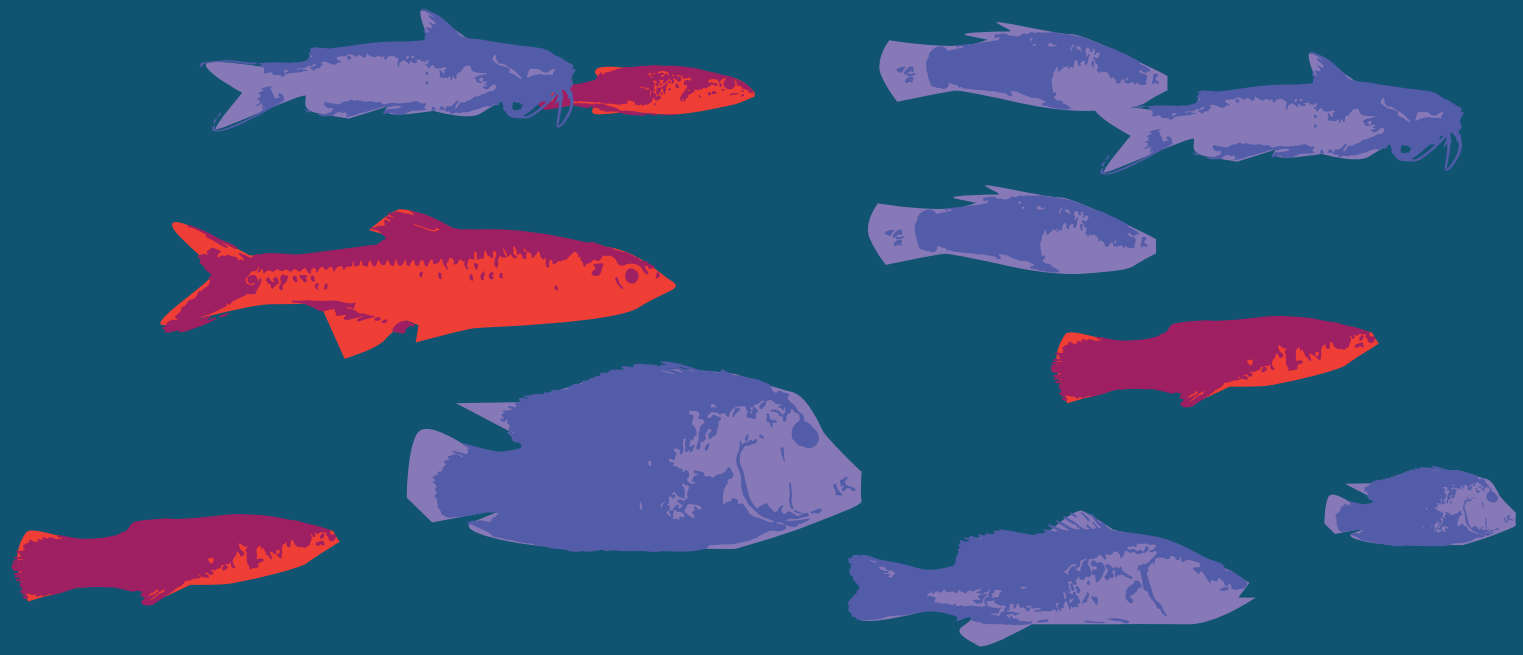

ICHTHYOFAUNA DIVERSITY OF THE BUSTAMANTE RIVER, NUEVO LEON, MEXICO.

PRIORITY LAND REGION FOR THE STATE

Jorge Armando Contreras- Lozano[1], Maria- Lourdes Lozano-Vilano[2], and Armando Jesus Contreras-Balderas[2].

1Universidad Autónoma de Nuevo León, Facultad de Medicina Veterinaria y Zootecnia, Cuerpo Académico de Ecología de Enfermedades y Fauna Silvestre. Av. Francisco Villa s/n, Col. Ex Hacienda el Canadá, Escobedo, Nuevo León, México, CP 66050. Corresponding autor: jorge.contreraslzn@uanl.edu.mx
[2]Private Consultant. Cerro de Conformidad #115 Las Puentes 2° Sector, San Nicolás de los Garza, Nuevo León, México. 66460.

Resumen

El estado de Nuevo León está localizado al noreste de México y el rio Bustamante se encuentra localizado en la parte noroeste del mismo estado. Es un área limitada donde las lluvias y el agua son de vital importancia para las actividades antropogénicas. La preservación de los ríos y comunidades acuáticas son muy importantes y no reciben atención adecuada en esta región. El estudio fue realizado en el área terrestre prioritaria, colindando con el estado de Coahuila. Este representa el primer estudio de peces que se realiza en el presente rio, que en su mayor parte del tiempo está sujeto a inundaciones, también es un tributario al río Salado, y por esta razón, el objetivo fue realizar un estudio ictiofaunístico, así como un estudio zoogeográfico y ecológico, así como detectar la presencia de especies exóticas o invasivas. Los individuos fueron colectados utilizando un aparato de electropesca, y las especies fueron identificadas y depositadas en la colección científica de FCB-UANL. Como resultados, se reportaron ocho especies nativas, representadas en seis familias y ocho géneros. Dos especies presentaron una categoría de protección de acuerdo a las normas oficiales mexicanas, *Cyprinella* cf. *rutilla* (Amenazada), probablemente una nueva especie, y *Dionda melanops* (en peligro). La afinidad zoogeográfica presenta cuatro especies neárticas y cuatro neotropicales, y la presencia de tres especies exóticas *Micropterus dolomieu, Oreochromis* sp. Indet y *Xiphophorus variatus*. Es importante continuar con los muestreos debido a la posibilidad de encontrar más especies dentro del área de conservación.

Abstract

The state of Nuevo León is in the northern of México, the Bustamante river is in the portion of northwestern of this state. It is a limited area where rainfall and the water are a vital resource for anthropocentric activities. The preservation of the rivers is very important, and the fish communities are override in this region. The study was conducted in a Priority Terrestrial Region, bordering Coahuila. There is the first study on fishes in this river, that the most of time is a close flood, is a tributary of the Salado River, for this reason, the objective was to know the ichthyofauna, as well as conduct a zoogeographical and ecological analysis, and the presence of exotic and/or invasive species. Individuals were collected using seine net and electrofishing equipment, species were identified and stored in the Scientific Collection of FCB-UANL. As a result, were reported the presence of eight native species, where is represented six families and eight genera. There are two species under a status of protection laws of the country, *Cyprinella* cf. *rutilla* (Threatened) probably a new species and spotted minnow, *Dionda melanops* (Endangered). Zoogeographical affinity presents four Nearctic species and four Neotropical species, and three, smallmouth bass, *Micropterus dolomieu*, Tilapia probably *Oreochromis* sp. Indet. and *Xiphophorus variatus*, as exotic species were collected. It is important to continue the surveys due to is possible to find species that important area for conservation.

Palabras clave: Bustamante, Nuevo León, Ríos, Ictiofauna

Keywords: Bustamante, Nuevo León, Rivers, Ichthyofauna

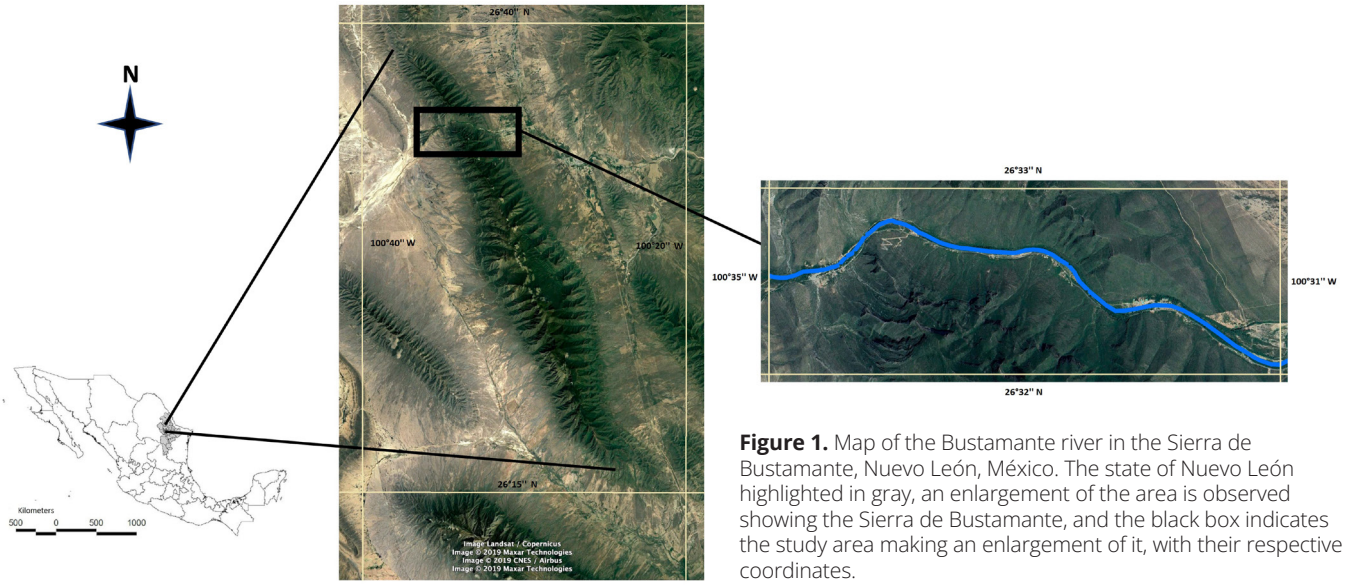

Figure 1. Map of the Bustamante river in the Sierra de Bustamante, Nuevo León, México. The state of Nuevo León highlighted in gray, an enlargement of the area is observed showing the Sierra de Bustamante, and the black box indicates the study area making an enlargement of it, with their respective coordinates.

Introduction

The state of Nuevo León is in the northern region of México, and the Bustamante river is in the northwestern portion of this state. It is a limited area where rainfall and the water are a vital resource for anthropocentric activities. The preservation of the rivers is very important, and the fish communities are override in this region. The present study was conducted in a Priority Terrestrial Region (RTP-77), which represents an environmental stable unit in the national territory, highlighting the presence of an ecosystemic richness and specific diversity, with a significative ecological integrity and opportunity for conservation. In the Sierra of Bustamante, bordering the state of Coahuila where this region was determined based on plant communities, reptiles, birds and mammals, and fishes weren't considered and are important part of the group of vertebrates and directly affected by ecotourism, fishing, and water extraction (Anonymous, 2000; Arriaga *et al.,* 2000; Martínez-Muñoz and Rodríguez- González, 2018). This is the first study on fishes in this river, that the most of time is a close flood, and is a tributary of the Salado River, for this reason, it is important to know the ichthyofauna, as well as conduct a zoogeographical and ecological analysis, and assess the presence of exotic and/or invasive species.

There is a lack of knowledge about the fishes in the state of Nuevo León, only a few general works as well as Meek (1904) reports in large spring in Monterrey, referenced six species of characids, cyprinids, and cichlids. Álvarez-del-Villar (1952) reports 48 species for the state of Nuevo León. Contreras-Balderas (1967) increase the inventory for the state to 54 species, then Contreras- Balderas *et al.* (1995) mention the presence of 83 species in 46 genera and 18 families, which 28 species are considered as exotic, and specific areas as Contreras-Balderas *et al.* (2002) published an inventory for the fishes of Monterrey where included 20 species in seven families and 14 genera, and nine considered as exotic. A management program of the Monumento Natural del Cerro de la Silla (CONANP, 2014) refers to vertebrates, but fishes are not included; also, Lozano-Vilano *et al*. (2013) mention the fishes for the Parque Nacional Cumbres de Monterrey the presence of 28 species and nine introduced species; but particularly for the Bustamante river there are no surveys of possible fishes present in the area, also contribute to the knowledge of the natural areas and species that are used *a posteriori* in evolutive and conservation studies.

Materials and methods

Study site. Sierra de Bustamante is located at the coordinates (26°11'15"-26°43'19" N and 100°22'55"-100°46'23" W), and is part of a mountain range in the northwest portion of the state of Nuevo León that extends to the municipality of Candela in the state of Coahuila, extending to the municipalities of Mina, Salinas Victoria, Villaldama, Bustamante, and Lampazos de Naranjo in the state of Nuevo León, and the Bustamante river is located in the north portion of the mountain extending from coordinates (26°32'25" N and 100°31'46´´ W) (Fig. 1). The climate is semi-arid, temperate with an average annual of 18-22ºC and an average rainfall of 5-10.2% per year. This region has an altitudinal gradient from 550-2,000 meters above sea level (masl). All these characteristics contribute to the presence of a great variety of plant communities starting in the lower part with submontane scrubland,

xerophilous and rosetofilous scrubland, which are the predominant plant communities. In addition, communities such as chaparral, oak, pine in the highest parts of the mountain are included (Anonymous, 2000).

Method. To collect the specimens, a seine net was used with 2 and 3 meter long, 1.8m wide with a 1/16' sieve, and an electrofishing device LR-24 Smith-Root, Inc. The collection method used was the capture per unit of effort, for one hour each locality. The material was labeled and deposited in Scientific collection of Facultad de Ciencias Biológicas UANL, and material was deposited using 10% formalin, for 7 days, and preserved in 50% isopropyl alcohol. Collection permit was SGPA/DGVS/10766/16. The collection sites were georeferenced by a Garmin eTrexâ 20x GPS and a Rebel T6s EOS EF-S 18-135 IS STM camera to obtain the individual's photographic records at the time of being captured to have the registration of their coloration before being fixed under preservation methods.

Identification of species. Material was identified following criteria of Álvarez-del-Villar (1970) and Miller *et al.* (2005), updated scientific and common names by Nelson *et al.* (2004) and Fricke *et al.* (2024). Zoogeographical origin and ecological affinity of the species based in Darlington (1963). Status of protection of the species was based on Norma Oficial Mexicana NOM-059-SEMARNAT-2010 (SEMARNAT, 2010).

Data analysis. The statistical analysis was performed by nonparametric diversity analysis using the EstimateS Ver. 9.1.0 program with the indicators of Jacknife1, Chao2 and Bootstrap to determine the representativeness of sampling based on absence and presence of species in the study area (Colwell, 2011; Colwell and Coddington, 1994).

Results

At the end of the survey were identified the species of fishes for the Bustamante river with a total of 11 species in 172 individuals, distributed in six families and 10 genera (Table 1).

From the 11 species two species (*Dionda melanops* and *Cyprinella rutila*) are under a category of protection according to the NOM-059SEMARNAT-2010. Also were found in the surveys three species that are consider exotic, which include *Micropterus dolomieu, Oreochromis sp*. and *Xiphophorus variatus*. The zoogeographical origin of the Bustamante river consists of eight species reported which are distributed in four Nearctic and four Neotropical species, and ecological affinity are distributed in five primary and three secondary.

The results of the statistical analysis of the nonparametric diversity indexes of Jacknife1, Chao2 and Bootstrap including the species accumulation curve

Table 1. Ichthyofauna diversity, ecological affinity and zoogeographical origin in the Bustamante river, Nuevo León, México. Abbreviations: STATUS: Category of law protection of species according to Norma Oficial Mexicana (P: endangered, A: Threatened and SE: Without status).

Species	Ecological affinity	Zoogeographical origin	Status
Centrarchidae			
Micropterus dolomieu			Exotic
Micropterus salmoides	Primary	Nearctic	SE
Characidae			
Astyanax argentatus	Primary	Neotropical	SE
Cichlidae			
Herichthys cyanoguttatus	Secondary	Neotropical	SE
Oreochromis sp.			Exotic
Cyprinidae			
Dionda melanops	Primary	Nearctic	P
Cyprinella rutila	Primary	Nearctic	A
Ictaluridae			
Ictalurus punctatus	Primary	Nearctic	SE
Poeciliidae			
Gambusia affinis	Secondary	Neotropical	SE
Poecilia mexicana	Secondary	Neotropical	SE
Xiphophorus variatus			Exotic

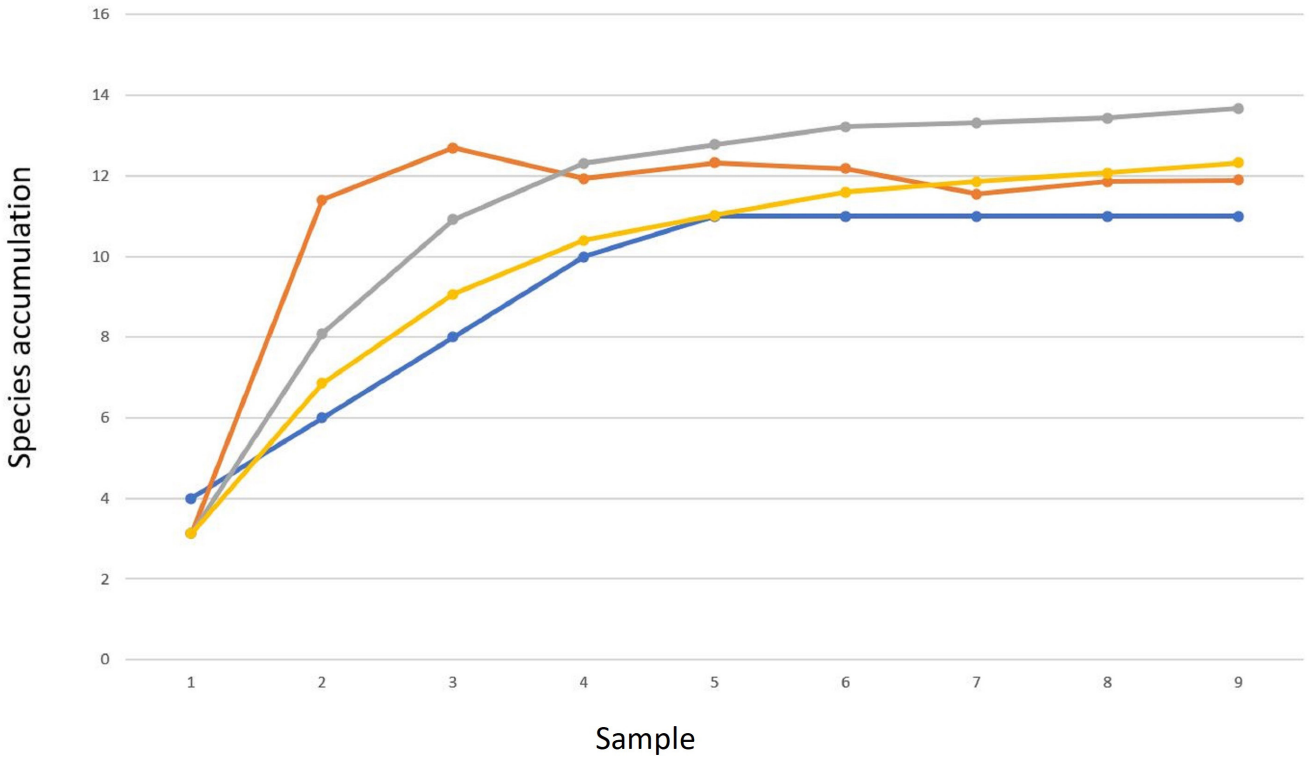

Figure 2. Species accumulation curve in the Bustamante river (blue line), including non parametric diversity index of Jacknife 1 (grey line), Chao2 (orange line), and Bootstrap (yellow line) indicating horizontal line surveys, and vertical line number of species.

showed values of 13.67, 11.89 and 12.32 respectively, indicating that surveys reach the asymptote from sampling six (Fig. 2).

Discussion

The ichthyofauna present for the Bustamante river includes 11 species (172 individuals) distributed in six families, 10 genera and 11 species (Fig. 3). For these species is confirmed their presence according to the distribution maps mentioned by Álvarez-del-Villar (1970), Fricke *et al.* (2024), Miller *et al.* (2005), and Nelson *et al.* (2004). Is important to mention the presence of three exotic species *Micropterus dolomieu, Oreochromis sp.* and *Xiphophorus variatus* that are species from USA, south and east of México and Africa used for aquaculture or sportfishing and have been introduced in several rivers, in this case Bustamante river is a balneary and ecotouristic river where the introduction of these species could be for the same reasons as aquaculture or sportfishing (Brewer and Orth, 2014; Torres-Jaramillo *et al.,* 2010).

The species accumulation curve indicates that the number of species represented in the Bustamante river reach the asymptote, representing the ichthyofauna in the area with an average of 87.16% (Colwell and Coddington, 1994). The selected statistical estimators allow to determine, based on presence/ absence of species, the number of species that can occur in one sample, and provide the least biased estimator for small samples (Colwell and Coddington, 1994; Moreno, 2001), therefore, the similar value obtained from these non-parametric indicators and the species accumulation curve corroborates the effectiveness of estimation of species diversity in the study area.

According to the laws of protection of the country the Normal Oficial Mexicana NOM-059-SEMARNAT-2010 (SEMARNAT, 2010) are reported two species under a category of protection, *Cyprinella rutila* in the category of threatened and *Dionda melanops* as endangered, this represents 25% of the native species of fishes reported for Bustamante river in present study. Although it is not a considerable percentage of vulnerable ichthyofauna, it is important to conserve these natural aquatic environments since the state of Nuevo León is considered a semi-arid area (CONANP, 2014; SEMARNAT, 2010), this two species under Mexican law protection are vulnerable due to anthropocentric activities and freshwater mismanagement as *Xiphophorus couchianus*

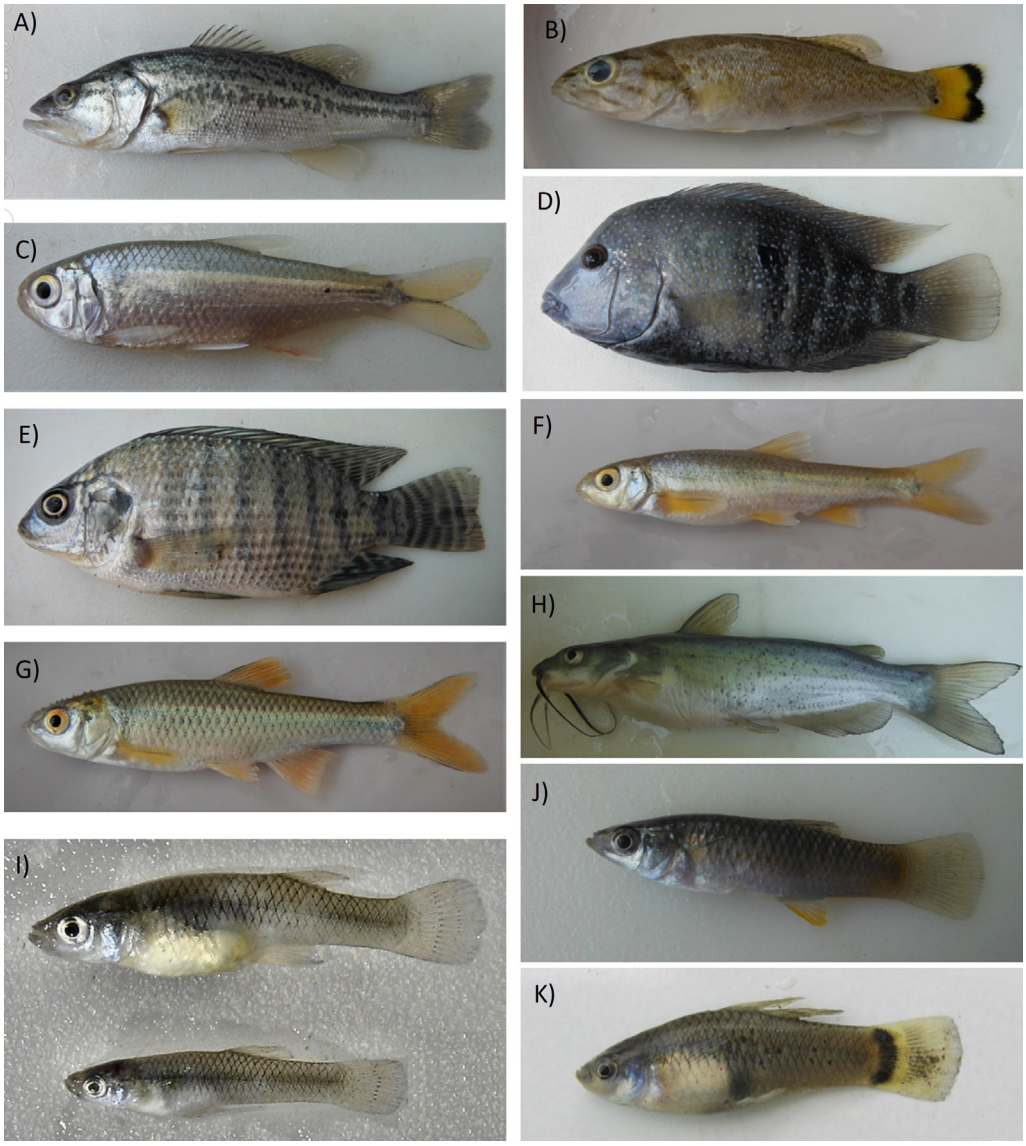

Figure 3. Photos of the species found in Bustamante river, in Nuevo León, México. Order of the photos: A) ***Micropterus salmoides***, B) ***Micropterus dolomieu,*** C) ***Astyanax argentatus***, D) ***Herichthys cyanoguttatus***, E) ***Oreochromis sp.***, F) ***Dionda melanops***, G) ***Cyprinella rutila***, H) ***Ictalurus punctatus***, I) ***Gambusia affinis*** upside female, downside male, J) ***Poecilia mexicana*** and K) ***Xiphophorus variatus.***

disappeared of natural environments in 1968? or *Notropis saladonis* extinct before 1983, among others, in Nuevo Leon state (Contreras-Balderas *et al.,* 1995).

The ecological affinity of the species present in Bustamante river are five primary freshwater species representing the 62.5% and three secondary freshwater species with 37.5% of the native species, indicating that the study site is mainly composed of freshwater and there is no influence of brackish water (Soria-Barreto *et al.,* 2018). The zoogeographical origin consists of four Nearctic and four Neotropical species representing the 50% for each of the native species (Miller *et al.,* 2005). According to Darlington (1963), mention that the study site is in the southern limit of the Nearctic and the northern limit of the Neotropical region. Also, the Nearctic and Neotropical region seems to have a strong competition for resources which keeps the number of species in this zoogeographic region regulated (Darlington, 1963; Espinosa *et al.,* 2008; García-Contreras, 2012). One of the most notable and negative changes for the ichthyofauna of the river is the presence of three exotic species (*Micropterus dolomieu, Oreochromis sp.* and *Xiphophorus variatus*), because they have some characteristics that can alter the aquatic ecosystem, affect food chains, affect the ability of native species to compete for food and habitat acquisition due to the lack of biological control as diseases and predators and predation of native species; resulting in decline and possible extinction of native species (Root *et al.,* 2013).

Acknowledgements

Project supported by PAICyT-UANL CN382-15. SEMARNAT permission No. SGPA/DGVS/09017/17.

Literature cited

Álvarez-del-Villar. 1952. Los peces de Nuevo León y la psicultura rural. Instituto de Investigaciones Científicas, Nuevo León, 43pp.

Álvarez-del-Villar. 1970. Peces mexicanos (claves). Instituto Nacional de Investigación Biológico Pesquera, México, 166pp.

Anonymous. 2000. Áreas naturales para la conservación ecológica en el estado de Nuevo León. Secretaría de Desarrollo Urbano y Obras Públicas y Subsecretaria de Ecología. Gobierno del Estado de Nuevo León, Nuevo León, 341pp.

Arriaga, L., J.M. Espinoza, C. Aguilar, E. Martínez, L. Gómez y E. Loa (coordinadores). 2000. Regiones terrestres prioritarias de México. Comisión Nacional para el Conocimiento y uso de la Biodiversidad, México, 611pp.

Brewer, S.K. y D.J. Orth. 2014. Smallmouth bass Micropterus dolomieu Lacepede, 1802. American Fisheries Society Symposium, 82:9-26. https://www.researchgate.net/publication/281206490_Smallmouth_Bass_Micropterus_dolomieu_Lacepede_1802

Colwell, R. K. 2011. Estimates: Statistical Estimation of Species Richness and Shared Species from Samples. Version 9.1.0, 2018, User's Guide and application publishedat, University of Colorado, Colorado.

Colwell, R.K., y J.A. Coddington. 1994. Estimating terrestrial biodiversity through extrapolation. Philosophical Transactions of the Royal Society of the London Society B. Biological Science. 345(1311): 101-118. https://www.researchgate.net/publication/15227591_Colwell_RK_Coddington_JA_Estimating_terrestrial_biodiversity_through_extrapolation_Philos_Trans_R_Soc_London_B-Biol_Sci_345_101-118.

Contreras-Balderas, S. 1967. Lista de peces del estado de Nuevo León. Cuadernos del Instituto de Investigación Científica, UANL, 11:1-12.

Contreras-Balderas, S., M.L. Lozano-Vilano, y M.E. García-Ramírez. 1995. Tercer lista anotada y revisada de peces de Nuevo León, México. Pp. 73-78. En: Contreras-Balderas S., F. González-Saldivar, D. Lazcano-Villarreal & A. Contreras-Arquieta (Eds.). Listado preliminar de fauna silvestre del estado de Nuevo León, México. Ediciones Consejo Estatal para la Preservación y Fomento de la Flora y Fauna Silvestre de Nuevo León, Monterrey. 152pp.

Contreras-Balderas, S., M.L. Lozano-Vilano, y M.E. García-Ramírez. 2002. Peces, historia, inventario, y estado de conservación. Pp. 69-74. En: Galán-Wong, L., H.A. Luna-Olvera, J.A. García-Salas, K. Arévalo-Niño, A. Cavazos-Leal & B. Pereyra-Alférez (Eds.). Alba y Horizonte. Universidad Autónoma de Nuevo León, Monterrey, 277pp.

CONANP. 2014. Programa de Manejo Monumento Natural El Cerro de la Silla. SEMARNAT y CONANP, México D.F., 129pp.

Espinosa, H., L. Huidobro, C. Flores, P. Fuentes y R. Funes. 2008. Peces. Pp. 1-78. En: Ocegueda, S. & J. Llorentes-Bousquets (Eds.). Catalogo taxonómico de especies de México, Capital natural de México, Vol. I: conocimiento actual de la biodiversidad. Conabio, México, CD, 78pp.

Fricke, R., W.N. Eschmeyer, y R. Van der Laan. 2024. Eschmeyer's catalog of Fishes: Genera, Species, References. En: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (consultado el 07/02/2024).

García-Contreras, E.V. 2012. Ictiofauna de las áreas naturales protegidas Monumento Natural Cerro de la Silla y Sierra de la Silla, Nuevo León, México. Tesis Licenciatura, Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, 72pp.

Darlington, P.J.Jr. 1963. Zoogeography: the geographical distribution of animals. J. Wiley & Sons, New York, London, 675pp.

Lozano-Vilano, M., M. García-Ramírez y M. Espinoza-Narváez. 2013. Peces. Pp. 195-206. En: Cantú-Ayala, C., M. Rovalo-Merino, J. Marmolejo-Moncivais, S. Ortiz-Hernández & F. Seriña-Garza (Eds.). Historia Natural del Parque Nacional Cumbres de Monterrey, México. UANL-CONANP, México, 414pp.

Martínez- Muñoz, A. y M. Rodríguez- González. 2018. Estudio técnico justificativo para la declaratoria de la Sierra de Bustamante como Monumento Natural Estatal, en el municipio de Bustamante Nuevo León. En: http://mundosustentable.org/bienvenidos/wp-content/uploads/2018/07/ETJ-Bustamante-v4jul2018.pdf (consultado el 01/04/2023).

Miller, R.R., W.L. Minckley y S.M. Norris. 2005. Freshwater fishes of México. University of Chicago Press, Chicago, 490pp.

Meek, S.E. 1904. The freshwater fishes of México North of the Isthmus of Tehuantepec. Publication of the Field Columbian Museum, Zoological Series V., Chicago, 252pp.

Moreno, C.E. 2001. Métodos para medir la biodiversidad. M&T-Manuales y Tesis SEA, Zaragoza, 83pp.

Nelson, J.S., E.J. Crossman, H. Espinosa-Pérez, L.T. Findley, C.R. Gilbert, R.N. Lea, y J.D. Williams. 2004. Common and scientific names of fishes from the United States, Canada and México. American Fisheries Society, Special Publication 29, Bethesda, Maryland, USA, 386pp.

Root, T.L., S.H. Schneider, R. Warren, J.R. Price, y P.R. Mastrandrea. 2013. Climate change and wild species. Pp. 79-99. En: S.A. Levin (Ed.). Encyclopedia of Biodiversity. Academic Press, USA, 5504pp.

SEMARNAT. 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Secretaria del Medio Ambiente y Recursos Naturales (SEMARNAT), Diario Oficial, México.

Soria- Barreto, M., A.A. González-Díaz, A. Castillo-Domínguez, N. Álvarez-Pliego y R. Rodiles-Hernández. 2018. Diversidad íctica en la cuenca del Usumacinta, México. Revista Mexicana de Biodiversidad, 89(2018): S100-S117. https://doi.org/10.22201/ib.20078706e.2018.4.2462

Torres-Jaramillo, J., J.M. Muñoz, H. Cárdenas, L.A. Álvarez, y J.D. Palacio. 2010. Caracterización de tilapia roja (Oreochromis sp.) con marcadores moleculares RAPD. Acta Agronómica, 59(2): 236-246. https://www.redalyc.org/articulo.oa?id=169916224012