Online ISSN: 0718-1957 RBMO
Revista de Biología Marina y Oceanografía
Vol. 57, N° especial: 49-57, 2022
<https://doi.org/10.22370/rbmo.2022.57.Especial.3331>

ARTICLE

Diet of the Dusky finless skate *Gurgesiella furvescens* (Chondrichthyes: Rajidae) from the continental shelf and slope of the north-central area of Chile

Dieta de la raya de profundidad *Gurgesiella furvescens* (Chondrichthyes: Rajidae) de la plataforma y talud continental del área centro-norte de Chile

Tania S. Ponce[1,2], Luis A. Cubillos[2*], Enzo Acuña[3,4] and Cecilia Gatica[3]

[1]Centro de Investigación en Ecosistemas de la Patagonia (CIEP), Coyhaique, Chile
[2]Centro COPAS COASTAL, Departamento de Oceanografía, Facultad de Ciencias Naturales y Oceanográficas, Universidad de Concepción, Casilla 160-C, Concepción, Chile
[3]Departamento Biología Marina, Facultad de Ciencias del Mar, Universidad Católica del Norte, Coquimbo, Chile
[4]Center for Ecology and Sustainable Management of Oceanic Islands (ESMOI), Departamento de Biología Marina, Facultad de Ciencias del Mar, Universidad Católica del Norte, Larrondo 1281, Coquimbo, Chile
*Corresponding author: lucubillos@udec.cl

Resumen.- La raya de profundidad *Gurgesiella furvescens* aparece esporádicamente como parte de la captura incidental en la pesquería de arrastre dirigida a crustáceos demersales en la plataforma continental y el talud superior de la zona centro-norte de Chile (26ºS-33ºS). Los crustáceos demersales podrían ser forraje para predadores de aguas profundas como *G. furvescens*, y el tamaño y forma de las presas ingeridas podrían estar restringidas por el tamaño de la boca. Se determinó la composición de la dieta de *G. furvescens* en base a especímenes recolectados de la captura incidental de arrastres dirigidos a crustáceos demersales en 2013. El análisis del contenido estomacal reveló que la dieta fue principalmente de camarón nailon *Heterocarpus reedi* (32,8% en peso), gamba *Haliporoides diomedeae* (7,2% en peso) y crustáceos indeterminados (9,0% en peso). La composición de la dieta fue similar ya sea entre sexos, longitud corporal o estratos de profundidad. El tamaño de la presa fue una función lineal del ancho de la boca de *G. furvescens* y la masa de la presa relacionada positivamente con la masa individual de *G. furvescens*. Aunque los langostinos *Pleuroncodes monodon* y *Cervimunida johni* fueron abundantes en el área de estudio, la presencia del camarón nailon y la gamba en la dieta de *G. furvescens* se puede deber a la preferencia o selección de este tipo de presa en aguas profundas.

Palabras clave: Raya, dieta, presas, predador especialista, aguas profundas

Abstract.- The dusky finless skate *Gurgesiella furvescens* appears sporadically as part of the bycatch in the trawl fishery targeting demersal crustaceans on the continental shelf and upper slope of the north-central area of Chile (26ºS-33ºS). Demersal crustaceans could be forage for deep-water predators such as *G. furvescens*, and sizes and shapes of prey eaten could be restricted by mouth size. The diet composition of *G. furvescens* was determined based on specimens collected from the bycatch of trawls targeting demersal crustaceans in 2013. Analysis of the stomach contents revealed that the diet was mainly nylon shrimp *Heterocarpus reedi* (32.8% by weight), deep-water shrimp *Haliporoides diomedeae* (7.2% by weight), and indeterminate crustaceans (9.0% by weight). The diet composition was similar between sexes, body length, or depth strata. Prey size was a linear function of *Gurgesiella furvescens* mouth width, and prey mass positively related with *G. furvescens* individual mass. Although squat-lobsters *Pleuroncodes monodon* and *Cervimunida johni* were abundant in the study area, the presence of nylon shrimp and deep-water shrimp in the diet of *G. furvescens* may be due to the preference or selection of this type of prey in deep waters.

Key words: Skate, diet, prey, specialist feeder, deep-water

INTRODUCTION

Skates represent a diverse group, distributed worldwide, from shallow to near 2,000 m depth (Priede *et al*. 2006). More than 90% of elasmobranch species inhabit deep waters on the continental shelves and slopes (Compagno 1990, Bizzarro *et al*. 2017). In Chile, and according to Bustamante *et al*. (2014), at least 30 cartilaginous fishes inhabit (or did occur) on the continental shelf off the central zone. Evidence suggests an overall increase in cartilaginous species richness with increasing latitude and depth down to 500 m (Bustamante *et al*. 2014).

Understanding elasmobranchs' ecological role in deepwater ecosystems is a challenge and only possible by knowing the diet and feeding habits (Brown *et al.* 2012). Skates can play an essential role in transferring energy of benthic and demersal trophic webs (Wetherbee & Cortés 2004, Ebert & Bizzarro 2007). Stevens *et al*. (2000) pointed out that most sharks and some batoids are predators at the top of marine food webs, but it is more likely that most rays and skates have a mid-trophic level (Treloar *et al*. 2007, Ajemian *et al*. 2012, Kemper *et al*. 2017, Reis & Figueira 2020). The foraging of skates varies from specialists to generalist species, but the diet composition reveals that many deepwater skates feed primarily on decapod crustaceans and fishes, followed by amphipod and polychaetes (Ebert & Bizzarro 2007). According to Wilga *et al*. (2007), elasmobranchs specializing in suction-feeding are likely limited to bottom-associated prey. Besides, species with small gape may have a diet restricted to relatively small prey. Barbini *et al*. (2018) showed that body length is an important predictor of skates' feeding habits. Furthermore, subtle morphological aspects such as snout length and bathymetric distribution could have implications for the feeding ecology.

The dusky finless skate, *Gurgesiella furvescens* de Buen, 1959, has a distribution from the Galápagos in Ecuador to Valparaíso in Chile (De Buen 1959, Lamilla & Sáez 2003). The southern limit of the *Gurgesiella furvescens* distribution ends at 35ºS, which coincides with the Peruvian biogeographic province (Pequeño & Lamilla 1993, Sielfeld & Vargas 1996, Bustamante *et al*. 2014). McEachran & Compagno (1980) pointed out a distribution between 400 and 960 m depth, while Yáñez & Barbieri (1974) found the species between 351-600 m at 33ºS (Valparaíso), and Sielfeld & Vargas (1996) found *Gurgesiella furvescens* between 300 and 600 m depth. In general, the biological aspects of the genus *Gurgesiella* are poorly known, and *Gurgesiella furvescens* is a scarcely studied deepwater species (Ebert *et al.* 2020). According to McEachran & Compagno (1980), the maturity size is at 50.9-52 cm body length in males and from 55.2 to 56.8 cm body length in females. Rincon *et al*. (2008) described the trophic spectrum of *Gurgesiella dorsalifera* in southern Brazil, which seems to be an opportunistic and generalist predator.

In Chile *Gurgesiella furvescens* is an incidental species in the bycatch of demersal crustacean trawl fisheries operating in the north-central area (Acuña *et al*. 2005, Queirolo *et al*. 2011, Bustamante *et al*. 2014). The trawl fisheries target the yellow squat-lobster (*Cervimunida johni*), the red squat-lobster (*Pleuroncodes monodon*), the nylon shrimp (*Heterocarpus reedi*) and the deep-water shrimp (*Haliporoides diomedeae*) (Arana *et al*. 2003, Acuña *et al*. 2014). In the north-central area, estimates of yellow squat-lobster biomass fluctuated between 5.828 and 12.176 tons, and the biomass of red squat-lobster between 4.554 and 14.235 tons in the period 2011-2017 (Queirolo *et al*. 2018). The nylon shrimp biomass ranged between 7.978 and 20.361 in the same period (Acuña *et al*. 2018), while Arana *et al*. (2003) estimated the biomass of deepwater shrimp between 702 and 745 tons in 2002 (Arana *et al*. 2003). The relatively high abundance of those demersal crustaceans on the slope and continental shelf along the central-northern Chilean coast (Acuña *et al*. 2014, Ahumada *et al*. 2019) could be forage for deepwater predators such as *Gurgesiella furvescens*. Besides, the body length and mouth width could restrict the sizes and shapes of prey eaten by the dusky finless skate. In the present paper, the objectives were to determine the diet of *Gurgesiella furvescens* and evaluate relationships between prey mass and mouth width of the predator and between the prey's weight and the body mass of the predator.

Materials and methods

Study area and sampling

The study area was located on the slope and continental shelf off north-central Chile (Fig. 1) and covered by fishing tows obtained between 25º30'S to 33ºS at depths between 180 and 511 m (Table 1). The vessel FOCHE was fishing for red squat-lobster (*Pleuroncodes monodon*) and yellow squat-lobster (*Cervimunida johni*) (Acuña *et al*. 2014) while the second vessel (Isla Orcas) targeted the nylon shrimp (*Heterocarpus reedi*) (Acuña *et al*. 2015, 2018).

Once captured, the dusky finless skate specimens were immediately frozen on board (-4 ºC), landed after one or three days (the far tows), and transported directly to the laboratory of the Universidad Católica del Norte, Coquimbo, Chile. Specimens were sexed, and the body length and mouth width measured (0.1 cm). The total body mass was recorded utilizing a monoplate balance (0.1 g).

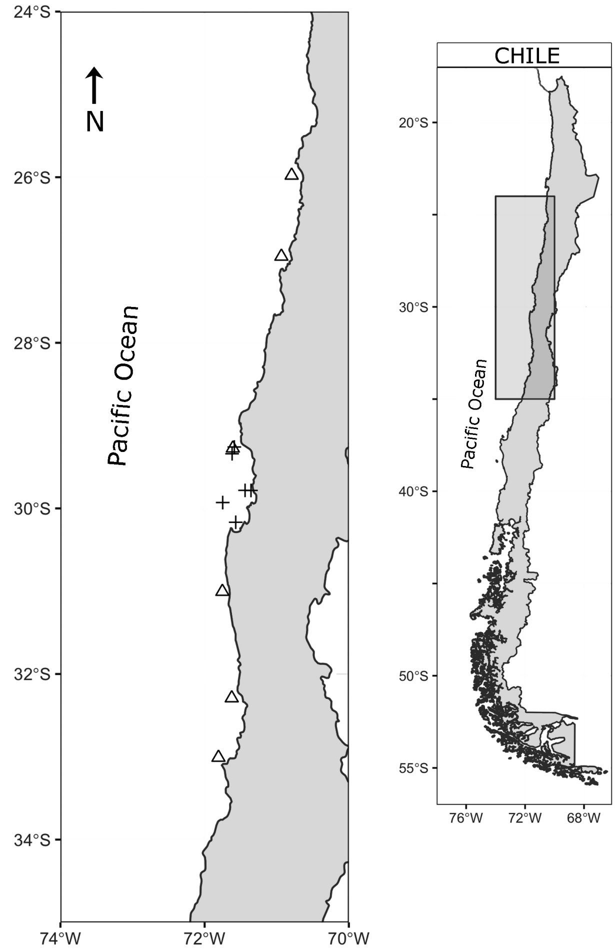

Figure 1. Study area and location where the dusky finless skate *Gurgesiella furvescens* specimens were captured. Triangles represent tows in the squat-lobsters trawler, and the crosses represent tows in the trawler targeting nylon shrimp (see Table 1) / Área de estudio y posición donde se capturaron los especímenes de raya de profundidad *Gurgesiella furvescens*. Los triángulos representan lances en los arrastreros de langostinos, y las cruces representan lances en los arrastreros de camarón nailon (ver Tabla 1)

Table 1. Log of trawling hauls in which *Gurgesiella furvescens* samples were obtained / Bitácora de los lances de pesca de arrastre en los cuales se obtuvo muestras de *Gurgesiella furvescens*

Trawl vessel	Target species	Date	Depth (m)	Number of specimens
Isla Orcas	nylon shrimp*	26/10/2013	460	1
		29/10/2013	229	4
		31/10/2013	388	4
		06/12/2013	395	2
		10/12/2013	428	1
Foche	squat-lobsters**	17/10/2013	511	5
		13/07/2013	418	6
		16/07/2013	408	3
		16/07/2013	433	2
		22/07/2013	448	3
		22/07/2013	179	3
		23/07/2013	394	1
		03/08/2013	382	1

**Heterocarpus reedi*; ***Cervimunida johni* and *Pleuroncodes monodon*

Stomach contents analysis

Fish were dissected (Fig. 2), and the stomach removed, weighed (±0.1 g), and classified according to the filling level in empty, semi-full, or full. The frequency of filling level was counted and plotted against depth strata. The prey found in each stomach were separated, counted, weighed (after drying the excess of surface water with a paper towel, ±0.01 g), and identified to the lowest taxonomic level. To evaluate whether the number of stomachs analyzed was enough to describe the diet, the stomachs sampled were randomized 100 times, and the accumulation prey curve was constructed as a function of stomach number (Ferry & Caillet 1996, Cortés 1997). The cumulative prey curve was computed as a function of the number of stomachs with the BiodiversityR package (Kindt & Coe 2005) for the software and language R (R Core Team 2020).

The importance of prey in the diet considered the number, the wet weight (including hard parts), the frequency of occurrence, and all expressed as a percentage. The Prey-Specific Index of Relative Importance (%PSIRI) (Brown *et al*. 2012) was computed to describe the prey's contribution to the diet [*i.e*., %PSIRIi= (%Ni+%Wi)/2]. The Prey-Specific Index of Relative Importance is a standardized measure of prey contribution that contrasts with the Index of Relative Importance (Pinkas *et al*. 1971, Cortés 1997) because of its additive condition between taxonomic levels and allowed comparisons with other studies (Brown *et al*. 2012). Permutational multivariate analysis of variance (PERMANOVA) allowed testing for significant differences in diet composition among sex, body length, and depth strata. The one-way PERMANOVA test considered the %W matrix and permuted 999 times by utilizing the "adonis2" function in the "vegan" package for R, which uses the Bray-Curtis distance as default (Oksanen *et al*. 2020).

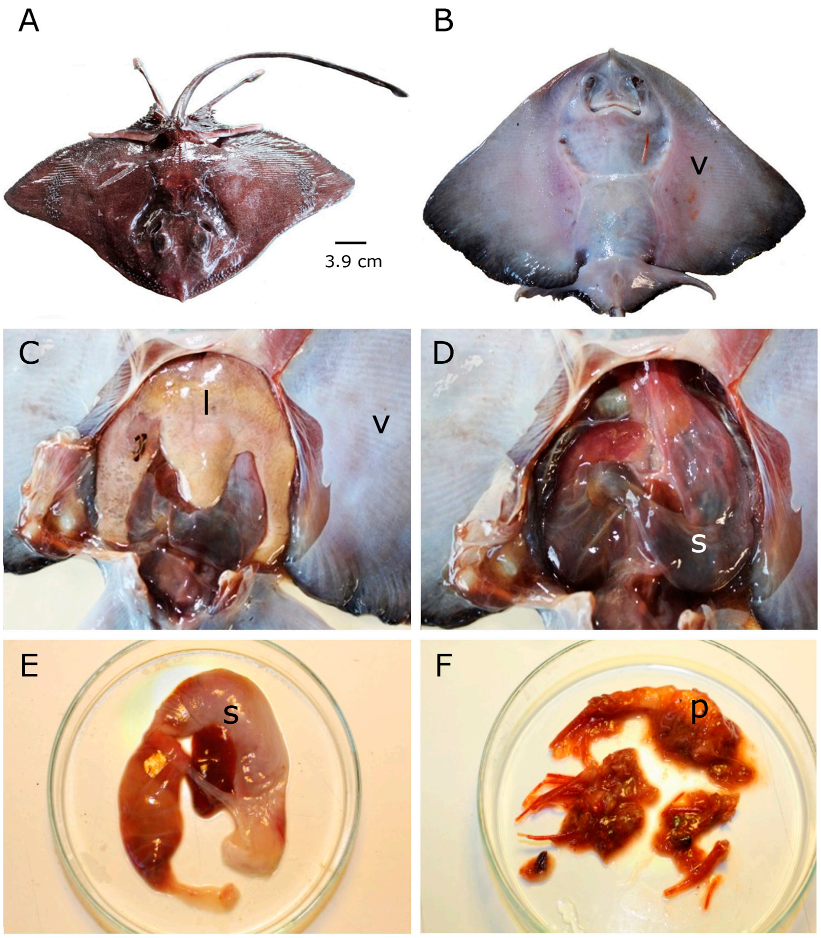

Figure 2. *Gurgesiella furvescens*. A) Dorsal view of specimen, scale: 1:3.9 cm. B) ventral view (v). C) dissection of the abdomen exposing the liver (l) on a ventral view of a specimen (v). D) After removing the liver (l), the stomach (s) was exposed. E) stomach (s) removed. F) prey (p) contents
/ *Gurgesiella furvescens* Vista dorsal de un individuo, escala: 1:3,9 cm. B) vista ventral (v). C) disección del abdomen exponiendo el hígado (l) en vista ventral (v) de un espécimen. D) después de remover el hígado (l), el estómago (s) fue expuesto. E) estómago (s) removido. F) contenido de las presas (p)

Quantile regression was applied to establish the relationships between the prey size and the mouth width and between prey mass and predator's body mass. Quantile regression is a preferred technique (Scharf *et al*. 1998) because the interest was in the relationship limit. The "quantreg" package for the R language was utilized (R Team 2020), setting 90% as a quantile that describes the relationship's limit.

Results

The body length of dusky finless skate fluctuated between 20.3 and 64.5 cm, with a mean of 39.5 cm (SD= 11.9 cm), and the sex proportion is 1:1, with 18 females (n=36). The stomachs had contents, with 50% classified as full, most of them in the 400-500 m depth strata (Fig. 3). Decapod crustaceans were the main prey items in the stomach contents and represented by the nylon shrimp (*Heterocarpus reedi*) and the deep-water shrimp (*Haliporoides diomedeae*). The rest of the contents were indeterminate crustaceans and an indeterminate mollusk. The stomach contents reveal a narrow trophic spectrum represented by only three main prey items and a rare prey (*i.e.*, an indeterminate mollusk). The cumulative prey curve reaches an asymptote after 20 stomachs (Fig. 4), suggesting that the sample size was sufficient to describe the dusky finless skate's diet.

According to the quantitative analysis, from a total of 43 prey specimens, *Heterocarpus reedi* contributed 58.3% by frequency, 60.5% by number, 32.8% by weight, and 59.0% of PSIRI (Table 2). Indeterminate crustaceans contributed 24.2% PSIRI, which were digested or parts of the same kind of main items (Fig. 2). The deepwater shrimp represented 13.2% of PSIRI, and 3.47% was due to an indeterminate mollusk (Table 2). The diet composition by weight is not significantly different between sexes, body length, or depth strata (Table 3).

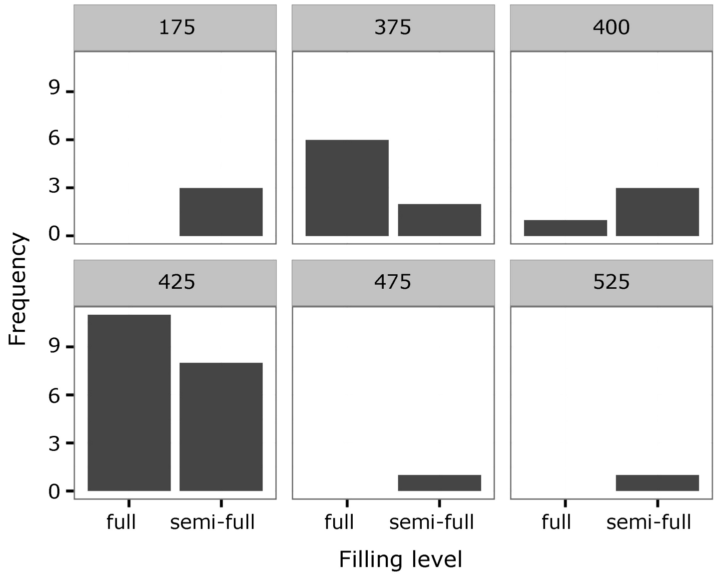

Figure 3. Filling level of the *Gurgesiella furvescens* stomachs according to depth strata (m). The mean depth of each stratum is shown on the top of each panel / Nivel de llenado de los estómagos de *Gurgesiella furvescens* según estratos (m). La profundidad promedio de cada estrato se muestra en la parte superior de cada panel

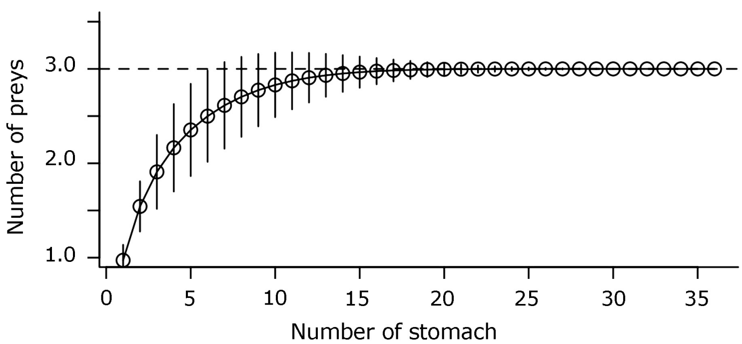

Figure 4. Cumulative prey curve for randomly pooled stomach contents from dusky finless skate *Gurgesiella furvescens* (mean ± SD) / Curva acumulada de presas para los contenidos estomacales agrupados aleatoriamente de la raya de profundidad *Gurgesiella furvescens* (media ± DE)

Table 2. Diet composition of 36 *Gurgesiella furvescens* specimens of northern-central Chile / Composición de la dieta de 36 ejemplares de *Gurgesiella furvescens* en el centro-norte de Chile

Prey item	FO (%)	N (%)	W (%)	PSIRI (%)
Heterocarpus reedi	58.3	60.5	32.8	59.0
Haliporoides diomedeae	16.7	14.0	9.0	13.2
Indeterminate crustaceans	22.2	23.3	7.2	24.2
Indeterminate mollusk	2.8	2.3	3.5	3.7

FO (%): frequency of occurrence, N (%): percentage in number, W (%): percentage in mass, PSIRI (%): Prey-Specific Index of the Relative Importance

Table 3. Permutation multivariate analysis of variance of the diet composition of prey (%W) against sex, body length and depth strata (Permutation: free, Number of permutations: 999) / Análisis multivariante por permutación de la varianza de la composición de la dieta de las presas (%W) frente al sexo, la longitud corporal y los estratos de profundidad (Permutación: libre, Número de permutaciones: 999)

Source	Degree of freedom	Sum of squares	R^2	F	*P*-value
Sex	1	0.0833	0.0079	0.273	0.888
	34	10.3889	0.9920		
Body length	1	0.5814	0.0555	1.988	0.146
	34	9.8909	0.9445		
Depth	5	0.6806	0.0649	0.417	0.967
	30	9.7917			

The 90% quantile regression between prey size and mouth size shows a clear linear border and the relationship between the prey weight (PW) in the stomach contents and the predator's body mass (Fig. 5). The average relationship between prey size (PS) and mouth width (MW) is PS= -0.76+1.03MW (r^2= 0.532, P < 0.01), and the standard error was 0.626 and 0.167 for the intercept and slope, respectively. Besides, the average relationship for the prey weight as a function of body mass shows a linear relationship described by PW= -0.084+0.017BM (r^2= 0.742, P < 0.01) and standard error of 0.385 and 0.002 for the intercept and slope, respectively.

Discussion

Gurgesiella furvescens occurred in low numbers of specimens in the trawl nets, but the cumulative samples covered broader depth distribution, from 179 to 511 m, slightly deeper than previously reported (Acuña *et al*. 2005, Bustamante *et al*. 2014). The filling level showed that stomach contents were full in the depths in which the dusky finless skate was recorded. Although the number of individuals was low, the diet composition was similar between sexes, body length, or depth strata. This result is probably due to demersal crustaceans are abundant in the latitudinal and depth range analyzed (Acuña *et al*. 2018, Ahumada *et al*. 2019).

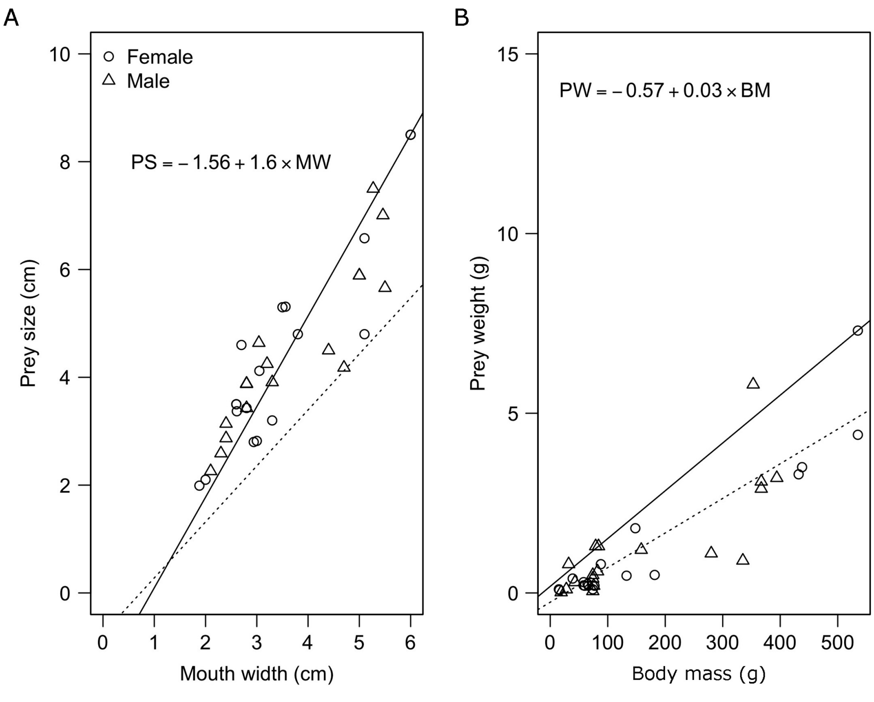

Figure 5. Relationship between A) prey-size and mouth width, and B) prey weight and body mass, of *Gurgesiella furvescens*. The solid line and model represent quantile regressions at 90%, while the segmented line represents an ordinary linear regression / Relaciones entre A) el tamaño de presa y ancho de la boca, y B) entre el peso de la presa y el peso corporal de *Gurgesiella furvescens*. Las líneas sólidas y modelo lineal representan las regresiones de cuantiles al 90%, mientras que las líneas segmentadas representan las regresiones lineales ordinaria

The stomach contents revealed a minimal number of prey represented by *Heterocarpus reedi*, *Haliporoides diomedeae*, and indeterminate crustaceans. The latter were digested and probably have been parts of either *Heterocarpus reedi* or *Haliporoides diomedeae*, but not try was made to allocate the indeterminate crustaceans. Interestingly, no more than one or two shrimp individuals were found in the stomach contents. Although *Gurgesiella furvescens* was also caught in the bycatch of squat-lobsters (*Cervimunida johni* and *Pleuroncodes monodon*), these crustaceans were not present in the stomach contents. Both nylon shrimp and deep-water shrimp are distributed deeper than squat-lobsters and overlap near the shelf break (Arana *et al*. 2003, Acuña *et al*. 2018, Ahumada *et al.* 2019). Therefore, the dusky finless skate seems to be more associated with the depth range of *Heterocarpus reedi*, in which this prey is much more abundant (Acuña *et al*. 2018).

The Prey-Specific Index of Relative Importance (PSIRI) revealed a strong preference for *Heterocarpus reedi*. Probably *Gurgesiella furvescens* is a specialist predator based on *Heterocarpus reedi*. Besides, considering the low number of specimens per stomach, probably the feeding requirement of *Gurgesiella furvescens* could be likely low. *Heterocarpus reedi* is an abundant and available prey for *Gurgesiella furvescens* and probably enough to meet its feeding requirements. The depth range between the prey and the predator is overlapped, but the latitudinal distribution of *Heterocarpus reedi* extends to 37º10'S (Acuña *et al*. 2014), south of the latitudinal boundary of *Gurgesiella furvescens* (Pequeño & Lamilla 1993, Sielfeld & Vargas 1996). In this context, the southern limit of the distribution cannot be explained by its preference for feeding *Heterocarpus reedi*. The nylon shrimp is a relatively smaller prey than the deepwater shrimp. The maximum carapace length of nylon shrimp fluctuates around 40.68 to 48.34 mm (Roa & Ernst 1996), while the maximum carapace length of deepwater shrimp is 72 mm (Arana *et al*. 2003). The ratio between prey size and the mouth size of the predator was 1.67 at the 90% quantile. Because prey tends to be larger than mouth size, shrimps are probably sucked by *Gurgesiella furvescens*. The suction-feeding specialization is beneficial for a skate with a small gape (Wilga *et al*. 2007, Barbini *et al.* 2018). Furthermore, the ratio between the weight of prey and body mass tends to be constant, suggesting that large skates tend to eat larger prey.

Acknowledgments

TP thanks J Lamilla (r.i.p.) for being a great reference and a great inspiration in the world of chondrichthyans and for the learning granted by allowing me to work in ELASMOLAB. Also, TP thanks the fishery laboratory of the Universidad Católica del Norte (UCN), especially Christian Véliz for their support in processing the samples and the crew of the vessels FOCHE and ISLA ORCAS for providing the samples analyzed here. Thanks also to the EPOMAR Laboratory of the Oceanography Department of the Universidad de Concepción for funding. LC was funding by COPAS Sur-Austral ANID PIA APOYO CCTE AFB170006.

Literature cited

Acuña E, JC Villarroel, A Cortes & M Andrade. 2005. Fauna acompañante en pesquerías de arrastre de crustáceos de Chile: Implicancias y desafíos desde la perspectiva de la Biodiversidad. En: Figueroa E (ed). Biodiversidad marina: Valoración, usos y perspectivas ¿Hacia dónde va Chile?, pp. 395-425. Editorial Universitaria, Santiago de Chile.

Acuña E, R Alarcón, H Arancibia, A Cortés, L Cubillos & L Cid. 2014. Evaluación directa de langostino colorado y langostino amarillo entre la II y VIII Regiones, año 2013. Informes Técnicos FIP. FIP/IT 2013-02: 1-384. <https://www.subpesca.cl/fipa/613/w3-article-89324.html>

Acuña E, R Alarcón, H Arancibia, A Cortés, L Cubillos & L Cid. 2015. Evaluación directa de camarón nailon entre la II y VIII Regiones, año 2013. Informes Técnicos FIP. FIP/IT 2013-01: 1-261. <https://www.subpesca.cl/fipa/613/w3-article-89323.html>

Acuña E, R Alarcón, H Arancibia, A Cortés, S Klarian, P Haye & P Petigas. 2018. Evaluación directa de camarón nailon entre la II y VIII Regiones, año 2017. Informe Final, Convenio de Desempeño 2017, Subsecretaría de Economía y EMT, Instituto de Fomento Pesquero, Valparaíso. <https://www.ifop.cl/wp-content/contenidos/uploads/RepositorioIfop/InformeFinal/2018/P-682048.pdf>

Ahumada M, D Queirolo, P Apablaza, R Wiff, G Plaza, M Lima, J Montero, A Flores & SA Klarian. 2019. Evaluación directa de langostino amarillo y langostino colorado entre la región de Antofagasta y Biobío, y camarón nailon entre la región de Antofagasta y Biobío, año 2018. Informe Final, Convenio de Desempeño 2018, Subsecretaría de Economía y EMT, Instituto de Fomento Pesquero, Valparaíso. <https://www.ifop.cl/wp-content/contenidos/uploads/RepositorioIfop/InformeFinal/2019/P-682057_.pdf>

Ajemian MJ, SP Powers & TJT Murdoch. 2012. Estimating the potential impacts of large mesopredators on benthic resources: Integrative assessment of spotted eagle ray foraging ecology in Bermuda. PLOS ONE 7(7): e40227. <https://doi.org/10.1371/journal.pone.0040227>

Arana P, M Ahumada & A Guerrero. 2003. Distribución y abundancia de la gamba *Haliporoides diomedeae* (Crustacea: Decapoda: Penaeidae) frente a la costa central de Chile. Investigaciones Marinas, Valparaíso 31: 57-71.

Barbini SA, DE Sabadin & LO Lucifora. 2018. Comparative analysis of feeding habits and dietary niche breadth in skates: the importance of body size, snout length, and depth. Reviews in Fish Biology and Fisheries 28: 625-636.

Bizzarro J, A Carlisle, W Smith & E Cortes. 2017. Diet composition and trophic ecology of northeast Pacific Ocean sharks. Advances in Marine Biology 77: 111-148.

Brown SC, JJ Bizzarro, GM Cailliet & DA Ebert. 2012. Breaking with tradition: Redefining measures for diet description with a case study of the Aleutian skate *Bathyraja aleutica* (Gilbert 1896). Environmental Biology of Fishes 95: 3-20.

Bustamante C, C Vargas-Caro & MB Bennett. 2014. Biogeographic patterns in the cartilaginous fauna (Pisces: Elasmobranchii and Holocephali) in the southeast Pacific Ocean. PeerJ 2:e416. <https://doi.org/10.7717/peerj.416>

Compagno LJV. 1990. Shark exploitation and conservation. In: Pratt HL, SH Gruber & T Taniuchi (eds). Elasmobranchs as living resources: advances in the biology, ecology, systematics, and the status of the fisheries. NOAA Technical Report NMFS 90: 397-414.

Cortés E. 1997. A critical review of methods of studying fish feeding based on analysis of stomach contents application to elasmobranch fishes. Canadian Journal of Fisheries and Aquatic Science 54: 726-738.

De Buen F. 1959. Notas preliminares sobre la fauna marina preabisal de Chile, con descripción de una familia de rayas, dos géneros y siete especies nuevas. Boletín Museo Nacional de Historia Natural, Chile 27(3): 171-201.

Ebert DA & JJ Bizzarro. 2007. Standardized diet compositions and trophic levels of skates (Chondrichthyes: Rajiformes: Rajoidei). Environmental Biology of Fishes 80: 221-237.

Ebert DA, F Concha, E Acuña, K Herman & PM Kyne. 2020. *Gurgesiella furvescens*. The IUCN Red List of Threatened Species 2020: e.T44654A124437462. <https://dx.doi.org/10.2305/IUCN.UK.2020 3.RLTS.T44654A124437462.en>

Ferry L & G Caillet. 1996. Sample size and data analysis: are we characterizing and comparing diet properly? In: MacKinlay D & K Shearer (eds). Feeding, ecology and nutrition in fish. Symposium Proceedings, pp. 71-80. American Fisheries Society, San Francisco.

Kemper JM, JJ Bizzarro & DA Ebert. 2017. Dietary variability in two common Alaskan skates (*Bathyraja interrupta* and *Raja rhina*). Marine Biology 164: 1-22.

Kindt R & R Coe. 2005. Tree diversity analysis. A manual and software for some common statistical methods for biodiversity and ecological analysis, 196 pp. World Agroforestry Centre (ICRAF), Nairobi.

Lamilla J & S Sáez. 2003. Clave taxonómica para el reconocimiento de especies de rayas chilenas (Chondrichthyes, Batoidei). Investigaciones Marinas, Valparaíso 31: 3-16.

McEachran JD & LJV Compagno. 1980. Results of the research cruises of FRV "Walther Herwig" to South America. LVI. A new species of skate from the southwestern Atlantic *Gurgesiella dorsalifera* sp. Nov. (Chondrichthyes, Rajoidei). Archiv fur Fischereiwissenschaft 31: 1-14.

Oksanen J, FG Blanchet, M Friendly, R Kindt, P Legendre, D McGlinn, PR Minchin, RB O'Hara, GL Simpson, P Solymos, MHH Stevens, E Szoecs & H Wagner. 2020. vegan: Community Ecology Package. R package version 2.5-7. <https://CRAN.R-project.org/package=vegan>

Pequeño G & J Lamilla. 1993. Batoideos comunes a las costas de Chile y Argentina-Uruguay (Pisces: Chondrichthyes). Revista de Biología Marina 28: 203-217.

Pinkas L, MS Oliphant & ILK Inverson. 1971. Food habits of albacore, bluefin tuna, and bonito in Californian waters. Fishery Bulletin 152: 11-105.

Priede IG, R Froese, DM Bailey, OA Bergstad, MA Collins, JE Dyb, C Henriques, EG Jones & N King. 2006. The absence of sharks from abyssal regions of the world's oceans. Proceedings of the Royal Society B, Biological Sciences 273: 1435-1441.

Queirolo D, K Erzini, CF Hurtado, E Gaete & MC Soriguer. 2011. Species composition and by-catches of a new crustacean trawl in Chile. Fisheries Research 110: 149-159.

Queirolo D, M Ahumada, R Wiff, P Apablaza, M Lima & A Flores. 2018. Evaluación directa de langostino amarillo y langostino colorado entre la II y VIII Regiones, año 2017. En: Informe Final, Convenio de Desempeño 2017, Subsecretaría de Economía y EMT, Instituto de Fomento Pesquero, Valparaíso, 78 pp.<https://www.ifop.cl/wp-content/contenidos/uploads/RepositorioIfop/InformeFinal/2018/P-682047.pdf>

R Core Team. 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. <https://www.R-project.org/>

Reis M & WF Figueira. 2020. Diet and feeding habits of two endemic demersal bycatch elasmobranchs: *Trygonorrhina fasciata* & *Dentiraja australis*. Ichthyological Research 67: 320-329.

Rincon G, T Vaske Jr & CM Vooren. 2008. Stomach contents and notes on the reproduction of the onefin skate *Gurgesiella dorsalifera* (Chondrichthyes: Rajidae) off Southern Brazil. Neotropical Ichthyology 6: 689-692.

Roa R & B Ernst. 1996. Age structure, annual growth, and variance of size-at-age of the shrimp *Heterocarpus reedi*. Marine Ecology Progress Series 137: 59-70.

Scharf FS, F Juanes & M Sutherland. 1998. Inferring ecological relationships from the edges of scatter diagrams comparison of regression techniques. Ecology 79: 448-460.

Sielfeld W & M Vargas. 1996. Composición y estructura de la ictiofauna demersal en la zona norte de Chile. Investigaciones Marinas, Valparaíso 24: 3-17.

Stevens JD, R Bonfil, NK Dulvy & PA Walker. 2000. The effects of fishing on sharks, rays, and chimaeras (Chondrichthyans), and the implications for marine ecosystems. ICES Journal of Marine Science 57: 476-494.

Treloar MA, LJB Laurenson & JD Stevens. 2007. Dietary comparisons of six skate species (Rajidae) in south-eastern Australian waters. In: Ebert DA & JA Sulikowski (eds). Biology of skates. Developments in Environmental Biology of Fishes 27: 75-90. <https://doi.org/10.1007/978-1-4020-9703-4_6>

Wetherbee BM & E Cortés. 2004. Food consumption and feeding habits. In: Musick JA, JC Carried & M Heithaus (eds). Biology of sharks and their relatives, pp. 223-244. CRC Press, Boca Raton.

Wilga CA, PJ Motta & CP Sanford. 2007. Evolution and ecology of feeding in elasmobranchs. Integrative and Comparative Biology 47: 55-69. <https://doi.org/10.1093/icb/icm029>

Yáñez E & MA Barbieri. 1974. Distribución y abundancia relativa estacional de los recursos disponibles a un arte de arrastre camaronero frente a la costa de Valparaíso (invierno 1973). Investigaciones Marinas, Valparaíso 5: 137-156.

Editor: Francisco Concha
Received 12 July 2020
Accepted 28 July 2021