Modern Agricultural Science and Technology, ISSN 2375-9402, USA
November 2020, Volume 6, No. 7-12, pp. 19-24
Doi: 10.15341/mast(2375-9402)/02.06.2020/003
Academic Star Publishing Company, 2020
www.academicstar.us

Selectivity and Structure of the Callinectes Arcuatus Population in Marismas Nacionales, Nayarit, Mexico 2017

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Abstract: The swimming crab fishery is a growing and socioeconomically important productive activity in Nayarit. Aspects of the capture technology used in the blue swimming crab *Callinectes arcuatus* fishery were analysed from March to October 2017, in the fishing community of Antonio R. Laureles, Nayarit. Chesapeake-type swimming crab traps with mesh sizes of 2 and 3 inches were used. The selectivity of the traps was determined based on the logistic function that allows one to estimate the average length for the selection of specimens (L_{50}). These were L_{50} = 99 mm for the 2 inch traps and L_{50} = 103 mm for the 3 inch traps. A one factor variance analysis of the carapace width and total weight of the specimens collected with the two mesh sizes showed a significant difference for carapace width P = 4.83 E-21 ($p < 0.05$) and no significant difference for total weight P = 0.70 ($P > 0.05$). The 3 inch traps collected 72.6% and the 2 inch traps collected 63.0% of specimens with sizes equal to or greater than the minimum catch size of 95 mm established for this species in the current fishing regulations of Mexico.

Key words: selectivity, mesh size, swimming crab

1. Introduction

The geographic distribution of the blue swimming crab *Callinectes arcuatus* Ordway, 1863 spans from Los Angeles, California, USA to Mollenda, Peru and Islas Galápagos, Ecuador [5]. The blue swimming crab is an important fishery resource in Nayarit. It has a moderate growth rate, a negative allometric growth, a life span of three years and a greater number of males than females in estuarine ecosystems [7]. It is widely accepted in the Mexican national market for direct consumption. The texture and flavour of its meat make it an exportation product, either as soft crab or as crab meat ("pulpa de jaiba") [3]. The exploitation of this resource constitutes one of the main fisheries in Mexico and contributes to the regional economy of the localities where it is fished, as well as to the national economy. Regarding volume, it occupies the 10^{th} place in Mexico's fishery production, while regarding value it occupies the 12^{th} place [2]. Studies carried out by the Instituto Nacional de Pesca y Acuacultura (INAPESCA) indicate that, of the swimming crab species found along the Mexican Pacific coasts, the green swimming crab *Callinectes bellicosus* provides 75% of the total catch of this resource, the blue swimming crab *C. arcuatus* provides 24% and the black swimming crab *C. toxotes* provides 1%. Knowledge of the size structure of species is basic in establishing the population dynamics of fishery resources, and selectivity is the relationship between the fishing gear that collect fishery resources of a certain size range and the mesh size used [4]. Thus, the selectivity of the swimming crab traps is decisive in the

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fishery management of the resource. In order to improve the selectivity of the traps, studies have been carried out mainly on changing or finding new designs that will prevent the entry or facilitate the escape of the smaller or sublegal sizes [1]. A project to change the Norma Oficial Mexicana NOM-039-PESC-2003 has indicated that fishing gear are closely related to the life cycle phases of *C. arcuatus* — a swimming crab species of fishery importance along the Mexican Pacific — including the minimum catch size of 95 mm carapace width (CW) and traps with a rigid structure, "Chesapeake" — type or similar, with a maximum length and width of 60 cm, a height of 40 cm and a mesh size equal to or greater than 76 mm (3 in) for the length of the Pacific Ocean littoral [2]. This regulation instrument seeks to protect, through the use of regulated fishing gear, reproductive events, protecting the specimens of this species that have not had at least one first spawning. In view of this, the aims of this study were to establish the size structure of the *C. arcuatus* population near the fishing town of Antonio R. Laureles, Nayarit, to determine the selectivity of swimming crab traps with mesh sizes of 2 and 3 inches, and to estimate the efficiency of the fishing gear.

2. Materials and Methods

The study area included the estuaries of La Lodoza and Las Latas in the region of Marismas Nacionales, Nayarit, near the fishing town of Antonio R. Laureles, at 22° 29' 10" N, 105° 36' 50" W (Fig. 1).

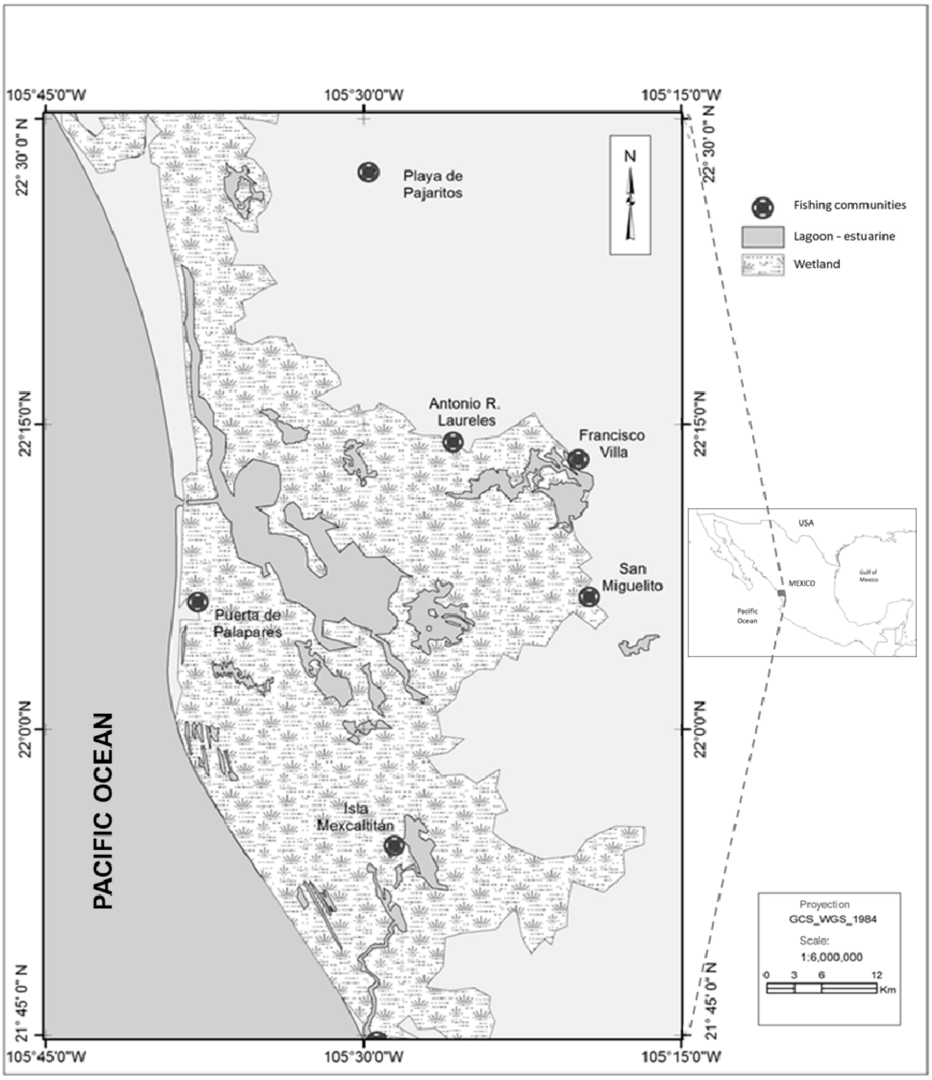

Fig. 1 ***Callinectes arcuatus*** **collection area in Marismas Nacionales of Nayarit, Mexico.**

Chesapeake-type swimming crab traps were used to collect specimens in accordance with Mexican legislation. Four sizes were used (60×60×40, 53×53×27, 50×50×20 and 40×40×20 cm) with mesh sizes of 2 and 3 inches, on a fishing line and with a resting time of 12 hours. The specimens collected were analysed in the laboratory. The biometrical variables recorded were carapace width (CW, with a 0.1 mm precision calliper) and total weight of the specimens (W, with a 0.1 g precision electronic scale). Histograms were prepared for the size structure data. The logistic function proposed by P. Sparre and S. Venema [8] was used to estimate the selectivity of the fishing gear with the following equation:

$$L_{50} = 1/(1 + \exp(a - b\mathrm{AC}))$$

where a and b are the variables of the logistic function that characterise the selection curve [6]. This calculation makes it possible to estimate the average length for the selection of specimens (L_{50}) and the carapace width at which 50% of the specimens are retained by the traps. The range size (RS) and the selection factor (SF) were calculated following [8]. In addition, a one way variance analysis was applied to the carapace width and total weight data of the specimens, for the two mesh sizes of the traps [9].

3. Results

During the sampling activities, 799 specimens were collected with the 2 inch mesh size traps and 977 specimens with the 3 inch mesh size traps, with total catches of 62.133 k and 98.897 k respectively. Carapace width (CW) varied from 56 to 144 mm, with an average of 97.53±14.45 mm, in the 2 inch mesh size traps, and from 70 to 171 mm, with an average of 104.75±16.96 mm, in the 3 inch mesh size traps. The CW distribution of the *C. arcuatus* collected in the 2 and 3 inch mesh size traps is presented in Fig. 2, together with the effect of the fishing activity on the minimum catch size (mcs) of 95 mm established for this species [2].

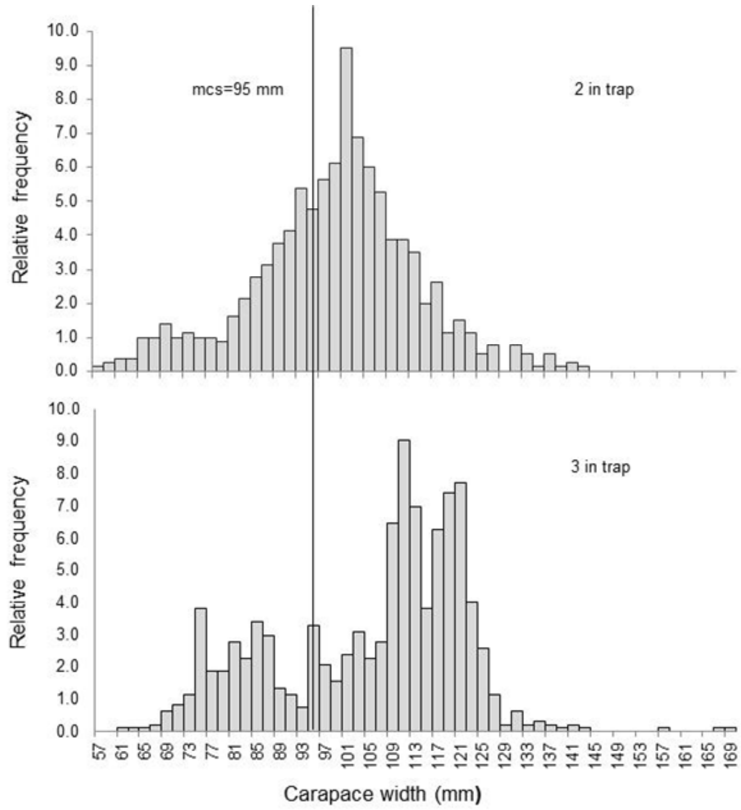

Fig. 2 Relative frequency of carapace width of *Callinectes arcuatus* recorded for the 2 and 3 inch mesh size traps and its relation to the minimum regulated catch size of 95 mm.

Regarding the collection of specimens of equal or greater size than the minimum catch size of 95 mm established in the NOM-039-PESC-2003, the 2 inch mesh size traps collected 502 specimens with CW values of 95 to 144 mm, an average of 106.17±9.32 mm and a catch of 41.08% of specimens with respect to the minimum catch size, while the 3 inch mesh size traps collected 720 specimens with CW values of 95 to 171 mm, an average of 113.35±9.32 mm and a catch of 58.91% of specimens equal to or greater than 95 mm (Table 1).

The average length for the selection of specimens was estimated at L_{50} = 99 mm for the 2 inch mesh size traps and L_{50} = 103 mm for the 3 inch mesh size traps. The curves for this selection are presented in Fig. 3.

The selectivity parameters for the 2 inch traps presented a selection range of 79 to 119 mm, a range size of 40 and a selection factor of 1.96, while the 3 inch traps recorded a selection range of 81 to 125 mm, a range size of 44 and a selection factor of 1.36 (Table 2).

Table 1 Total catch in number, percentage, average value, minimum, maximum and standard deviation (SD) of *Callinectes arcuatus* carapace width for the 2 and 3 inch mesh size traps, and collection of specimens with a carapace width equal to or greater than 95 mm.

	Trap	Number	Percentage	Average (mm)	Minimum (mm)	Maximum (mm)	SD
Total catch (CW)	3 in	977	55.01	104.75	70	171	16.96
	2 in	799	44.99	97.53	56	144	14.45
CW ≥ 95 mm	3 in	720	58.91	113.35	95	171	9.32
	2 in	502	41.08	106.17	95	144	9.23

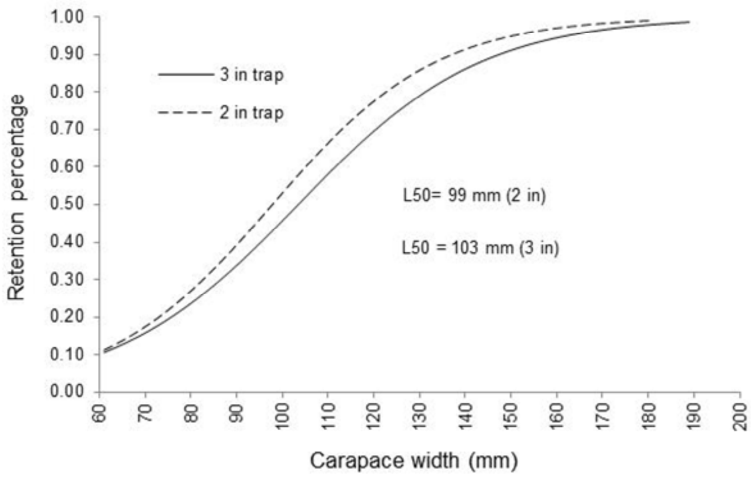

Fig. 3 Curves for the selection of *Callinectes arcuatus* specimens for the 2 and 3 inch mesh size traps.

Table 2 Selectivity parameters for the 2 and 3 inch mesh size traps used in the *Callinectes arcuatus* fishery in Nayarit.

Fishing gear	*a*	*b*	L50 (mm)	Selection range (mm)	Range size (mm)	Selection factor
3 in trap	5.172	0.050	103	(81 - 125)	44	1.36
2 in trap	5.466	0.055	99	(79 - 119)	40	1.96

A one way variance analysis was applied to provide statistical support to the results on selectivity with respect to the differences in carapace width and total weight of the specimens collected with the 2 and 3 inch traps. It indicated significant differences in the CW of the specimens collected with the two mesh sizes (P = 4.839 E-21 with a significance of α = 0.05) and no differences for the total weight data (P = 0.705 with α = 0.05).

4. Discussion

Studies on fishing gear selectivity constitute an important tool for managers and fishermen [8]. In particular, studies on the selectivity of swimming crab traps have focused on allowing the escape of specimens of sublegal sizes, which in this case are the *C. arcuatus* specimens smaller than 95 mm, as well as on decreasing the handling of both the smaller sizes and ovigerous females. In fisheries, it is necessary to establish the length interval of specimens to be collected, as this defines the vulnerability of a species in relation to a particular fishing gear [4]. The 2 inch mesh size traps collected 63.0% of specimens larger than the minimum catch size of 95 mm, while the 3 inch traps collected 72.6%. These percentages, related to the average length for the selection of specimens (L_{50}) for both mesh sizes, were greater, and were also greater than the minimum catch size of 95 mm established for *C. arcuatus*, a situation that possibly favours the state of growth of this fishery. The variance analysis indicated that the traps with different mesh sizes have a different effect on the specimens with respect to carapace width, but not with respect to the total weight of the specimens. This study is the first in the line of research on the selectivity of traps used in the fishery of the blue swimming crab in the Mexican Pacific. An important contribution is that the 3 inch mesh size traps are the most efficient with a total catch of 98.897 k, compared with a total catch of 62.133 k recorded for the 2 inch mesh size traps. In addition, they favour the collection of larger specimens — with carapace widths of up to 171 mm — and a capture of 720 specimens equal to or greater than the minimum catch size of 95 mm carapace width. Differences were also observed for the two traps when comparing the catch per unit effort regarding the number of specimens of legal sizes (AC ≥ 95 mm) that were collected, as more specimens were collected with the 3 inch mesh size traps. The results obtained here allow us to establish that the exploitation of the stock that may be captured by the swimming crab fishery off Nayarit is best with an average length for the selection of specimens of 103 mm — greater than the minimum catch size of 95 mm established in the NOM-039-PESC-2003.

Acknowledgement

The authors thank the Cooperative Societies of Fishery Production of the state of Nayarit for supporting this study of interest to the fisheries sector and responsible institutions in the country.

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