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Trophic ecology of *Plagioscion magdalenae* (Pisces, Sciaenidae) in a neotropical reservoir in the lower Magdalena River Basin, Colombia

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Abstract

Trophic ecology of Plagioscion magdalenae *(Pisces, Sciaenidae) in a neotropical reservoir in the lower Magdalena River Basin, Colombia*. *Plagioscion magdalenae* is an endemic species of the Magdalena River basin in Colombia. It is classified within the near–threatened category. The species supports the artisanal fishery in the Lower Magdalena Basin. As little is known about its role and trophic relationships in aquatic ecosystems we studied aspects of its trophic ecology such as diet, trophic niche, feeding period, and degree of robustness in the El Guájaro reservoir, Department of Atlántico, Colombia. Monthly fish capture sampling was carried out over 10 months, from April 2018 to January 2019 so as to cover the flood pulse of the area. We collected and studied a total of 211 individuals. Sample analysis included the numerical method, volumetrics, frequency of occurrence, vacancy coefficient, food importance index, condition factor, trophic niche breadth, and trophic overlap analysis between sizes. Our results indicate that *P. magdalenae* is a specialist carnivore with piscivorous tendencies. Similarity of the trophic overlap between small and large sized fish was below 70 %, with the diet consisting of invertebrates such as Chironomidae, *Campsurus* sp. and *Macrobrachium* sp. for juveniles (14.5–21.8 cm LE) and fish such as *Caquetaia kraussii*, *Andinoacara latifrons* and fish remains for adults (29.2–36.5 cm LE). The supply of prey in the system was lower in the dry season than in the rainy season. However, condition factor K showed that the species has a high degree of robustness in dry periods, associated with preparation for reproduction when the water level rises due to increased flow. *Plagioscion magdalenae* is the primary predator in the reservoir, using multiple trophic resources that vary depending on body size differences. *Plagioscion magdalenae* showed adaptive strategies to decrease intraspecific competition for food and a relationship with the variation of the reservoir water level, reaching robustness in dry periods so as to be fit for reproduction in rainy periods.

Key words: Diet, Diversity, Endemic fish, Predator

Resumen

Ecología trófica de Plagioscion magdalenae *(Pisces: Sciaenidae) en un embalse neotropical de la cuenca baja del río Magdalena, Colombia. Plagioscion magdalenae* es una especie endémica de la cuenca del río Magdalena, en Colombia, que se encuentra en categoría de casi amenazada, es una de las especies que soporta la pesca artesanal en el Bajo Magdalena y poco se conoce acerca de su rol y sus relaciones tróficas en los ecosistemas acuáticos. Por lo tanto, se estudiaron aspectos de la ecología trófica de la especie como la dieta, el nicho trófico, el período de alimentación y el grado de robustez en el embalse El Guájaro, departamento del Atlántico, Colombia. Se realizaron muestreos mensuales de captura de peces durante 10 meses, entre abril de 2018 y enero de 2019, con el fin de abarcar el pulso de inundación de la zona, y se recolectaron y examinaron 211 individuos. Los análisis de los datos incluyeron el método numérico, el volumétrico, la frecuencia de ocurrencia, el coeficiente de vacuidad, el índice de importancia alimentaria, el factor de condición, la amplitud del nicho trófico y el análisis de solapamiento trófico entre tallas. Nuestros resultados indican que *P. magdalenae* es un depredador especialista de comportamiento carnívoro con tendencia piscívora. El solapamiento trófico entre las tallas pequeñas y grandes se observó por debajo del 70 % de similitud, siendo la dieta representada por invertebrados como Chironomidae, *Campsurus* sp. y *Macrobrachium* sp. en ejemplares juveniles (14,5–21,8 cm LE), y por peces como *Caquetaia kraussii* y *Andinoacara latifrons* y restos de peces en ejemplares adultos (29,2–36,5 cm LE). La oferta de presas en el sistema fue menor en la temporada de sequía con respecto a la de lluvias; sin embargo, el factor de condición K mostró que la especie tiene un grado de robustez alto en los períodos secos, asociado a la preparación para la reproducción cuando el nivel del agua sube debido al aumento del caudal. *Plagioscion magdalenae* cumple el rol de depredador primario en el embalse, utilizando múltiples recursos tróficos que varían en función de las diferencias de tamaño corporal. *Plagioscion magdalenae* mostró estrategias adaptativas para disminuir la competencia intraespecífica por el alimento y una relación con la variación del nivel de agua del embalse, alcanzando robustez en periodos secos para estar apta para la reproducción en periodos lluviosos.

Palabras clave: Dieta, Diversidad, Pez endémico, Depredador

Resum

Ecologia tròfica de Plagioscion magdalenae *(Pisces, Sciaenidae) en un embassament neotropical de la conca baixa del riu Magdalena, a Colòmbia*. *Plagioscion magdalenae* és una espècie endèmica de la conca del riu Magdalena, a Colòmbia, es troba en categoria de gairebé amenaçada, és una de les espècies que suporta la pesca artesanal al Baix Magdalena i es coneix poca cosa sobre el rol que desenvolupa i les relacions tròfiques que estableix en els ecosistemes aquàtics. Per tant, es van estudiar aspectes de l'ecologia tròfica de l'espècie, com ara la dieta, el nínxol tròfic, el període d'alimentació i el grau de robustesa a l'embassament El Guájaro, al departament de l'Atlàntic, a Colòmbia. Es van fer mostrejos mensuals de captura de peixos durant 10 mesos, entre l'abril de 2018 i el gener de 2019, amb l'objectiu de cobrir l'impuls d'inundació de la zona, i es van recol·lectar i examinar 211 exemplars. Per a analitzar les dades, es van fer servir el mètode numèric, el volumètric, la freqüència d'ocurrència, el coeficient de vacuïtat, l'índex d'importància alimentària, el factor de condició, l'amplitud del nínxol tròfic i l'anàlisi de solapament tròfic entre talles. Els nostres resultats indiquen que *P. magdalenae* és un depredador especialista de comportament carnívor amb tendència piscívora. El solapament tròfic entre les talles petites i grans es va observar per sota del 70 % de similitud, i la dieta incloïa invertebrats com ara Chironomidae, *Campsurus* sp. i *Macrobrachium* sp. pel que fa als exemplars juvenils (14,5–21,8 cm LE), i peixos com ara *Caquetaia kraussii* i *Andinoacara latifrons* i restes de peixos pel que fa a exemplars adults (29,2–36,5 cm LE). L'oferta de preses en el sistema era més baixa durant la temporada de sequera que durant la de pluges; tot i

això, el factor de condició K va mostrar que l'espècie té un grau de robustesa elevat en els períodes secs, associat al fet que es prepara per reproduir–se quan el nivell de l'aigua puja per l'augment del cabal. *Plagioscion magdalenae* compleix el rol de depredador primari a l'embassament, i utilitza diversos recursos tròfics, que varien en funció de les diferències de mida corporal. *Plagioscion magdalenae* va mostrar estratègies adaptatives per a fer disminuir la competència intraespecífica per l'aliment i una relació amb la variació del nivell d'aigua de l'embassament, de manera que aconsegueix robustesa en períodes secs per a estar a punt per a la reproducció en períodes plujosos.

Paraules clau: Dieta, Diversitat, Peix endèmic, Depredador

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Introduction

Colombia has the greatest richness of freshwater fish in the world when evaluating diversity per unit area (1,142 km^2), with 1,692 species. The Magdalena–Cauca basin holds 14.6 % of Colombia's fish diversity and is the central axis of the country's socio–economic development (García–Alzate et al., 2020; DoNascimiento et al., 2021). Ichthyofauna therefore constitute one of the most ecologically, economically and socially important resources. *Plagioscion magdalenae*, commonly called 'pacora', is one of the more than 68 % endemic species of the Magdalena River basin in Colombia (Rojas–Luna and García–Alzate, 2023). It is listed in the Vulnerable Threat category in the basin and in the Near Threatened category at the national level (Álvarez–León and Jiménez–Segura, 2012). Studies have been conducted on its reproductive ecology (Rojas–Luna and García–Alzate, 2022, 2023), the phenotypic variability of its populations in the lower Magdalena (Hernández et al., 2023) and an approximation of its feeding habits (Segura–Guevara et al., 2023), but little has been published regarding its diet, trophic ecology, and predator–prey interactions in relation to the subsistence fishing in El Guájaro reservoir and the lower Magdalena basin (Ortega–Lara et al., 2011; Segura–Guevara et al., 2023).

Knowledge of the ecology and trophic habits of ichthyofauna is important to establish the relationships between species and their habitat, their position in the food web, and their ecological role in the community and the ecosystem. Such aspects are fundamental to establish management protocols for their populations (Morales and García–Alzate, 2016). Such studies also make it possible to evaluate the effect that could be caused by alterations to the biological cycle of fish species, such as fishing exploitation, absence of prey and/or predators, and changes in the physicochemical conditions of the water (Ibarra–Trujillo and García–Alzate, 2017).

Information is lacking regarding the feeding interactions of the pacora, its role in the energy flow in the food web, and the population dynamics of its prey at different times of the hydrological regime. In addition, the species is threatened in the El Guájaro reservoir due to activities such as fishing pressure exerted as the result of its importance in the

Fig. 1. Geographical location of El Guájaro reservoir, lower Magdalena River basin, Colombia. The monitoring stations represent fishing ports in the south (S1), center (S2) and north (S3) of the reservoir.

Fig. 1. Ubicación geográfica del embalse El Guájaro, cuenca baja del río Magdalena, Colombia. Las estaciones de monitoreo representan puertos pesqueros del sur (S1), centro (S2) y norte (S3) del embalse.

subsistence of the populations of the southern Department of Atlántico and the lower basin of the Magdalena River. Our objective here was therefore was to evaluate aspects of the trophic ecology of *P. magdalenae* and its relationship with the flood pulse.

Material and methods

Study area

The study was carried out in El Guájaro reservoir, which is located in the southwest of the Department of the Atlántico, within the Magdalena River basin, from which it receives its waters through the Canal del Dique, in the Colombian Caribbean region (fig. 1). The reservoir currently covers an area of 13,000 ha (Rojas–Luna and García–Alzate, 2023).

El Guájaro corresponds to the floodplains of the Magdalena River and is connected to the south by means of a lotic system through a system of floodgates. This floodgate system is open to fill the reservoir during the rainy season, but it is usually kept closed during dry periods for water storage (García–Alzate et al., 2016). It has a marked flood pulse related

to the hydrological regime: the reservoir holds the most water (high water) in November and December. From January to March the water level tends to drop (falling water). April and May are the driest months and the water level reaches its minimum levels (low water). Maximum rainfall occurs in September and October (rising water), generating an increase in the water level of the reservoir (Rojas–Luna and García–Alzate, 2023).

Sampling phase

Monthly fish capture sampling was carried out for 10 months, from April 2018 to January, 2019. Fish were caught by means of traps and trammel nets, and with the help of fishermen in the area. Immediately after capture, the specimens were taken to the fishing ports of the reservoir and deposited in polyethylene coolers with ice to avoid the process of stomach digestion and / or regurgitation of food (Ibarra–Trujillo and García–Alzate et al., 2017). All fish were collected during the day, between 8:00 a.m. and 4:00 p.m. The captured specimens were weighed using a digital scale (OHAUS CS2000 ± 0.0001 g). Total length and standard length were measured using a tape measure. A uroventral incision was then made to extract the digestive system and gonads. Organs were preserved in 70 % alcohol, deposited in containers, labeled, and transported to the Laboratory of Scientific Collections of the Universidad del Atlántico Región Caribe (UARC–IC).

Laboratory phase

Stomach and intestine were measured and weighed. To determine the food items in the diet of *P. magdalenae*, each stomach and the final section of the intestine were placed in Petri dishes and dissected under stereoscope for classification and identification to the lowest taxonomic category possible, with the help of taxonomic keys such as Roldán (1996), Maldonado–Ocampo et al. (2005) and Domínguez and Fernández (2009). Parts of organisms that did not allow complete taxonomic identification, such as heads, antennae, scales or limbs, were cataloged as fish remains, insect remains, and crustacean remains, respectively. Sex was determined at the macroscopic level by comparison with reproductive parameters for this species (Rojas–Luna and García–Alzate, 2023).

The numerical method (%N) was used with the formula:

$$\%N = (n_i/N_p) \times 100$$

where n_i is the total number of representatives of prey *i*; N_p is the total number of preys consumed. The volumetric method (%V) (Hyslop, 1980) was calculated from the displacement of a known volume in a test tube. The frequency of occurrence method (%FO) was applied:

$$\%FO = (E_i/E_t) \times 100$$

where E_i is the number of stomachs with prey *i*; E_t is the total number of stomachs examined for each species (Hyslop, 1980). Similarly, the Food Importance Index (FII) was used as follows:

$$FII = (\%V \times \%FO)/100$$

to estimate the contribution of each of the prey in the diet (Kawakami and Vazzoler, 1980). The vacuity coefficient (Va) was used to know the feeding period of the species, using the formula:

$$Va = (n/N) \times 100$$

where *n* is the number of empty stomachs and N the number of stomachs examined (Hyslop, 1980).

The specimens were distributed according to their standard length in the sizes proposed by Rojas–Luna and García–Alzate (2023) through the formula:

$$A = N/R,\ R = \sqrt{n}\ y\ N = Max - Min$$

where A is the width of the intervals, R is the number of intervals, n the number of observations, Max and Min are the maximum and minimum values, respectively. Similarly, the condition factor K (Vazzoler, 1996) was estimated to know the degree of robustness of the animal associated with its feeding habits as follows:

$$K= Wt/LE^{b}$$

where Wt is the total weight of the fish (g), LE is the standard length (mm) and *b* is the angular coefficient of the Wt–LE regression.

Statistical analysis of the data

To evaluate the goodness–of–fit contrast, the Shapiro–Wilk normality test was applied for the values of %N, %V, %FO, %FII, K by length, sex and flood pulse moments. For data with non–parametric distribution, such as size and flood pulse, a Friedman's ANOVA was used and between sexes a Kolmogorov–Smirnov test was applied to establish significant differences for each estimate. For data with normal distribution, such as K, a *t*–test was used to evaluate statistical differences. A similarity analysis between sizes was applied using the Morisita index (Horn, 1966) based on the values of %FO, whose values vary between 0 and 1, where 0 (absence of trophic similarity) and 1 (maximum trophic similarity). Trophic niche breadth was determined using the standardized Levin's index (BA) (Hurlbert, 1978). The resulting scale of values is between 0 (minimum breadth) and 1 (maximum breadth), when less than 0.6 indicates narrow breadth. The general diet of the species was analyzed using descriptive statistics. A predator–prey interaction network was constructed, taking into account the %V values, between the food items belonging to the diet of *P. magdalenae* and the sexes, using the 'bipartite' package of the statistical software RStudio v.4.2.2.

Results

Diet

We examined a total of 211 individuals of *P. magdalenae,* distributed in 49 individuals in falling waters, 59 in low waters, 57 in rising waters, and 46 in high waters. This species has a well–defined digestive system with a terminal mouth, conical teeth, and a saccular, elastic and consistent stomach, located in the dorsal part of the abdominal cavity. It has a high number of pyloric caeca (16 to 18), and a long intestine with an average length of 163.7 mm. The species showed carnivorous habits, behaving as a specialist with a piscivorous tendency, (BA = 0.3), meaning it uses a low number of resources and has a preference for certain prey. In this study, the vacuity coefficient was 22.7 %, equivalent to 48 empty stomachs; therefore, it was highest in the period of rising water (26.5 %), followed by low water (24.6 %), high water (22.6 %), and the lowest value being recorded at the moment of falling water (16.1 %).

Twenty categories of food items were determined and the diet was dominated by fish, a group represented by four orders (Characiformes, Blenniiformes, Clupeiformes and Acanthuriformes), six families with nine identified species; followed by insects (four species), crustaceans and gastropods (one specie each) and vegetable material (this latter considered as incidental food) (table 1). The diet consisted of fish as the main food (26.17 %N, 91.41 %V, 60.8 %FO, 94.96 %FII) where *Astyanax* sp. (12.90 %N, 29.17 %V, 14.07 %FO, 39.37 %FII) was the most consumed species, followed by *Anchoa lyolepis* (5.38 %N, 15.51 %V, 6.53 %FO, 9.72 %FII) and *Caquetaia kraussii* (1.08 %N, 12.05 %V, 1.51 %FO, 1.74 %FII). The remaining component represented a high contribution to the diet of the pacora (14.12 %V, 30.65 %FO, 41.51 %FII). Therefore, insects were the second group of the animal component (65.6 %N, 4.86 %V, 26.13 %FO, 3.34 %FII), and represented by Diptera of the family Chironomidae (48.03 %N, 1.71 %V, 8.54 %FO, 1.40 %FII), followed by the Ephemeroptera genus

Table 1. General diet of *Plagioscion magdalenae* in El Guájaro reservoir, lower Magdalena River basin: %N, numerical percentage; %V, volumetric percentage; %FO, percentage frequency of occurrence; %FII, percentage of food importance index; L, larva; A, adult.

Tabla 1. Dieta general de Plagioscion magdalenae *en el embalse El Guájaro, cuenca baja del río Magdalena: %N, porcentaje numérico; %V, porcentaje volumétrico; %FO, porcentaje de la frecuencia de ocurrencia; %FII, porcentaje del índice de importancia alimentaria; L, larva; A, adulto.*

Class Order Family	Items	%N	%V	%FO	%FII
Actinopterygii					
Characiformes					
Characidae	*Astyanax* sp.	12.90	29.17	14.07	39.36
	Roeboides dayi	1.08	6.14	1.51	0.88
	Hyphessobrycon proteus	2.87	5.00	2.51	1.20
Triportheidae	*Triportheus magdalenae*	0.36	0.50	0.50	0.02
Clupeiformes					
Engraulidae	*Anchoa lyolepis*	5.38	15.51	6.53	9.71
Blenniiformes					
Hemiramphidae	*Hyporhamphus unifasciatus*	0.36	0.50	0.50	0.02
Cichlidae	*Caquetaia kraussii*	1.08	12.05	1.51	1.74
	Andinoacara latifrons	0.36	7.73	0.50	0.37
Acanthuriformes					
Sciaenidae	*Plagioscion magdalenae*	0.36	0.18	0.50	0.01
Insecta					
Diptera					
Chironomidae	Chironomidae (L)	48.03	1.71	8.54	1.40
Ephemeroptera					
Polymitarcydae	*Campsurus* sp. (L)	12.54	1.68	7.54	1.21
Odonata					
Libellulidae	*Pantala flavescens* (L)	4.66	1.18	5.53	0.62
Hymenoptera					
Formicidae	*Crematogaster* sp. (A)	0.36	0.03	0.50	0.01
Malacostraca					
Decapoda					
Palaemonidae	*Macrobrachium* sp.	6.45	2.35	6.03	1.36
Gastropoda					
Neotaenioglossa					
Thiaridae	Thiaridae	1.79	0.24	1.51	0.03
Others					
Fish remains		0.00	14.12	30.65	41.51
Insect remains		0.00	0.25	4.02	0.09
Crustacean remains		0.00	0.55	3.02	0.15
Fish larvae		1.43	0.56	2.01	0.10
Vegetable material		0.00	0.59	2.51	0.14

Campsurus sp. (12.54 %N, 1.68 %V, 7.54 %FO, 1.21 %FII), the larvae of odonates represented by the species *Pantala flavescens (*4.66 %N, 1.18 %V, 5.53 %FO, 0.63 %FII). The pacora also consumes crustaceans as secondary food, such as specimens belonging to the genus *Macrobrachium* sp. (6.45 %N, 2.35 %V, 6.03 %FO, 1.36 %FII) and gastropods of the family Thiaridae as occasional food (1.79 %N, 0.24 %V, 1.51 %FO, 0.03 %FII). The vegetable component of the diet was scarce and was represented by fibrous material (0.59 %V, 2.51 %F, 0.142 %FII). It is of note that that *P. magdalenae* had cannibalistic behaviors due to the consumption of juveniles of its own species. However, the incidence of this behavior in the specimens analyzed was low (0.36 %N, 0.18 %V, 0.50 %FO, 0.009 %FII).

Diet variation between sizes

At the smallest size (size I: 14.5–21.8 cm) there were few items with representation in number and volume with maximum values (> 5 %N and > 10 %V). The most highly consumed prey items were Chironomidae (68.9 %N), *Campsurus* sp. (13 %N) and *Macrobrachium* sp. (5.08 %N). However, those items that contributed most in terms of volume were *Astyanax* sp. (27 %N) and *Anchoa lyolepis* (27 %N). This sized fish had a diet represented by small prey, with fish (21 %FII) and chironomids (19 %FII) being the most important food items.

Medium sized fish (size II: 21.9–29.1 cm) and large fish (size III: 29.2–36.5 cm) showed a higher number of food items, represented by high %N values with respect to size I, these differences were statistically significant (H: 7.59, *p*–value: 0.01). The diet of size II was composed mainly of *Astyanax* sp. (26.03 %N), Chironomidae (15.07 %N), *Pantala flavescens* and *A. lyolepis* (12.33 %N), *Macrobrachium* sp. (9.59 %N), *Campsurus* sp. (8.22 %N) and Gastropoda (6.85 %N); two items (*Astyanax* sp. and fish remains) occupide more than 50 % of the occurrences in this size. The similarity analysis showed a trophic overlap between medium and large length individuals (> 90 %), reflecting high intraspecific competition for resources, while overall we observed similarity greater than 65 %, with the smallest size reflecting a differentiation in the prey of the smaller size specimens (fig. 2).

Size III included more diversity of food items in its trophic activity (17) than sizes I and II, with 12 and 15 food items, respectively. In terms of volume, fish were the largest contributors (> 10 %V) as fish of a larger size were not consumed by smaller sizes: *Caquetaia kraussii, Andinoacara latifrons,* fish remains, and small fish such as *Astyanax* sp. and *Roeboides dayi.* Consumption of fish in the diet was an increasing characteristic as *P. magdalenae* grew in size, from 64.8 %FII (size I), through 97.0 %FII (size II), to 98.3 %FII (size III), showing its piscivorous predatory behavior on prey with high motility.

Diet variation between sexes

We analyzed 127 males (60.2 %) and 84 females (39.8 %) with 16 and 17 food items, respectively. The diet of the pacora was similar between sexes, with a greater abundance among its prey of chironomids (> 35 %N), a predominance of *Astyanax* sp. in terms of volume (> 25 %V), and an occurrence of fish remains above 25 %FO. However, the categories of food items differed in dietary importance. For females, the consumption of *Astyanax* sp. was more important (47.9 %FII) while for males it was fish remains (53.7 %FII). However, these differences were not statistically significant (K–S: 0.2, *p*–value > 0.05).

Diet variation by hydrological regime

The feeding habits of the pacora varied according to the flooding pulse of the reservoir. In the dry season, the number of items was lower (falling waters: seven; low waters: nine) than that for the period associated with the rains (rising waters: 16; high waters: 11). During the drought, the food supply was limited to insects belonging to Chironomidae and Odonata and small fish of the order Characiformes (*Roeboides dayi, Hyphessobrycon proteus,*

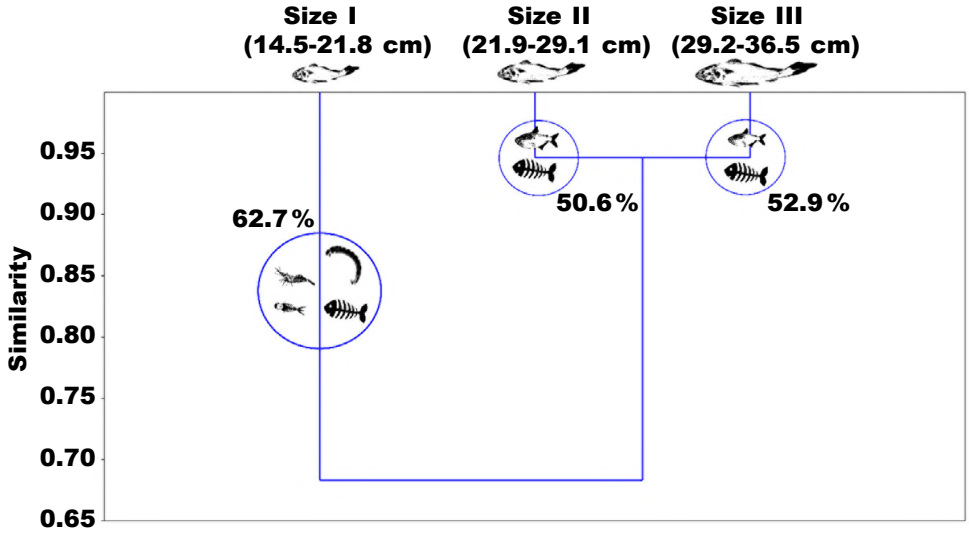

Fig. 2. Trophic similarity analysis using the Morisita index between the sizes of *Plagioscion magdalenae*, based on the frequency of occurrence data (%FO) of the prey.

Fig. 2. Análisis de similitud trófica mediante el índice de Morisita entre las tallas de Plagioscion magdalenae*, a partir de los datos de frecuencia de ocurrencia (%FO) de las presas.*

Astyanax sp.), while in the rainy period, the supply in terms of medium–sized (*Anchoa lyolepis, Andinoacara latifrons*) and large fish (*Caquetaia kraussii, Hyporhamphus unifasciatus, Plagioscion magdalenae*) was greater, with no statistical differences (fig. 3).

In the dry season, the diet of the pacora was restricted to *Astyanax* sp. (falling waters: 17.1%N; low waters: 29.2%N) and individuals of Chironomidae (falling waters: 60.0%N; low waters: 25.0%N) with a predominance in the food supply of fish remains (falling waters: 41.0%FII; low waters: 52.3%FII) and *Astyanax* sp. (falling waters: 35.15%FII; low waters: 40.3%FII). During the rainy season, *P. magdalenae* made inroads into the deep areas of the reservoir, areas covered on the surface by floating vegetation roots, and broadened its trophic spectrum, so there were more items of dietary importance for this species. In rising waters, *Astyanax* sp. showed the highest value (49.4%FII, 25.6%V), followed by fish remains (21.4%FII, 9.37%V) and *A. lyolepis* (14.63%FII, 16.7%V) and at the time of high water, *A. lyolepis* (28.8%FII, 28.5%V), fish remains (23.7%FII, 10.4%V), *Astyanax* sp. (13.7%FII, 18.1%V), *Macrobrachium* sp. (10.4%FII, 8.27%V) and *Campsurus* sp. (10.3%FII, 5.9%V) predominated.

Condition of the species

The average condition factor K ranged from 0.92 to 2.79, reflecting a high degree of robustness for *P. magdalenae*. Females (K: 1.17–4.41) showed better condition than males (K: 0.58–2.84), with higher values than males at all four moments of the flooding pulse, but without statistically significant differences (t: 2.10, *p*–value: 0.07). Seasonally, the species was most robust during low water (K–male: 1.36 and K–female: 2.79) followed by a marked

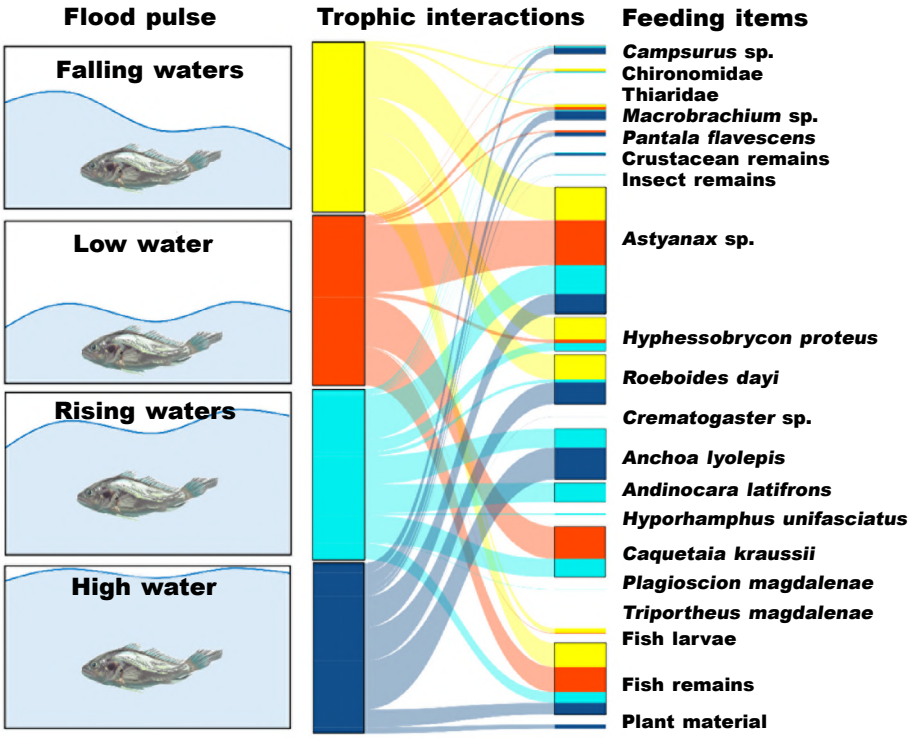

Fig. 3. Predator–prey network of *Plagioscion magdalenae* by moments of the reservoir flood pulse, constructed from the volumetric method data (%V). (Illustration of *Plagioscion magdalenae* by Daniel Villa).

Fig. 3. Relación depredador–presa de Plagioscion magdalenae *en momentos del pulso de inundación del embalse, a partir de los datos del método volumétrico (%V).*

decrease when the reservoir water began to rise (K–male: 0.92 and K–female: 1.67). This suggests at the time of low water, *P. magdalenae* makes an effort to obtain food and have an optimal condition to reach the reproductive event when the water level of the reservoir rises. A decrease in the condition factor is thus observed in the period of rising water (fig. 4).

Discussion

Trophic analyses show that *Plagioscion magdalenae* is a carnivorous species in the lower Magdalena River basin. Our findings indicate it mostly prefers fish, its main trophic group among its prey, but it also tends to consume invertebrates such as mollusks, crustaceans and insect larvae in its early life stages. These observations coincide with those obtained for this species in the basin of the San Jorge River (Segura–Guevara et al., 2023), and are similar to those of *P. squamosissimus* in Venezuela, Brazil and Peru (Lasso–Alcalá et al., 1998; Riofrío, 2009; Stefani and Rocha, 2009).

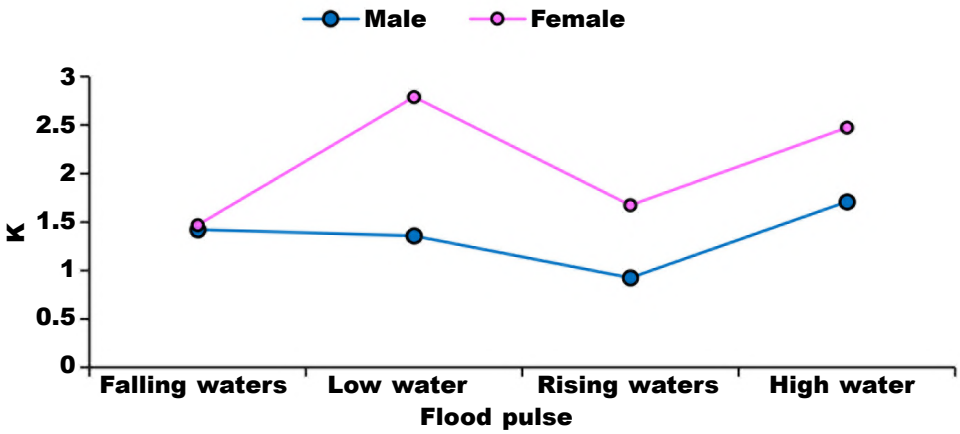

Fig. 4. Condition factor (K) by sex of *Plagioscion magdalenae* and its variation with respect to the flood pulse of El Guájaro reservoir, lower Magdalena River basin.

Fig. 4. Factor de condición (K) por sexos de Plagioscion magdalenae *y su variación con respecto al pulso de inundación del embalse El Guájaro, cuenca baja del río Magdalena.*

Plagioscion magdalenae was cataloged as a piscivorous and specialist species that feeds on a wide variety of fish species as prey (nine), more than previously reported (*Astyanax* sp., *Andinoacara* sp., *Cyphocharax magdalenae*, *Sternopygus macrurus* and *P. magdalenae* according to Segura–Guevara et al., 2023). This suggests that the pacora explores various microhabitats of the ecosystem in search of food, as characteristic of predatory organisms. Additionally, vegetable remains were recorded in the diet as accidental food, possibly associated with the predatory behavior of the species in an environment with abundant presence of macrophytes, as is the case of the El Guájaro reservoir with representation of at least 25 species of aquatic vegetation (Riofrío, 2009; García–Alzate et al., 2016).

Within fish consumption, we observed a low percentage (%N: 0.71) of cannibalistic behavior compared to maximum values of 11.2% recorded in the San Jorge River basin. This may be related to the fact that the individuals analyzed in this study did not reach large lengths (size IV: 36.6–58.5 cm LE) proposed by Rojas–Luna and García–Alzate (2023), fish of larger size where the consumption of juvenile organisms belonging to the same species is more frequent (Segura–Guevara et al., 2023). Cannibalism in species of the family Sciaenidae is common and has been reported by several authors (Lasso–Alcalá et al., 1998; Moraes et al., 2001; Bezerra Figueiredo et al., 2014; Santos et al., 2016), possibly related to a null morphological recognition, absence of communication by generation of sounds through the swim bladder with intrinsic muscles of immature individuals, or intraspecific competition for resources or reproduction.

We recorded fewer empty stomachs and a higher degree of robustness in the drought period (falling water and low water) than in the rainy period (rising water and high water). In preparation for the reproductive period in September–October and December–January, *Plagioscion magdalenae* feeds more abundantly in times of lower prey diversity (low water) (Rojas–Luna and García–Alzate, 2022). The greatest diversity of items occurred during the high–water hydrological period, reflecting the expansion of the environment, which incorporates new microhabitats as the plain floods (Fugi et al., 2007) and water and biota are incorporated from the Canal del Dique and the Magdalena River due to the anthropogenic opening of the reservoir gates.

Small individuals (size I) basically exploited the larvae of Diptera, Ephemeroptera, Odonata and small fishes, a pattern that gradually changes as the pacora increase in size (size II and III) by consuming larger prey such as cichlids (*C. kraussii* and *A. latifrons*), halfbeak fish (*H. unifasciatus*), herring (*T. magdalenae*) and other pacora. This pattern is characteristic of differences in energy requirements and morphological constraints (Abelha et al., 2001; Rezende and Mazzoni, 2006). In addition, these dietary changes are an advantageous strategy that generally decreases intraspecific competition (Araújo et al., 2005).

Knowing the ecological role of *Plagioscion magdalenae* is fundamental to understanding its interactions with prey, which, although not of commercial importance, are essential for the stability of the food web. This has significant implications for the management and conservation of the species as it is crucial to maintain the fish populations that form part of its diet (Jiménez–Segura et al., 2020). In this way, it contributes to maintaining the percentages of fish landings of this species of commercial interest and endemic to the Magdalena River basin in Colombia.

Conclusion

Plagioscion magdalenae is a specialized piscivorous species with a diet dominated by fish, although it also includes invertebrates in its early life stages. The diet varies significantly throughout its life cycle, with small individuals feeding mainly on insect larvae and small fish while larger individuals feed on larger fish, reflecting an adaptive strategy to reduce intraspecific competition. Its trophic niche is modified according to the hydrological regime of the reservoir, showing greater prey diversity during periods of flooding in deep areas with abundant macrophytes. In addition, the pacora showed a higher degree of robustness during the dry season, this being related to the preparation of the species for its reproductive event during the rainy season.

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