobiidae), and *Synbranchus marmoratus* (Synbranchidae) were documented for the first time for Tobago. The ichthyofaunal richness for this survey now stands at 13 species. The drainage with the greatest species richness was Roxborough River, with nine species noted.

Key words: Tobago, fish, freshwater, distribution, survey, Trinidad and Tobago.

INTRODUCTION

The freshwater fish assemblages of Trinidad and Tobago have been described previously by several authors including Kenny (1995), Phillip (1998), Phillip and Ramnarine (2001), Mohammed *et al.* (2010), and most recently by Phillip *et al.* (2013). Guppy (1910) listed only two species from Tobago, whilst Phillip (1998) listed 10 species. Most authors have focussed their attention on Trinidad; here we focus on Tobago's freshwater ichthyofaunal distribution.

Tobago can be considered as the last outpost of the Andean chain, at the edge of the South American continental shelf and separated from the Lesser Antilles by many kilometres of deep waters (Hardy 1982). As a result, the flora and fauna of Tobago is typical of continental South America, yet it differs from that of Trinidad in being rather depauperate, as is typical of small islands, with a distinct West Indian influence. Trinidad has a colonising zone with a South American influence (Kenny 1995) as a result of low salinities in the Columbus Channel, coastal near shores of the Atlantic and heavy Orinoco River discharge. Tobago, however, does not seem to possess such a region. Kenny (Ibid.) noted that the major oceanic currents near Tobago are influenced by the Orinoco River and the Atlantic Ocean and come from a southeastern direction, flowing in a northwest direction. Coupled with a steep coastal topography, colonisation of Tobago's estuaries and watercourses by South American or Trinidadian freshwater fish would seem very unlikely. However, brackish estuarine regions are ideal habitats for migratory species of fish, and such habitats should be investigated and their ichthyofauna documented in dedicated surveys.

The nature of freshwater fish sampling means that there can be considerable heterogeneity over space and time and imperfect sampling, especially for rare species. New species may be added to the list by means of increased sampling effort and increased number of sites sampled. Previous datasets of fish distribution on Tobago are dated, with Phillip (1998) being the most recent study. The purpose of our account is to provide an updated baseline distribution for future studies rather than a definitive account of which species are present on Tobago.

METHODOLOGY

Between 2004 and 2015, several freshwater sites in Tobago were visited by parties that varied from 1 to 4 persons including R.S. Mohammed and K. Phillips. These were done repeatedly for scientific observations or ecological evaluations. These sites included rivers, artificial water channels, and ponds. Surveys were conducted both nocturnally and diurnally. A total of 81 sites were visited, at least annually. Confirmed detection of fish species is reported here per site (Fig. 1). Identifications were confirmed by use of taxonomic keys in Phillip *et al.* (2013) where necessary.

We restrict our review herein to true freshwater species (outlined by Phillip *et al.* 2013) and intentionally omit estuarine species. Our account is also void of distributions

on Little Tobago and all other islands near Tobago, since these do not have permanent water channels.

Seining was done by use of two-person seines (1.0m and 5.0m) of mesh size 0.5cm and additionally by use of a single-person seine (1.0m) with a mesh size of <0.1cm. Cast netting with a 2.0m diameter (1.0cm mesh) was conducted. Fish pots (30.0 x 30.0 x 60.0cm, with a mesh size of 0.5cm) were used for overnight trapping at some sites where vegetation and water depth allowed. These methods were not standardised for all sites visited but were adjusted to suit each particular site, depending upon variability of substrate, riparian vegetation, and elevation. In addition, accessibility to sites was considered when transporting and deploying sampling gear. All specimens from sampling efforts were released immediately after identification at the site where collected.

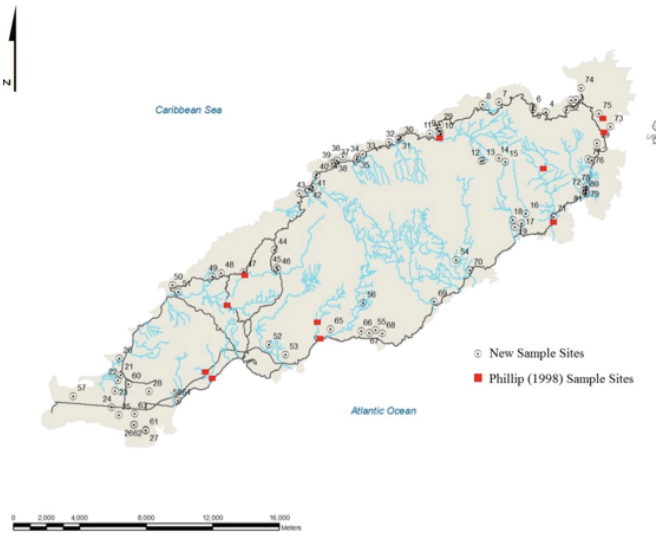

Fig. 1. New and previous (Phillip 1998) sample sites.

RESULTS

Our survey yielded nine families and 13 species of freshwater fish: two members of the Poeciliidae - *Poecilia reticulata* and *Micropoecilia picta*; one member of the Rivulidae - *Anablepsoides hartii* (formerly *Rivulus hartii*); three members of the Gobiidae - *Awaous banana*, *Ctenogobius boleosoma* and *Sicydium punctatum*; two members of the Eleotridae - *Eleotris pisonis* and *Gobiomorus dormitor*; one member of the Gobiesocidae - *Gobiesox nudus*; one member of the Synbranchidae - *Synbranchus marmoratus*; one member of the Mugilidae - *Agonostomus monticola*; one member of the Anguillidae - *Anguilla rostrata*; and one member of the Cichlidae - *Oreochromis mossambicus*.

Sicydium punctatum was the most widespread species. It had the most even distribution across the island, being found at 34 of 81 sites, followed closely by *Agonostomus monticola* (30 of 81 sites). However, the guppy, *Poecilia reticulata*, had the highest densities and abundances (pers. obs.). The Roxborough River supported nine of the 12 species reported and had the highest ichthyofaunal species richness.

The following maps (Figs. 2-13) show species distributions as well as comparisons to data from Phillip (1998). Table 1 provides GPS coordinates (UTM 20P) for all sites sampled. Most sightings of *Agonostomus monticola* were made on the periphery of the island along the southeastern, northeastern, and northwestern coasts, similar to the distributions noted by Phillip (1998) (Fig. 2). *Anablepsoides hartii* had sparse distributions across the island but was the only species that ventured across the Main Ridge and breached elevation barriers at several short waterfalls (Fig. 3). *Awaous banana* was detected on both the north and south coasts; previously, Phillip (1998) had noted its distribution only on the south coast (Fig. 4). The *Ctenogobius boleosoma* sightings represent the first report of this species for Tobago. The species is localised along east and northeast coast regions (Fig. 5). *Sicydium punctatum* was found at 34 of the 81 sites, giving it the widest distribution on the island; as did *Anablepsoides hartii*, it has also conquered elevation barriers of the Main Ridge (Fig. 6). *Gobiesox nudus* is the rarest species on the island, only found in the northern drainages. Previously, Phillip (1998) had noted it at multiple sites in the northeast; however, our data expand its distribution to additional drainages, mostly along the northern coast (Fig. 7). *Gobiomorus dormitor* has a wide distribution and has ventured into the interior of the island, conquering some of the elevation barriers (Fig. 8). *Eleotris pisonis* is the second rarest species on the island. It can be found in all coastal rivers but has a sparse distribution. Phillip (1998) found it on both north and south coastlines; our data expanded its distribution to additional sites on drainages of the flat water stretches below the last riffle towards the coastline (Fig. 9). *Synbranchus marmoratus* was found only in the central eastern drainages; our detection constitutes the first official confirmation of the species in Tobago (Fig. 10). *Poecilia reticulata* has a predominantly southeast to northeast distribution and is the most abundant freshwater fish species in Tobago (Fig. 11). *Micropoecilia picta* has a distribution similar to that of *P. reticulata*. *Micropoecilia picta* had sparse localised detections in the southern and northeastern regions; although regarded as a freshwater species, it has a wide tolerance for brackish systems. Mixed shoals of *P. reticulata* and *M. picta* were seen at Site 22 and on the Richmond, Lois D'or, Roxborough, Argyle, Goldborough, and Delaford Rivers (Fig. 12). However, the rare red male morph was noted at King's Bay, Bon Accord, Buccoo and Richmond. This morph has only been documented in males on the South American mainland (Lindholm *et al*. 2015). *Oreochromis mossambicus* is localised to southern Tobago and has an isolated population at the Hillsborough Dam (Site 56) (G. White pers. comm.) (Fig. 13).

Table 1. Family, species and sites list for Tobago. 0 indicates non-detection; 1 indicates presence. Ichthyofaunal species richness is also given per site.

		Anguillidae	Cichlidae	Eleotridae		Gobiesocidae	Gobiidae			Mugilidae	Poeciliidae		Rivulidae	Synbranchidae	
SITE #	GPS Co-ordinates 20P (UTM)	*Anguilla rostrata*	*Oreochromis mossambicus*	*Eleotris pisonis*	*Gobiomorus dormitor*	*Gobiesox nudus*	*Awaous banana*	*Ctenogobius boleosoma*	*Sicydium punctatum*	*Agonostomus monticola*	*Poecilia reticulata*	*Micorpoecilia picta*	*Anablepsoides hartii*	*Synbranchus marmoratus*	Site Species Richness
1	E 0767261, N 1252301	0	0	0	0	0	0	0	1	1	0	0	0	0	2
2	E 0766970, N 1252259	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	E 0766697, N 1251691	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	E 0765476, N 1251528	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	E 0764683, N 1251722	1	0	1	0	0	0	0	1	1	0	0	0	0	4
6	E 0764692, N 1251817	0	0	1	1	0	1	0	1	1	0	0	0	0	5
7	E 0762641, N 1252142	0	0	0	0	0	0	0	0	0	0	0	1	0	1
8	E 0761661, N 1252005	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	E 0759072, N 1250390	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	E 0759117, N 1250229	0	0	1	1	1	1	0	1	1	0	0	1	0	7
11	E 0758476, N 1250260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	E 0761567, N 1248633	0	0	0	0	0	0	0	0	0	0	0	1	0	1
13	E 0761692, N 1248663	0	0	0	0	0	0	0	0	0	0	0	1	0	1
14	E 0762631, N 1248804	0	0	0	0	0	0	0	1	0	0	0	1	0	2
15	E 0763010, N 1248559	0	0	0	0	0	0	0	0	0	0	0	1	0	1
16	E 0764265, N 1245467	0	0	0	1	0	1	1	1	1	1	0	1	1	8
17	E 0764007, N 1244901	0	0	0	1	0	1	1	1	1	1	1	1	1	9
18	E 0763475, N 1245093	0	0	0	1	0	1	1	1	1	1	0	1	1	8
19	E 0763579, N 1244659	0	0	0	1	0	1	1	1	1	1	1	1	0	8
20	E 0739810, N 1236828	0	1	1	0	0	0	0	0	0	1	1	1	0	5
21	E 0739894, N 1235823	0	0	0	0	0	0	0	0	0	1	0	1	0	2
22	E 0739710, N 1235517	0	1	0	0	0	0	0	0	0	1	1	1	0	4
23	E 0739551, N 1234884	0	0	0	0	0	0	0	0	0	1	0	1	0	2
24	E 0739337, N 1233903	0	0	0	0	0	0	0	0	0	1	0	0	0	1
25	E 0739780, N 1233428	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	E 0740682, N 1232858	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	E 0741387, N 1232513	0	1	0	0	0	0	0	0	0	0	0	0	0	1
28	E 0741596, N 1234864	0	0	0	0	0	0	0	0	0	1	0	0	0	1
29	E 0759090, N 1250795	0	0	0	1	0	0	0	0	1	0	0	0	0	2
30	E 0756722, N 1250015	0	0	0	1	1	1	0	1	1	0	0	0	0	5
31	E 0756581, N 1249923	0	0	0	1	1	1	0	1	1	0	0	0	0	5
32	E 0756035, N 1249761	0	0	0	1	0	1	0	1	1	0	0	0	0	4
33	E 0754451, N 1249015	0	0	0	1	0	1	0	1	1	0	0	0	0	4
34	E 0754133, N 1248845	0	0	0	0	0	0	0	1	1	0	0	0	0	2
35	E 0754092, N 1248742	0	0	0	0	0	0	0	1	1	0	0	0	0	2
36	E 0753243, N 1248885	0	0	0	1	0	1	0	1	1	0	0	0	0	4
37	E 0752876, N 1248649	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	E 0752754, N 1248500	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	E 0752591, N 1248477	0	0	0	1	0	1	0	1	1	0	0	0	0	4
40	E 0751669, N 1247798	0	0	0	1	0	1	0	1	1	0	0	0	0	4

41	E 0751478, N 1247077	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	E 0751206, N 1246909	0	0	0	0	0	1	0	0	0	0	0	0	0	1
43	E 0750643, N 1246681	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	E 0749128, N 1243306	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	E 0749275, N 1242236	0	0	0	0	0	0	0	1	0	0	0	1	0	2
46	E 0749325, N 1242124	0	0	0	0	0	0	0	1	0	0	0	1	0	2
47	E 0747280, N 1241992	0	0	0	0	0	0	0	1	0	0	0	1	0	2
48	E 0745921, N 1241927	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	E 0745400, N 1241715	0	0	0	0	0	0	0	0	0	1	0	0	0	1
50	E 0742994, N 1241216	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	E 0743362, N 1240788	0	0	0	1	0	0	0	0	0	0	1	0	0	2
52	E 0748812, N 1237643	0	1	0	1	0	1	0	1	1	1	0	1	1	8
53	E 0749805, N 1237050	0	0	0	0	0	0	0	0	0	1	0	1	1	3
54	E 0760065, N 1242718	0	0	0	1	0	1	0	1	0	1	0	1	1	6
55	E 0755217, N 1238527	0	0	0	0	0	1	1	1	1	0	0	0	1	5
56	E 0754465, N 1240124	0	1	0	0	0	0	0	0	1	0	0	0	0	2
57	E 0737044, N 1234576	0	1	0	0	0	0	0	0	0	1	0	0	0	2
58	E 0743325, N 1234317	0	0	0	0	0	0	0	0	0	0	1	0	0	1
59	E 0768524, N 1249681	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	E 0740337, N 1235276	0	1	0	0	0	0	0	0	1	1	0	0	0	3
61	E 0741387, N 1232543	0	1	0	0	0	0	0	0	0	0	0	0	0	1
62	E 0740685, N 1232857	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	E 0740714, N 1233536	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	E 0743328, N 1234318	0	0	0	0	0	0	0	0	0	0	1	0	0	1
65	E 0752513, N 1238563	0	0	0	1	0	1	1	1	1	1	0	0	0	6
66	E 0754356, N 1238472	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	E 0754841, N 1238352	0	0	0	0	0	0	0	0	0	1	0	0	0	1
68	E 0755626, N 1238313	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	E 0758751, N 1240233	0	0	0	0	0	0	0	0	1	1	0	0	0	2
70	E 0760892, N 1242105	0	0	0	1	0	0	0	0	0	1	1	1	1	5
71	E 0765925, N 1245273	0	0	0	1	0	1	1	1	1	1	1	1	0	8
72	E 0767726, N 1246873	0	0	0	1	0	1	0	1	1	0	1	0	0	5
73	E 0769336, N 1250683	0	0	1	1	0	1	0	1	1	0	0	1	1	7
74	E 0767585, N 1252971	0	0	0	0	0	0	0	1	1	0	0	0	0	2
75	E 0768653, N 1251453	0	0	0	0	0	1	1	1	0	1	0	1	0	5
76	E 0768201, N 1248640	0	0	0	0	0	0	1	1	0	0	0	0	0	2
77	E 0768023, N 1248741	0	0	0	0	0	0	1	1	0	0	0	0	0	2
78	E 0767893, N 1247128	0	0	0	1	0	0	1	1	1	0	0	0	0	4
79	E 0767887, N 1246659	0	0	0	0	0	0	0	0	0	0	1	0	0	1
80	E 0767873, N 1246748	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	E 0767852, N 1246851	0	0	0	1	0	0	1	1	1	0	0	0	0	4
Number of sites detected (N=81)		1	8	5	24	3	22	12	34	30	22	11	24	8	

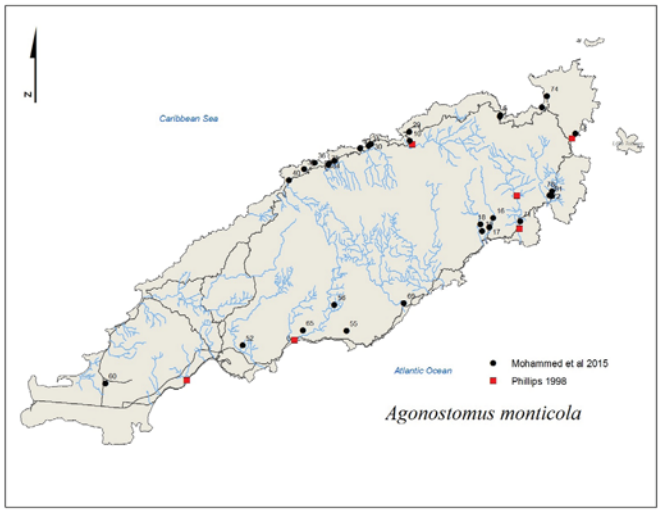

Fig. 2. *Agonostomus monticola* (Mugilidae) distributions. Common name: Mountain mullet.

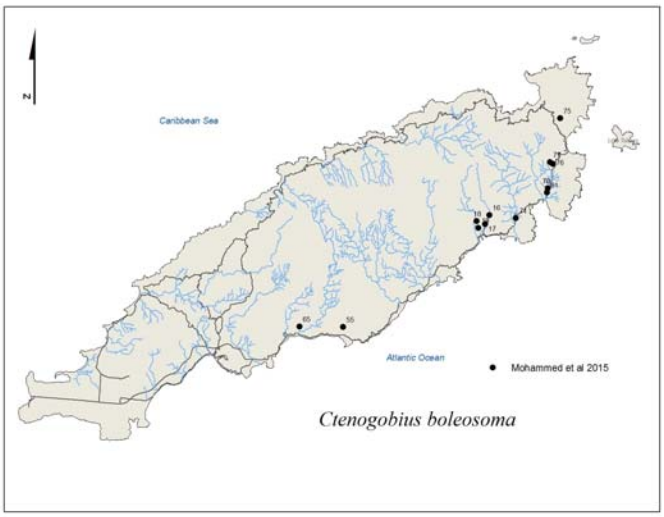

Fig. 5. *Ctenogobius boleosoma* (Gobiidae) distributions.

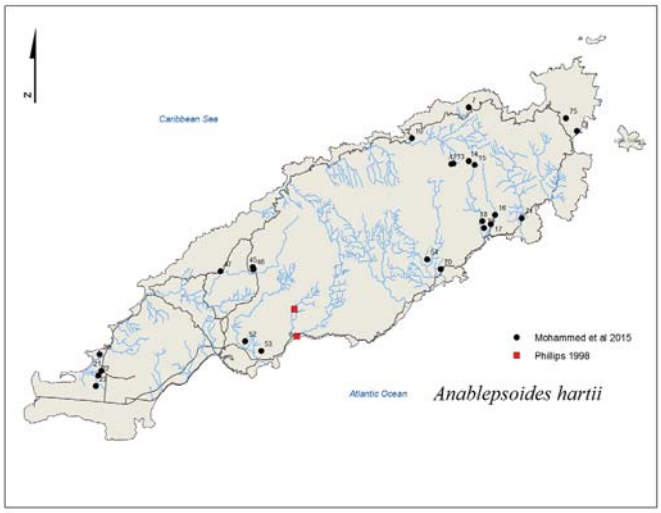

Fig. 3. *Anablepsoides hartii* (formerly *Rivulus hartii*) (Rivulidae) distributions. Common name: Jumping guabine.

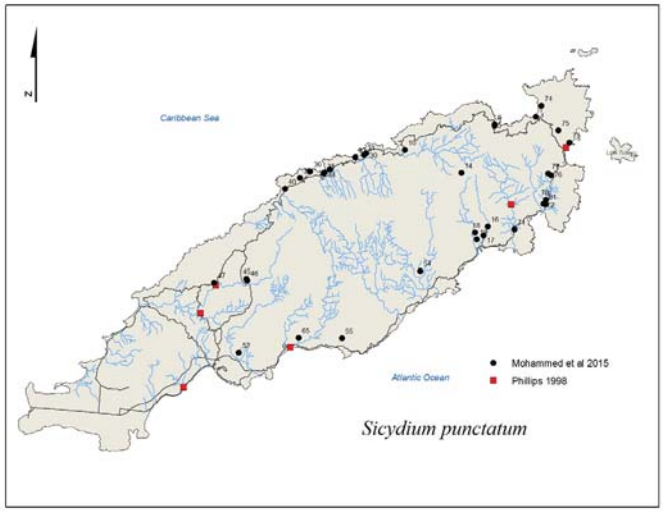

Fig. 6. *Sicydium punctatum* (Gobiidae) distributions.

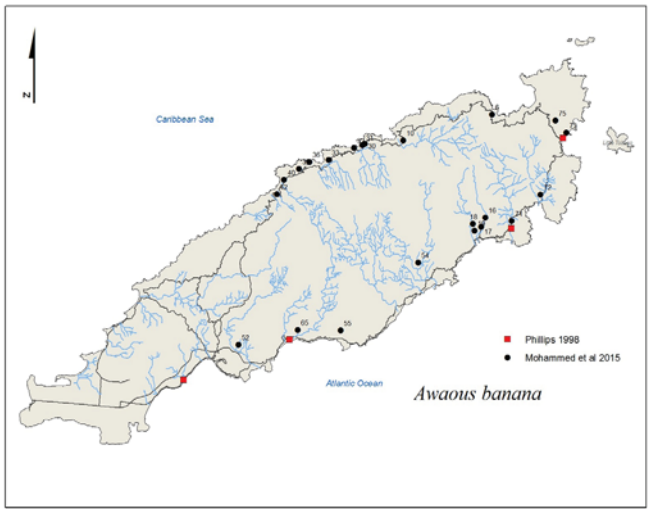

Fig. 4. *Awaous banana* (Gobiidae) distributions.

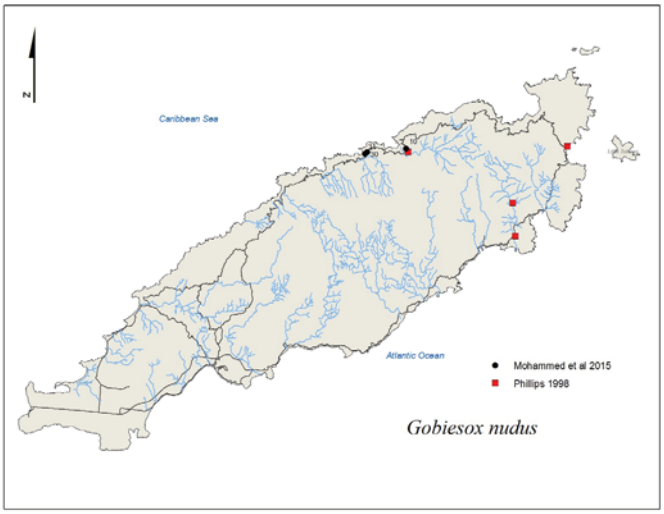

Fig. 7. *Gobiesox nudus* (Gobiesocidae) distributions. Common name: Cling fish.

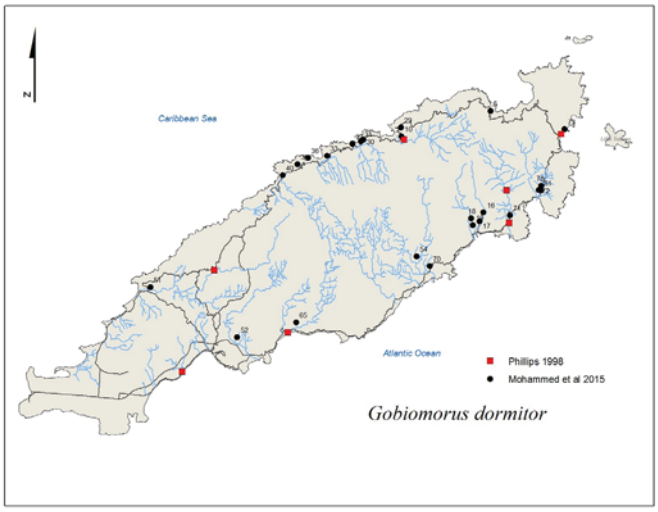

Fig. 8. *Gobiomorus dormitor* (Eleotridae) distributions. Common name: Sand guabine.

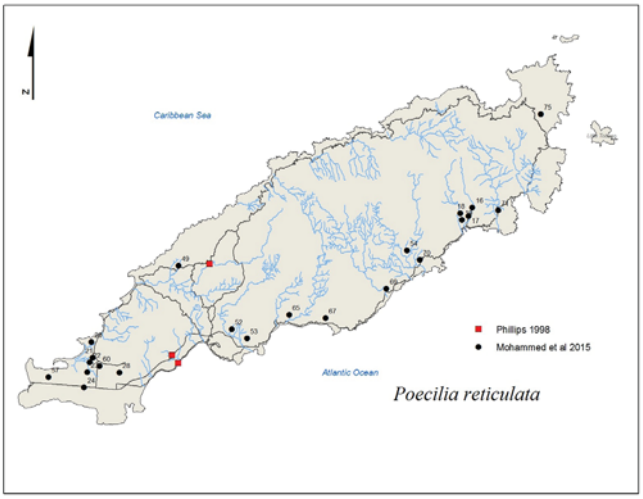

Fig. 11. *Poecilia reticulata* (Poeciliidae) distributions. Common name: Guppy, Millions fish, Seven colours.

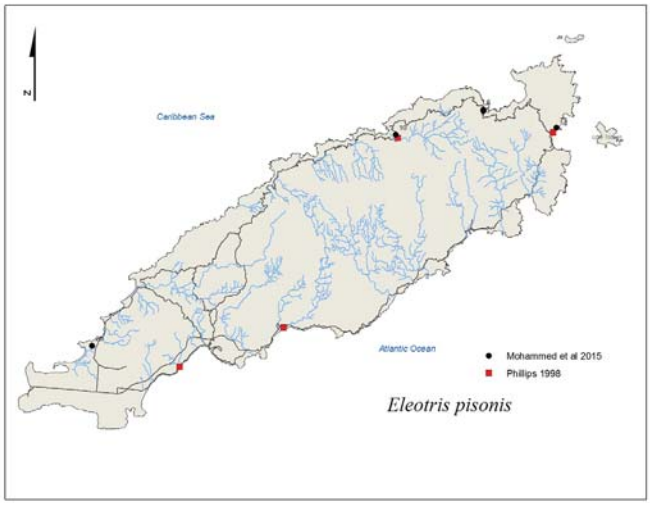

Fig. 9. *Eleotris pisonis* (Eleotridae) distributions. Common name: Sleeper goby.

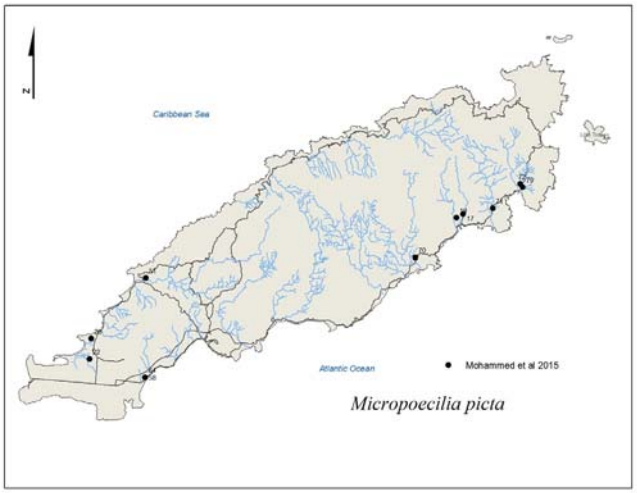

Fig. 12. *Micropoecilia picta* (Poeciliidae) distributions. Common name: Swamp guppy.

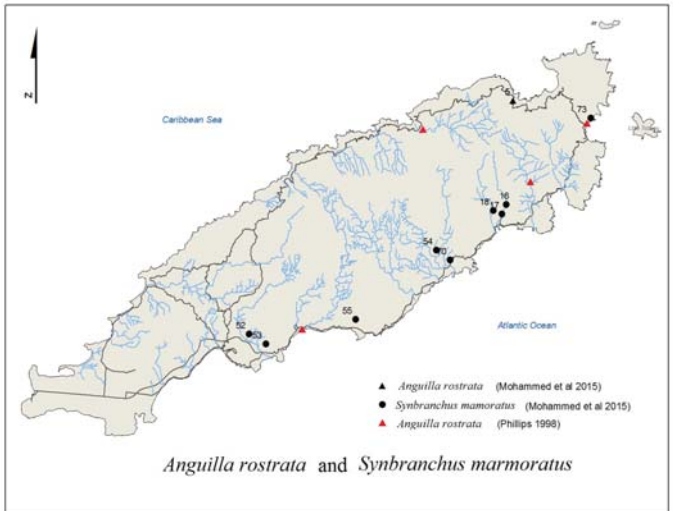

Fig. 10. *Synbranchus marmoratus* (Gobiesocidae) distribution. Common name: Zangee, Congo/Conga eel; and *Anguilla rostrata* (Anguillidae) distributions. Common name: American eel.

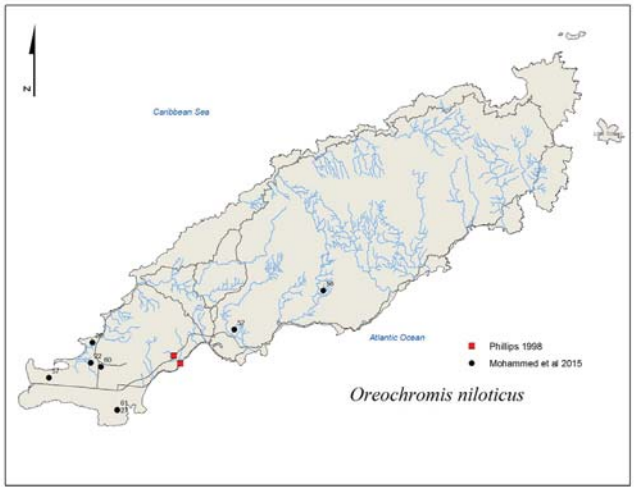

Fig. 13. *Oreochromis mossambicus* (Cichlidae) distributions. Common name: Mozambique tilapia, Black tilapia.

DISCUSSION

This paper provides comprehensive freshwater fish distribution data for Tobago because of number of sites and number of return visits. There were a number of limitations to our survey, including a lack of electrofishing as a method of sampling; however, our survey was more robust than any survey conducted previously, being spatially and temporally wide and including 81 sites visited over a span of ten years. Such prolonged, intensive sampling had not been conducted previously in Tobago.

We detected and have mapped the distribution in Tobago of 13 fish species, including three species new for Tobago: *M. picta* (Fig. 14), *C. boleosoma*, and *S. marmoratus* (Fig. 15). A narrower distribution of *Anguilla* during our survey likely resulted from lack of electrofishing and also because it is a rare species that may be missed during sampling efforts that are not extensive.

Only one introduced species, *Oreochromis mossambicus*, is known for Tobago. This species was first documented in Scarborough (Phillip 1998). It has inhabited the fresh and estuarine waters of south Tobago for the last 20 years (anecdotal account). G. White (pers. comm. 2012) noted *O. mossambicus* at Hillsborough Dam in the 1980s; high densities also were observed at a spring site in southwest Tobago (Mohammed 2014). It is unknown whether this species should be deemed an alien invasive species or simply an established exotic, as it also is not known whether it has negatively impacted other species of fish in the localised system or whether it has spread since it was first documented. This situation highlights the importance of conducting more detailed and focussed studies of the spread of alien invasive species in Trinidad and Tobago. Site 52 of this study was sampled by Phillip (1998); *O. mossambicus* was not detected at that time but was found during this study. This is another example of why it is crucial to conduct studies of species distributions and to provide extensive baseline data to enable understanding of potential relations between anthropogenic disturbances and the presence of invasive species. The mapping of the distribution of this species on Tobago would itself provide sufficient justification for publication of this paper, since baseline data for this species was lacking until these data were obtained.

Kenny (1995) described the ichthyofaunal assemblages of the north coast of Trinidad as Antillean; that region shares substantial aquatic fauna with Tobago, with some exceptions; no native species of Cichlidae were documented during our survey, nor had any been documented historically for Tobago, yet one cichlid species, *Cichlasoma taenia*, is present on the north coast of Trinidad in at least two regions. Similarly, one characin, *Astyanax bimaculatus*, can be found at northeast Trinidad, but no characins have been detected in Tobago. Hardy (1982) noted the catfish *Hypostomus robinii* in Tobago and went as far to allude to it being different in several morphological characteristics (without a description) from the Trinidad specimens and suspected it as being introduced. No freshwater catfish, native or introduced, have since been observed or documented for Tobago. Hardy (Ibid.) also mentioned a swamp eel being present but provided no description or distribution pattern. Communications with D. Hardy indicated he was referring to *Synbranchus marmoratus*. Apart from Trinidad, Tobago shares similar ichthyofaunal diversity with Barbados, having four species of freshwater fish in common, including *Awaous banana* (Gobiidae), *Agonostomus monticola* (Mugilidae), *Poecilia reticulata* (Poeciliidae), and an introduced exotic, *Oreochomis* sp. Such sharing of species gives support to Kenny's (1995) designation of Antillean similarities for Tobago.

The relatively high number of our detections and distribution expansions, compared to those from previous studies of freshwater fish in Tobago, are most likely an artefact of our longer periods of sampling, both diurnally and nocturnally, alongside a greatly increased number of sample sites. We do not provide evidence for any temporal changes to distribution patterns since previous surveys. It should be noted that our sampling yielded similar patterns to those recorded by Phillip (1998). Together, these studies confirm that very few fish species have traversed and surmounted the gentle elevations of the east coast and that even fewer species have moved inland from the west coast, which has an even steeper topography (Hardy 1982). Nonetheless, *Agonostomus monticola*, *Anablepsoides hartii*, and *Sicydium punctatum* managed to conquer some of these elevation barriers of the Main Ridge, which stretches along the diagonal axis of the island, influencing drainage patterns and producing a hybridised dendritic and radial system. *Ctenogobius boleosoma* and *S. marmoratus* have also shared similar south-to-northeastern distributions that are directly influenced by northwest-flowing oceanic currents from South America. It can be speculated these might have been the most recently colonised species; however, in the absence of genetic testing, we are unable to confirm their origins.

The eel-like freshwater fish *Synbranchus marmoratus* was seen in shallow, isolated pools among submerged riparian vegetation, feeding both diurnally and nocturnally. It is not surprising that the distribution of *S. marmoratus* closely resembles that of the poeciliids, as these were observed being preyed upon, particularly nocturnally. *Synbranchus marmoratus* and *Gobiomorus dormitor* can be regarded as the major freshwater piscivorous fish species for Tobago, although both will forage for carrion as opportunistic carnivores.

On the basis of the distributions reported by Phillip (1998) and the current data, *Gobiesox nudus* can be regard-

ed as the rarest freshwater fish in Tobago. This tiny cling fish (<15.0cm total length) is highly adapted to a benthic lifestyle in high velocity waters and is extremely cryptic. Efficient documentation and collection of this species usually requires electrofishing, which was not conducted in this survey but which was conducted by Phillip for her 1998 dissertation, which possibly explains why she found the species at more sites than we did. Nonetheless, even then it was documented at only four sites.

Some recommendations for further work include extensive quantitative sampling using multiple methods and taking into consideration abiotic, biotic, and anthropogenic factors that may contribute to variations in Tobago's fish assemblages. An area of concern is commercial gravel stripping from riverbeds, particularly in northwestern Tobago, where some of the rarer species are found, such as *Gobiesox nudus*, which is a benthic species. Coastal near-shore developers should also consider the impact of construction on estuarine species, catadromic species (such as *Anguilla rostrata* and *Agonostomus monticola*) (Harrison 1995), and anadromic species whose life cycle might be negatively affected by near-shore development.

Fig. 14. *Micropoecilia picta* (male) found in proximity to some coastal sites. (Approximately 2.0cm total length). Rare red male morph below.

Fig. 15. *Synbranchus marmoratus* found at several inland sites. (Approximately 1.0m total length).

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