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Research Note

# Association of three Carangidae juvenile fishes with cannonball jellyfish *Stomolophus meleagris* in Bahía de La Paz, Gulf of California

Asociación de juveniles de tres especies de peces Carangidae con la medusa bola de cañón *Stomolophus meleagris* en Bahía de La Paz, Golfo de California

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**Abstract.-** Three species of Carangidae family were caught incidentally during collection of cannonball jellyfish (*Stomolophus meleagris*) in Bahía de La Paz, Gulf of California, Mexico. All fish were measured, preserved and identified as post flexion larvae and early juvenile of *Chloroscombrus orqueta, Hemicaranx leucurus* and *Caranx caballus*. *C. orqueta* stood out in frequency and abundance. *H. leucurus* were found only in autumn, while the others were present in different seasons. This is the first time recording *H. leucurus* and *C. caballus* associating with cannonball jellyfish. Further studies must evaluate this association as all fish caught were at vulnerable stages, and must be considered in jellyfish fishery management.

**Key words***: Hemicaranx leucurus*, *Caranx caballus*, *Chloroscombrus orqueta,* fish-jellyfish association

## Introduction

By-catch is one of the most significant issues affecting fisheries management today. It can disturb the ecosystem, affect biodiversity, create a conservation problem and have economic implications (Alverson *et al*. 1994, Hall *et al*. 2000). Frequently, by-catch happens when different species (target and non-target catch) are present in the same area and season, but it could also happen that these species have an association; so it is common to catch them together.

These kind of association has been reported between different species of jellyfish and various kind of organisms like zooxanthellae, cestodes, trematodes, amphipods, barnacles, cephalopods, fishes and others (Arai 1997), where at least 55 fish species have associated with 27 jellyfish species (Mansueti 1963). The cannonball, *Stomolophus meleagris* Agassiz, 1862, is one of the most recurrent jellyfish with this kind of association, with reports of fish species from different families, mainly Gadidae, Monacanthidae, Nomeidae and Carangidae families (Mansueti 1963, López-Martínez & Rodríguez-Romero 2008, Riascos *et al*. 2018).

Kingsford (1993) points out that in open sea or pelagic habitats, jellyfish and drifting seagrass play very important roles for pelagic juvenile fish providing them with shelters. In terms of diversity, carangids represent 14.4% of all recorded species looking for shelter under floating objects (Castro *et al*. 2002). Also the majority (80%) of fish associated to floating structures are present at juvenile stages (Castro *et al*. 2002). This note reports three carangids fish species, at larvae and juvenile stages, swimming in association to *S. meleagris* jellyfish when incidentally caught during 2008-2011 surveys; two of this species are reported for the first time.

## Materials and methods

In the course of four years (2008-2011) approximately 30 live cannonball jellyfish were captured yearly to obtain natural spawning under controlled systems for subsequent laboratory research. Commercial spoon nets (42 cm diameter, ≤ 5 mm mesh size) were used to catch the jellyfish but some fish were incidentally caught with them.

Fishing area was from Rancho Rodríguez to Quelele (24°12′11.5N, 110°31′45.4W to 24°10′34.44N, 110°24′31.7W) in Bahía de La Paz, Baja California Sur, Mexico (Fig. 1). The bay is a partially protected area of approximately 4,500 km$^2$ from Isla San José to the north and Isla Espiritu Santo to the southeastern end; it is oval in shape, extending 90 km in a northwest-southeast direction and about 60 km in the northeast-southwest direction.

Small boats with outboard motors were used, the catch was performed from 10:00 to 24:00 h approximately at about 20 m offshore, fishing the jellyfish that was possible to see in sea surface. All specimens were stored in 60-L plastic containers that had been filled with seawater from the area. Then they were transported to our facilities, and all fish were fixed in 10% formalin and added to CIBNOR Ichthyological Collection. Prior to identification, the specimens were rinsed in running water and stored in 70% ethyl alcohol. The fish were identified to species level from guides (Smith & Heemstra 1991, Fischer *et al*. 1995). The samples were photographed, measured and weighed.

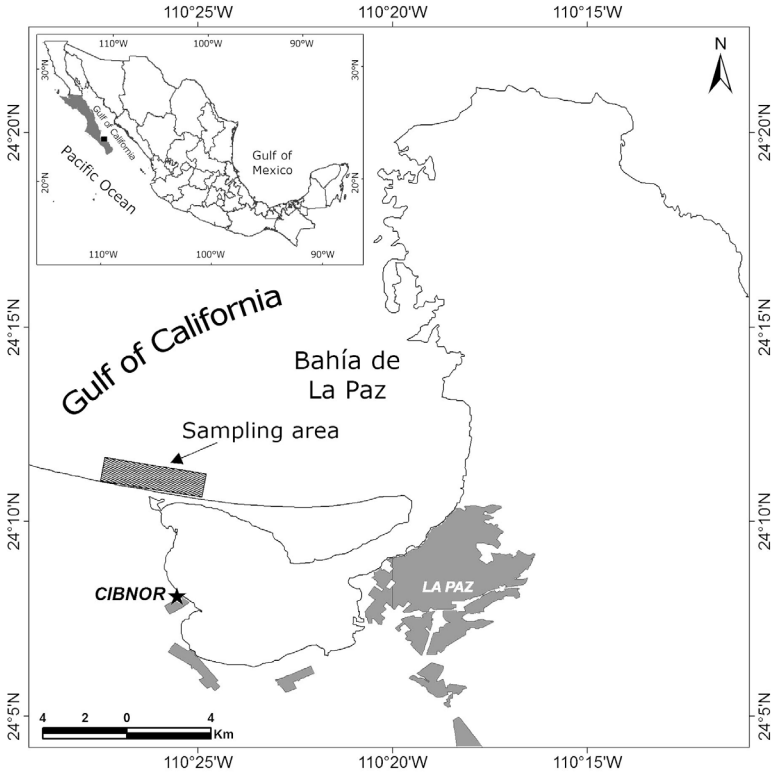


**Figure 1. Study area in the Bahía de La Paz in the southwestern region of the Gulf of California. Research facilities are indicated as CIBNOR /** Área de estudio en Bahía de La Paz en la región sudeste del Golfo de California. Las instalaciones de investigación se indican como CIBNOR

## Results and discussion

From 2008 to 2011, 96 fishes were incidentally caught with cannonball jellyfish. All fishes were identified as members of the Carangidae family: *Hemicaranx leucurus* (*Günther,* 1864), *Chloroscombrus orqueta* (Jordan & Gilbert, 1883) and *Caranx caballus* (Günther, 1868). *C. orqueta* was found in 2009, 2010 and 2011, which was the most abundant species (Table 1) with a total of 71 organisms, representing 74% of the incidental catch. *H. leucurus* and *C. caballus* were found only in two years (Table 1), with 11.5 and 14.6% of the total catch, respectively. Apparently, the three fish species caught coincided in time and distribution with the spawning season of the cannonball jellyfish, and to our knowledge no previous record of this swimming association has been done in this region.

The main factor that determines the composition of fish fauna and their abundance is the season of the year (Castro *et al*. 2002). *H. leucurus* was found only in autumn (September-October); most likely their spawning period is in August-September, but no previous information was found. *C. orqueta* and *C. caballus* were present in different seasons; their reproductive cycle have been reported during most of the year (Watson *et al.* 1996, Navarro-Rodríguez *et al.* 2001), so larvae and juvenile can be present almost throughout the year, and their abundance could depend on other factors as plankton biomass (Lauth & Olson 1996), sea surface temperature and salinity (Navarro-Rodríguez *et al*. 2001).

**Table 1. Occurrence of the three species of carangid fish found as incidental catch with the cannonball jellyfish *Stomolophus meleagris* /** Ocurrencia de tres especies de peces carángidos encontrados como pesca incidental con la medusa bola de cañón *Stomolophus meleagris*

| Carangidae species | Number of fish incidentally caught per year | | | |
|---|---|---|---|---|
| | 2008 (autumn) | 2009 (autumn) | 2010 (spring) | 2011 (summer) |
| *Hemicaranx leucurus* | 9 | 2 | 0 | 0 |
| *Chloroscombrus orqueta* | 0 | 20 | 49 | 2 |
| *Caranx caballus* | 0 | 13 | 1 | 0 |

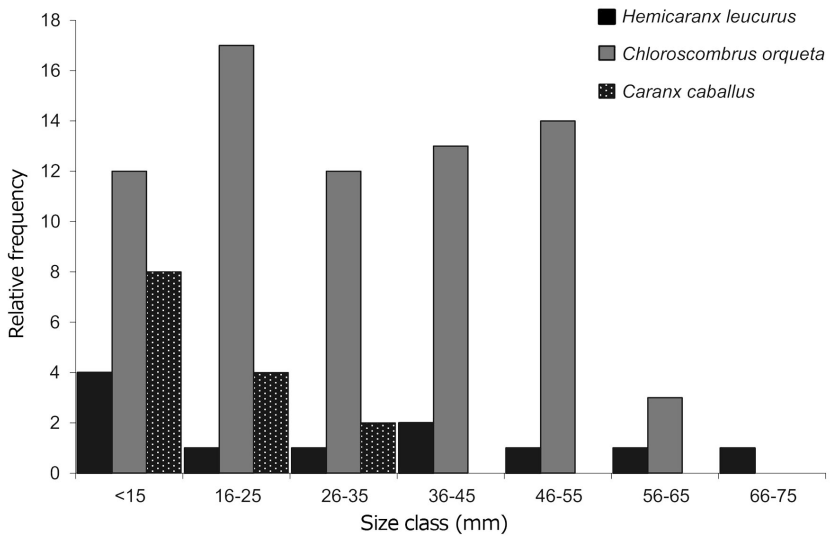


**Figure 2. Frequency size distribution of fish (*Hemicaranx leucurus, Chloroscombrus orqueta* and *Caranx caballus*) found in association with jellyfish (*Stomolophus meleagris*) captured at Bahía de La Paz from October 2008 to July 2011** / Frecuencia de la distribución de tallas de los peces (*Hemicaranx leucurus, Chloroscombrus orqueta* and *Caranx caballus*) encontrados en asociación con la medusa (*Stomolophus meleagris*) capturada en Bahía de La Paz entre octubre 2008 y julio 2011

The minimum sizes of the caught fish were from 8 to 10 mm of total length for all species while the largest fish were 66 and 60 mm for *H. leucurus* and *C. orqueta*, respectively, and 35 mm for *C. caballus* (Fig. 2). The net used for the capture had a mesh size of ≤ 5 mm, smaller than the smallest sizes of fish captured, so early larvae were not detected with jellyfish, it could be that early larvae with smaller sizes are eaten or at least damaged by the jellyfish; even when it is not common, Álvarez-Tello *et al*. (2016) reported few fish larvae in the stomach content of *Stomolophus meleagris*.

Based on the description of larvae (Sumida *et al*. 1985), *C. orqueta* and *C. caballus* were post-flexion larvae and early juvenile; possibly *H. leucurus* was in the same development stage. In previous reports the majority of fish species found aggregated around floating objects have been post-flexion larvae or juvenile fish (over 80% of the species recorded), frequently with dark vertical bars, as the fish in our study, and generally found very close to the floating device (Castro *et al*. 2002). Specifically, most of the studies reporting fish-jellyfish interactions have also been with juvenile fish (Mitani *et al*. 2001, Masuda 2009, Sato *et al*. 2015).

Aggregate behavior of fish under floating objects has been well documented. Castro *et al.* (2002) indicated 333 records in aggregation or association with any floating structures, such as drifting algae, objects, fish-aggregating devices (FADs), turtles, big animals, and jellyfish. Nevertheless, in coastal waters, stronger associations have been found between jack mackerel and jellyfish than with drifting weeds or flotsam (Mitani *et al*. 2001).

Many studies have indicated that fish associating with jellyfish may play important ecological and functional relationships in which young fish may benefit from drifting movements into the frontal convergence areas where planktonic food is accumulated and receive protection from predators besides serving as a meeting point for conspecifics (Mansueti 1963, Hunter & Mitchell 1967, Kingsford 1993, 1995; Purcell & Arai 2001, Castro *et al*. 2002, Masuda 2009). In this way 0-group (fish in their first year of life) could increase their survival as a result of the shelter relationship (Mansueti 1963; Hay *et al.* 1990). Growth occurs while the fish drift along with these objects (Hunter & Mitchell 1967, Kingsford 1993, 1995).

Masuda (2009) also mentioned changes in the interactions between host jellyfish and the development of fish; he found that the host jellyfish play roles as a site for school formation for the early stages of jack mackerel (mean standard length 11 mm), as a hiding place for the next stages (19 mm), and finally as a food source for the 38-50 mm stages. This ecological association could be happening between cannonball jellyfish and carangid fish from this report, as we found fish at precisely the same sizes (Fig. 2) and development stages described above, and we have observed this kind of behavior in the field and at our laboratory facilities; thus, further research is needed to describe in detail this association.

Masuda (2008) indicated that in Japanese coastal waters, where important jellyfish blooms take place, jack mackerel associating with jellyfish has been relatively abundant compared to other pelagic or reef fishes in the last decade; carangid fish survival and growth can therefore be improved by high abundances of cannonball jellyfish in this region. Nevertheless, in the Gulf of California, Mexico, cannonball jellyfish is a recent fishery reaching 16,581 metric t during 2010 (López-Martínez & Álvarez-Tello 2013), and associated fauna may be affected. As by-catch is the result of deficiencies in our ability to select what we harvest from the ocean (Hall *et al*. 2000) it must be considered to appropriately regulate the fishing gear and fishery itself of the cannonball jellyfish.

The carangid fishes reported in this study (*H. leucurus, C. orqueta* and *C. caballus*) were caught incidentally, found in association with cannonball jellyfish in their most vulnerable stages of development (postlarvae and juvenile), and were present at different seasons and years. Little information is available to understand the significance of the association between these fish species and cannonball jellyfish, and the biological and ecological implications of this. Further research is needed to elucidate the influence of biotic and abiotic factors, the relationship between jellyfish biomass and fish biomass, and the possible effect of a seasonal jellyfish bloom on fish dynamics, among others. Meanwhile, researchers and authorities should keep in mind this association during the cannonball jellyfish fishery.

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