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TRABAJOS ORIGINALES

Fishes from Chira River basin, Piura, Peru

Peces de la cuenca del río Chira, Piura, Perú

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Abstract

Chira River is located on the north coast of Peru. The scant information of the ichthyofauna from coastal drainages from Peru is noteworthy. The aim of this study is to characterize the ichthyofauna along the Chira River basin in terms of diversity and altitudinal range distribution. The material examined belongs to the Ichthyological collection of the Natural History Museum (MUSM). The diversity of fishes is composed of 27 species belonging to 19 families and ten orders. Siluriformes and Characiformes were the most diverse, consisting of 22% (six species) for each one. Five species are new records for the Chira River (three natives and two non-natives). Six marine species and seven exotic species were recorded as well. The altitudinal distribution patterns for all species were registered. This study increases the known diversity of freshwater fishes from Pacific Drainage Rivers in Peru, and it could be used for management and conservation plans.

Keywords:

North Andean Pacific Slopes; seasonal dry forest; Tropical coastal rivers; Peruvian coastal drainage; geographic distribution; ichthyofauna; exotic fishes.

Resumen

El río Chira está ubicado en la costa norte del Perú. La escasa información de la ictiofauna de las cuencas costeras del Perú es notable. El objetivo de este estudio es caracterizar la ictiofauna en la cuenca del río Chira en términos de diversidad y rango de distribución altitudinal. El material examinado pertenece a la colección ictiológica del Museo de Historia Natural (MUSM). La diversidad de peces está compuesta por 27 especies pertenecientes a 19 familias y 10 órdenes. Cinco especies son nuevos registros para el río Chira (tres nativas y dos no nativas). Fueron registradas seis especies marinas y siete especies exóticas. Este estudio incrementa el conocimiento de la diversidad de peces de las cuencas costeras en Perú, y puede ser usado para planes de manejo y conservación.

Palabras clave:

Vertientes del Pacífico Norte Andino; Bosque seco estacional; Cuencas costeras peruanas; Ríos costeros tropicales; distribución geográfica; ictiofauna; peces exóticos.

Introduction

The rivers of Andes western slopes of Peru are characterized by being independent, seasonable, short, and drain directly to the Pacific Ocean (Ortega & Hidalgo 2008). Most of the coast from Peru is a desert, except for the northern regions in Piura and Tumbes departments, which have tropical weather with marked rainy seasons. Contrary to most rivers in the Peruvian Pacific drainages, the Chira River (Piura department) has permanent flowing water. Also, the Chira River is the southernmost portion of North Andean Pacific Slopes-Rio Atrato ecoregion of the South America, according to the classifications of ecoregions for freshwater fishes (301, Abell et al. 2008, Reis et al. 2016).

The Pacific slope basins have relatively poor diversity in fishes but a high degree of endemism, making the northern slope richer than the southward (Ortega & Hidalgo 2008, Reis et al. 2016). The lack of knowledge on the distribution and taxonomy of ichthyofauna from coastal drainages from Peru is noteworthy. The Chira River is the second most diverse river of the Peruvian coast after the Tumbes River (Ortega et al. 2015). Studies on freshwater fishes from this basin are scarce; the first study was made by Fowler (1945) registering three species for the basin, followed by Lopez et al. (1982) who registered eight species. Furthermore, other research recorded 13 species (Bonastre 2008) and 20 species (Marchena 2013, Ortega et al. 2015). However, recent collections revealed the presence of new records for the basin.

Moreover, anthropogenic activities, like agriculture, artisanal mining, pollution, and domestic wastewater discharge, have affected the preservation of the aquatic systems and biodiversity of the basin (More 2019, Ortega 2012). The aim of this study is to (1) update the composition of freshwater fishes from the Chira basin and (2) provide the altitudinal distribution of the species along the basin to better understand the ichthyofauna.

Material and methods

Study area. The Chira River is in Piura department in north western Peru. The Chira is considered part of the bi-national basin Catamayo-Chira between Ecuador and Peru. The headwaters of the Catamayo-Chira basin are in the complex lakes in the Pacific slope of Parque Nacional Podocarpus, Loja Province in Ecuador; and in the complex lakes Las Huaringas and Arrabiatadas, Ayabaca Province in Peru (SOFIA, 2018). The bi-national basin has a total surface drainage area of 19095 km^2, where 11933 km^2 (62%) are in Peru (MINAM 2012) which drain to the Pacific Ocean.

The area of the Chira River and its tributaries goes from 0 – 3600 m above sea level. and crosses the provinces of Ayabaca and Sullana, flowing from east to west. Their main tributaries in Peru are Macara, Quiroz, Chipillico and Alamor rivers, and Jaguay de Poechos, Venados and Saman streams (Fig. 1).

The distribution of species is strongly related to elevation and vegetation; therefore, we show the distribution of species following ecosystem classification in Peru. Along the Peruvian coast are eleven ecosystems and the Chira basin passes through seven of them; Coastal desert (Dc, 0 – 2500 m a.s.l.), Andean scrub (Ma, 1500 – 3900 m a.s.l.), Paramo (Pa, more than 3000 m a.s.l.), Seasonally dry hill and mountain forest (Bes-cm, 400 – 2000 m a.s.l.), Seasonally dry plain forest (Bes-ll, 0 – 500 m a.s.l), Seasonally dry riparian forest (Besr, 100 – 700 m a.s.l.), Western relic montane forest (Br-mvoc, 1400 – 3000 m a.s.l.) according to MINAM (2019).

Sampling. Fish samples from the Chira River belong to scientific collections and correspond to extensive sampling in October 2015 of 47 sites along the Chira basin and tributaries (Fig. 1, Appendix 1). Fishes were collected using seine nets, gill nets, cast nets and hand nets using the standardized collecting according to Birindelli et al. (2016).

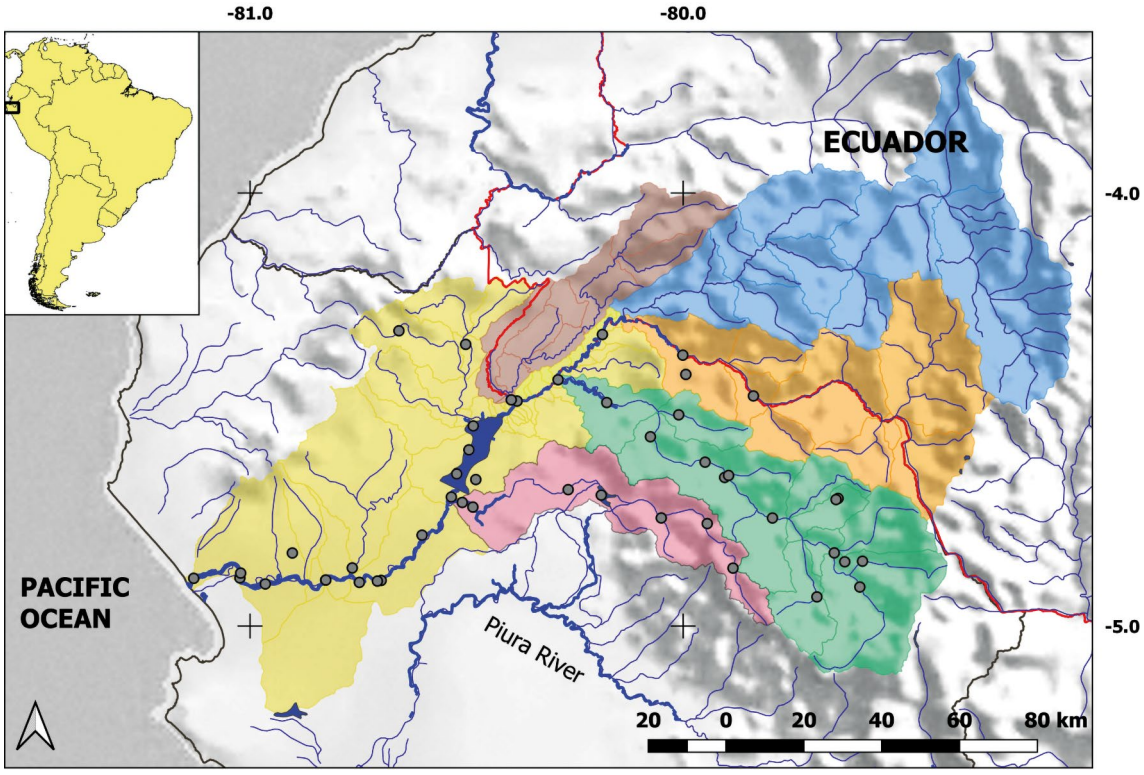

Figure 1. Location of sampling in Chira River basin, northwest Peru. Lower Chira (yellow), Alamor (brown), Chipillico (pink), Quiroz (green), Macará (orange), Catamayo (blue), International border (red line).

The captured fishes were anesthetized in clove oil (Lucena et al. 2013), then were fixed in 10% formalin and after 48 hours were preserved in 70% ethanol. Species were identified by primarily literature and deposited at the fish collection from Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima (MUSM) and Royal Ontario Museum, Toronto (ROM).

List of fishes. The complete list of species is arranged by the classification of order and family following Eschmeyer Catalog (Fricke et al. 2020). Additionally, information of the habitats (freshwater, brackish, and marine), the origin of species (native or introduced), the categorization of IUCN, and references are provided.

Results

The compilation of data recorded 27 species for the Chira River basin, distributed in 10 orders, 19 families (Table 1, Appendix 2). The ichthyofauna was predominantly Characiformes and Siluriformes representing 44% of all species (Fig. 2) with six species in each order. The most diverse families were Characidae and Cichlidae with four species in each family (Fig. 3).

Five species are considered new records for the Chira River: *Astroblepus rosei*, *Basilichthys semotilus*, *Trichomycterus piurae*, *Oncorhynchus mykiss* and *Poecilia reticulata*. *Trichomycterus* sp. is probably a new species to science. Furthermore, six marine species were recorded, collected approximately 90 m from the mouth of the river. Among the species recorded, 20 species are native; one catfish species (*Chinchaysuyoa ortegai*) is endemic to the Chira River; and seven species are introduced (Table 1).

Related to the abundance, a total of 3896 specimens were captured during fieldwork (October 2015). However, Poeciliidae were the most abundant with 39% of all specimens represented by *Poecilia reticulata* and *Gambusia affinis* which are non-native species; followed by Characidae with 27% of total represented by *Eretmobrycon peruanus*, *Landonia latidens* and *Rhoadsia altipinna*; Bryconidae with 13% of total represented by *Brycon atrocaudatus*; and Cichlidae with 15% represented by the native species *Andinoacara rivulatus* and *A. stalsbergi*, and the introduced species *Coptodon rendalli* and *Oreochromis niloticus*. Remaining families have less than 10% abundance (Fig. 3).

Regarding the ecosystems present in the basin, 15 species were exclusively found in the seasonally dry forest of the plain, eight species were found in both seasonally dry forest of the plain and seasonally dry forest of hill and mountain; *Astroblepus rosei*, *Trichomycterus* sp. and *Basilichthys semotilus* are exclusive from the latest. In Andean scrub ecoregion, *Oncorhynchus mykiss* is exclusive and *Astroblepus rosei* was found in both, Andean scrub and seasonally dry forest of hill and mountain (Fig. 4, Fig. 5).

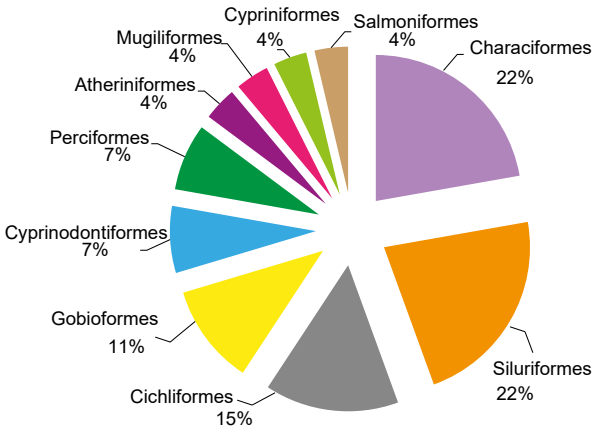

Figure 2. Species richness (percentages of total species number) according to fish orders sampled in Chira River basin.

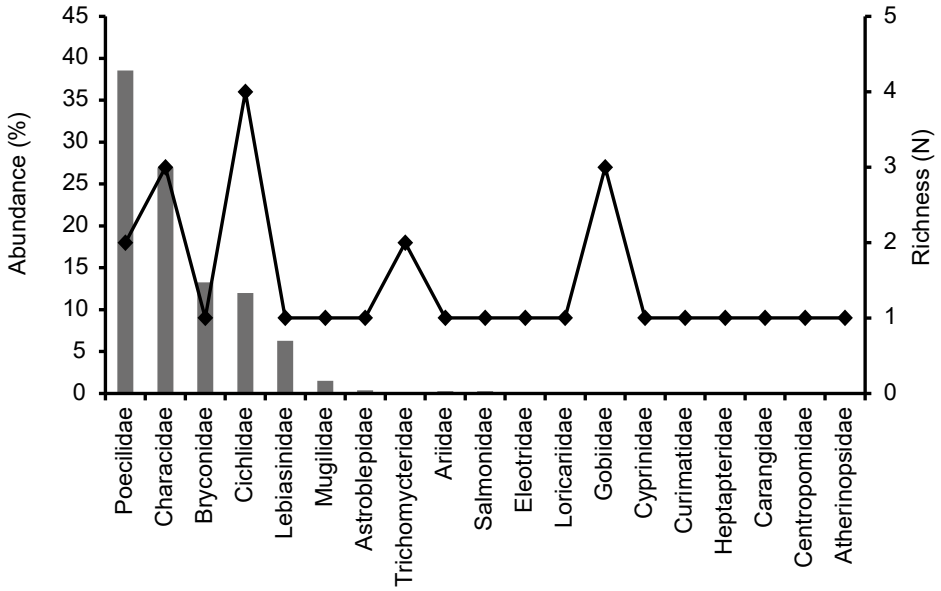

Figure 3. Species richness (N = expressed in species number) and abundance (percentages of total individuals), according to fish families sampled in Chira River basin.

Table 1. List of fishes in the Chira River basin. F = Freshwater; B = Brackish; M = Marine; N = Native; E = Endemic; I = Introduced; IUCN = Conservation status (IUCN 2020). * = New record

ORDER / Family / Species	Habitat	Origin	IUCN	MUSM / References
CHARACIFORMES				
Bryconidae				
Brycon atrocaudatus (Kner 1863)	F	N	-	48207, 48197, 48198, 52777
Characidae				
Eretmobrycon peruanus (Müller & Troschel 1845)	F	N	-	48187, 48195, 48199, 48219
Landonia latidens Eigenmann & Henn 1914	F	N	-	Meza-Vargas et al., 2019
Rhoadsia altipinna Fowler 1911	F	N	-	48191, 48215, 48218, 52753
Curimatidae				
Pseudocurimata troschelii (Günther 1860)	F	N	-	48229
Lebiasinidae				
Lebiasina bimaculata Valenciennes 1847	F	N	-	48194, 52754, 52758, 52762
SILURIFORMES				
Trichomycteridae				
Trichomycterus piurae (Eigenmann 1922) *	F	N	-	52816, 52817
Trichomycterus sp.	F	N	-	52759
Astroblepidae				
Astroblepus rosei Eigenmann 1922 *	F	N	DD	52747, 52755, 52756, 52760
Heptapteridae				
Pimelodella yuncensis Steindachner 1902	F	N	-	52780, 52797, 52808, 52810
Loricariidae				
Hypostomus sp.	F	I	-	48194
Ariidae				
Chinchaysuyoa ortegai Marceniuk, Marchena, Oliveira & Betancur 2019	F	E	-	Marceniuk et al., 2019
SALMONIFORMES				
Salmonidae				
Oncorhynchus mykiss (Walbaum 1792)	F	I	-	
CYPRINODONTIFORMES				
Poeciliidae				
Gambusia affinis (Baird & Girard 1853)	F	I	LC	48232,48243, 48246, 48250
Poecilia reticulata Peters 1859 *		I	-	23125
CICHLIFORMES				
Cichlidae				
Andinoacara rivulatus (Günther 1860)	F	N		23127, 48210
Andinoacara stalsbergi Musilová, Schindler & Staeck 2009	F	N		48190, 48217, 48226, 48234
Coptodon rendalli (Boulenger 1897) *		I	LC	48245
Oreochromis niloticus (Linnaeus 1758)	F	I	LC	23124, 48189, 48192, 48204
PERCIFORMES				
Carangidae				
Caranx caninus Günther 1867	F, B, M	N	LC	48225
Centropomidae				
Centropomus unionensis Bocourt 1868	B, M	N	LC	48255
GOBIIFORMES				
Eleotridae				
Gobiomorus maculatus (Günther 1859)	F, B, M	N	LC	48239, 48248, 48331, 52812
Gobiidae				
Awaous transandeanus (Günther 1861)	F, B, M	N	-	48249
Ctenogobius sagittula (Günther 1862)	F, B, M	N	LC	48256
ATHERINIFORMES				
Atherinopsidae				
Basilichthys semotilus (Cope 1874) *	F	N	LC	52750
MUGILIFORMES				
Mugilidae				
Mugil cephalus Linnaeus 1758	F, B, M	N	LC	48216, 48223, 48238, 48244
CYPRINIFORMES				
Cyprinidae				
Cyprinus carpio Linnaeus 1758	F, B	I	VU	Ortega et al., 2015

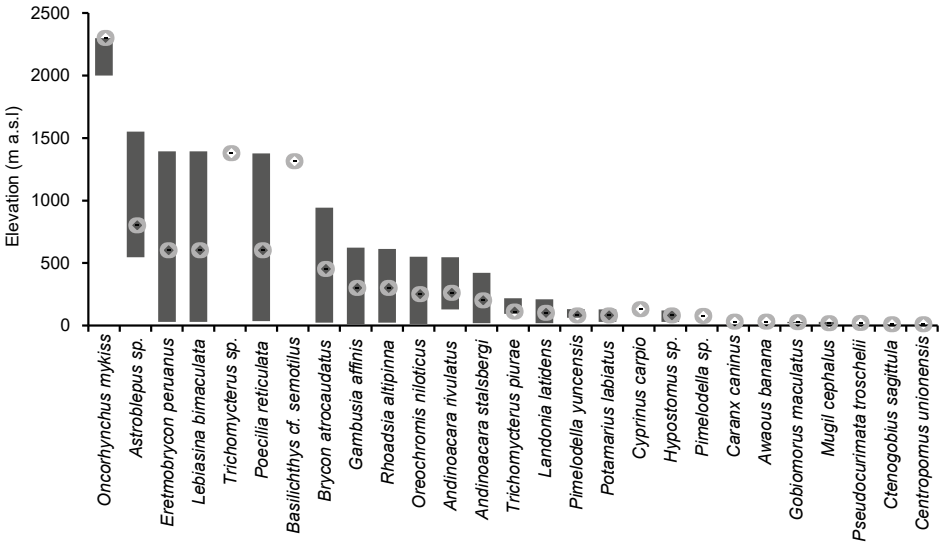

Figure 4. Fish in the Chira basin according to the elevation.

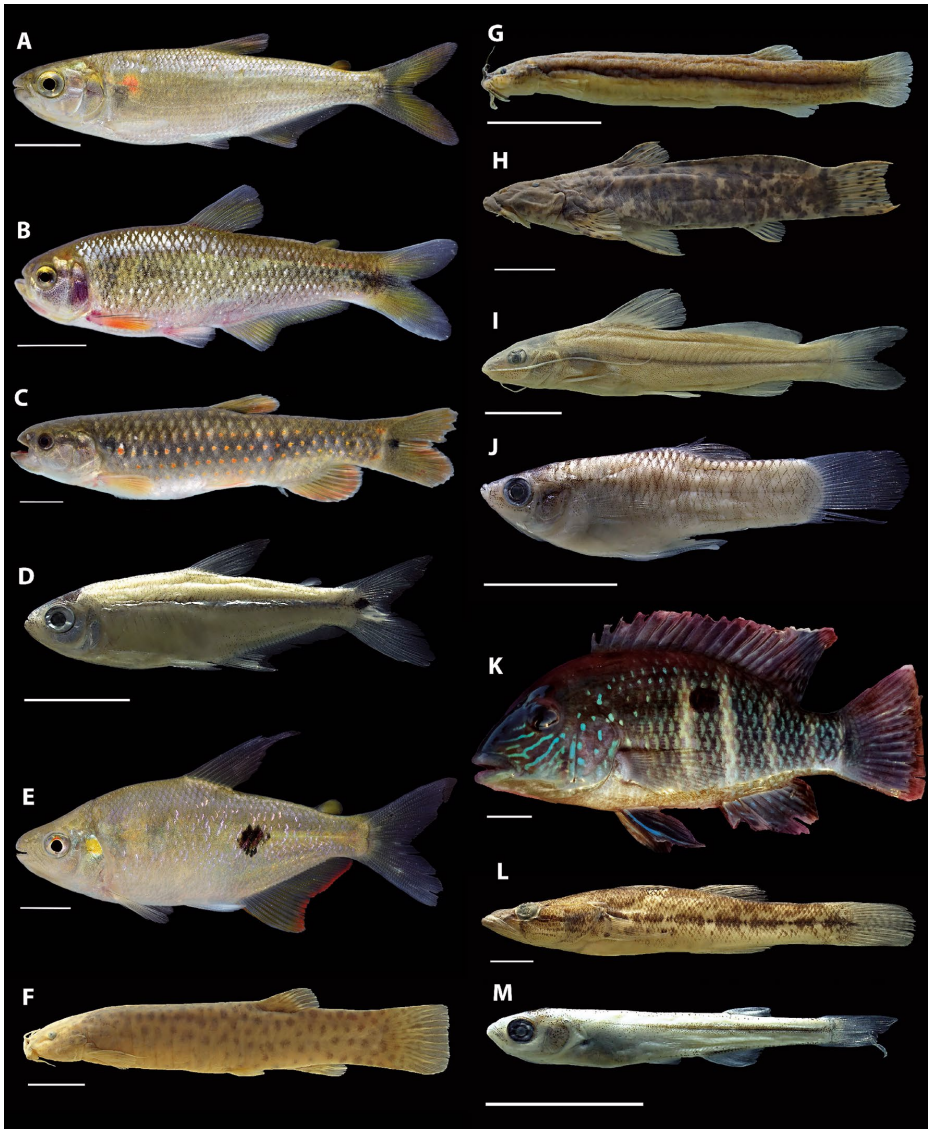

Figure 5. Photos of some species from the Chira River basin. (A) ***Brycon atrocaudatus***, ROM 109159. (B) ***Eretmobrycon peruanus***, ROM 109172. (C) ***Lebiasina bimaculata***, ROM 109170. (D) ***Landonia latidens***, MUSM 52785. (E) ***Rhoadsia altipinna***, ROM 109160. (F) ***Trichomycterus piurae***, MUSM 52816. (G) ***Trichomycterus*** sp., MUSM 52759. (H) ***Astroblepus rosei***, MUSM 52747. (I) ***Pimelodella yuncensis***, MUSM 52780. (J) ***Gambusia affinis***, MUSM 52781, male. (K) ***Andinoacara stalsbergi***, MUSM 52782. (L) ***Gobiomorus maculatus***, MUSM 52812. (M) ***Basilichthys semotilus***, MUSM 52750. Scale = 1 cm.

In the Chira River 11 species have been categorized according to IUCN (2020) conservation status, most of them euryhaline (occurs in freshwater, brackish, and marine habitats) and four introduced species (Table 1). Among native species, six are Least Concern (LC) and one species is in the Deficient Data (DD) category.

Discussion

The Chira River basin has characteristics of ecoregion and ecosystem that make it unique and because that is considered an endemic area (Albert et al. 2011, Reis et al. 2016). Although the Chira river basin is unique in comparison to other Peruvian river basins, little research has been done to demonstrate the diversity of the area. This survey represents the most thorough sampling of the Chira basin and most complete sampling on the Peruvian coast.

Although the river is considered an ecosystem (MINAM, 2019), it is not uniform from headwater to mouth in terms of fishes. There has been observed differential distribution of fishes along the Chira basin, which are related to ecosystems it crosses. As ecosystems are established by considering biodiversity and characteristics of habitats as elevation, vegetation, ecosystem services, weather, etc. (MINAM, 2019), future monitoring of biodiversity can be integrated with ecosystem assessments as well (Llambi et al. 2020).

Diversity of fishes in the basin was increased to 27 species, compared to previous ichthyofauna diversity studies in the basin and its tributaries (Bonastre 2008, Marchena 2013, Ortega et al. 2015). Most prolific species are the orders Characiformes and Siluriformes which belong to the superorder of Ostariophysi, predominant in most freshwater rivers of the Neotropical region (Roberts 1972, Lowe-McConnell 1987, Reis et al. 2003, 2016) and in coastal rivers from the northeast of Peru (Ortega et al. 2015). Besides, species show restricted distribution for altitude. For instance, most of them are distributed less than 500 m a.s.l, *Astroblepus*, *Basilichthys* and *Trichomycterus* are present in a range between 500-1500 m a.s.l. and the introduced species *Oncorhynchus* is found more than 2000 m a.s.l.

Among new additions there are three genera (*Chinchaysuyoa*, *Astroblepus* and *Basilichthys*), of which the catfish *Chinchaysuyoa ortegai* is a new genus, and species, endemic from the Chira River (Marceniuk et al. 2019). Additionally, the presence of *Astroblepus rosei* Eigenmann (1922), originally described from Jequetepeque River, 300 km south of Chira River, represents an extension in its distribution. The current distribution of *Basilichthys semotilus* is from Reque River, Lambayeque department to Sama River, Tacna department (Dyer 2003); however, the species was recorded in the Chira basin in the present study and by Bonastre (2008) in her unpublished undergraduate project (no voucher deposited in any fish collection), representing the northernmost distribution of *B. semotilus*.

Non-native fish species were introduced to several rivers in Peru as biological control vectors (*Gambusia affinis* and *Poecilia reticulata*), farming and sport fishing (*Oncorhynchus mykiss*), fish culture (*Oreochromis niloticus*), and living food to big fishes (*Coptodon rendalli*) (Ortega et al. 2007). Ortega et al. (2015) recorded *Gambusia affinis* and *Oreochromis niloticus* from Tumbes and Chira River which is the northernmost distribution for these species; in this study we added *Poecilia reticulata*, *Oncorhynchus mykiss*, and *Coptodon rendalli* (previously introduced as *Tilapia rendalli*) which represent the northernmost distribution for these species in the Pacific drainages. As non-native species have increased along the Chira River, the future impact that these exotic species could have on native species is of high importance. Some impacts on native species include competition, predation, and habitat alteration (Primack 1993, Simberloff 2000), which has already happened in some native species in the Amazonian drainages and Pacific coastal basins in Peru (Ortega et al. 2007). Additionally, *Hypostomus* sp. should be treated carefully, as the genus is well distributed along the Amazonian basin and not found in the Peruvian coast. This implies the species was transferred from the Peruvian amazon, or is a species related to *Hypostomus* species of the north coastal rivers from Ecuador; however, more taxonomic studies are needed. Also, *Arapaima gigas* (paiche) is the most recent species transferred to San Lorenzo reservoir for farming purposes to improve the economy of the residents of Las Lomas municipality (Produce 2018), but future studies could show us the impact of the introduction of this non-native species.

During fieldwork, anthropogenic activities were identified which have modified aquatic bodies, such as agriculture, mining, dams, pollution and even proliferation of exotic species which threaten native species (Ortega et al. 2007). Changes in environmental conditions can affect biodiversity and its distribution (Lujan et al. 2013, Albert et al. 2020); hence those anthropogenic activities are contributing to the modification of habitats. For instance, the lower Chira River, headwater of Chipillico and Queiroz River are highly impacted by agriculture (MINAM, 2019). Also, as was pointed out in Meza-Vargas et al. (2019), water diversion between Chira and Piura basins can explain the presence of *Landonia latidens* in the latest basin. We recommend increasing efforts for regulation of these activities for the sake of keeping in good conditions and conservation of the basin and the region. Finally, most of the species in the Chira basin lack categorization according to IUCN; therefore, we recommend categorizing mainly native species from the Chira River to avoid loss of fish diversity along the coastal rivers of Peru.

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Authors declare that they did not violate or omit ethical or legal norms in this research. All materials used belong to the Natural History Museums.

Appendix 1. Location of sampling from Chira River basin (October 2015).

Sample Sites	River/Streams	**Coordinates**	**Altitude (m a.s.l)**
1	Alamor	4°23'18.30"S; 80°14'32.02"W	120
2	Amotape	4°52'40.65"S; 81°01'17.99"W	18
3	Embalse San Lorenzo	4°41'52.41"S; 80°11'20.10"W	314
4	Huaca	4°54'10.86"S; 80°57'53.11"W	30
5	Huaypira	4°54'33.15"S; 80°44'19.13"W	130
6	Jibito	4°54'29.32"S; 80°44'57.48"W	20
7	Marcavelica	4°53'46.95"S; 80°42'21.42"W	30
8	Martínez	4°35'35.67"S; 80°29'40.06"W	94
9	Miramar	4°53'23.95"S; 81°07'48.18"W	8
10	Palo Blanco	4°54'36.26"S; 79°35'30.67"W	1366
11	Poechos	4°39'42.75"S; 80°28'43.15"W	107
12	Qda Encuentros	4°20'58.63"S; 80°30'07.17"W	211
13	Qda Montero	4°39'08.50"S; 79°53'41.71"W	623
14	Qda Ollería	4°42'29.27"S; 79°38'48.59"W	1377
15	Qda Ollería	4°42'19.47"S; 79°38'31.54"W	1393
16	Qda s/n	4°49'53.42"S; 80°54'08.19"W	54
17	Qda Salitral	4°25'08.54"S; 79°59'37.09"W	421
18	Qda Samán	4°51'57.51"S; 80°45'50.14"W	36
19	Qda San Pedro	4°51'59.06"S; 79°53'05.00"W	3040
20	Qda Seca	4°19'05.73"S; 80°39'22.12"W	440
21	Qda Solana	4°32'16.76"S; 80°29'04.18"W	124
22	Qda Suyo	4°30'44.48"S; 80°00'36.34"W	385
23	Qda Timbe	4°45'02.05"S; 80°03'01.57"W	547
24	Río Calvas	4°28'07.43"S; 79°50'15.37"W	551
25	Río Chipillico	4°41'06.63"S; 80°15'55.29"W	209
26	Río Chipillico	4°43'31.52"S; 80°29'07.42"W	94
27	Río Chipillico	4°42'53.05"S; 80°30'35.55"W	86
28	Río Chira	4°19'36.26"S; 80°11'10.55"W	207
29	Río Chira	4°28'49.97"S; 80°22'59.95"W	131
30	Río Chira	4°53'38.57"S; 80°49'31.29"W	23
31	Río Chira	4°53'20.84"S; 81°01'24.26"W	13
32	Río Chira	4°53'41.63"S; 80°41'49.89"W	44
33	Río Chira	4°42'08.08"S; 80°32'06.60"W	75
34	Río Macará	4°22'28.11"S; 80°00'02.29"W	366
35	Río Palo	4°51'01.82"S; 79°35'08.72"W	1312
36	Río Pomayaco	4°51'06.48"S; 79°37'35.97"W	1254
37	Río Quiroz	4°39'25.13"S; 79°54'14.49"W	612
38	Río Quiroz	4°45'02.40"S; 79°47'36.92"W	944
39	Río Quiroz	4°37'18.22"S; 79°56'57.14"W	513
40	Río Quiroz	4°33'46.70"S; 80°04'31.52"W	372
41	Río Quiroz	4°25'52.76"S; 80°17'18.99"W	140
42	Río Quiroz	4°29'02.49"S; 80°10'34.60"W	219
43	Río Quiroz	4°47'25.27"S, 80°36'09.87"W	62
44	Río Santa Rosa	4°49'52.46"S, 79°39'03.21"W	1168
45	Río Yangas	4°45'48.97"S; 79°56'39.20"W	1552
46	Sojo	4°53'38.08"S; 80°49'30.02"W	20
47	Tullman	4°55'58.48"S; 79°41'27.36"W	1592

Appendix2. List of additionally voucher species

Species	Vouchers
Brycon atrocaudatus	MUSM 48207, 48202, 48212, 48220, 48231, 48233, 48236, 48241, 48251, 52751, 52763, 52764, 52773, 52782, 52775; ROM 109159, 109166.
Eretmobrycon peruanus	MUSM 52757, 52761, 52768, 52774, 52778, 52788, 52813, 52814, 52800, 52820, 23126; ROM 109172, 109173.
Landonia latidens	MUSM 48200, 48201, 48209, 48222, 48227, 52802, 52806, 52809; ROM 109158.
Rhoadsia altipinna	MUSM 52801, 52805, 52815, 52818; ROM 109160, 109165.
Lebiasina bimaculata	MUSM 52794, 52810, 52812; ROM 109170.
Chinchaysuyoa ortegai	MUSM 48211, 48214, 48796, 63800.
Gambusia affinis	MUSM 48188, 48203, 48205, 48213, 48221, 48230; ROM 109157, 109164.
Andinoacara stalsbergi	MUSM 52791; ROM 109156, 109163.