

Behavioural Characteristics of Spawning in the Bermuda Chub (*Kyphosus sectatrix*)

Las Características de Comportamiento de la Desove en el Bermuda Chub (*Kyphosus sectatrix*)

Les Caractéristiques Comportementales de la Ponte dans la Bermuda Chub (*Kyphosus sectatrix*)

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ABSTRACT

This paper provides detailed descriptions of aggregation formation and mass spawning of the Bermuda chub (*Kyphosus sectatrix*). Spawning coloration and gamete release of *K. sectatrix* was observed and filmed at the Grammanik Bank, a deep spawning aggregation site used by many different species located on the southern edge of the Puerto Rican shelf 10 km south of St. Thomas, United States Virgin Islands. Underwater visual surveys using technical Nitrox and closed circuit re-breathers were conducted from December 2002 to March 2013 and documented spatial and temporal patterns of movement and aggregation formation along 1.5 km of mesophotic reef. The largest aggregations of *K. sectatrix* (> 200 fish) were observed on the Grammanik Bank January to March from 0 to 11 days after the full moon with peak abundance from 60 to 80 days after the winter solstice across all survey years. Aggregation formation of *K. sectatrix* coincided with the spawning season of Nassau (*Epinephelus striatus*) and yellowfin (*Mycteroperca venenosa*) groupers. These spatial and temporal patterns of aggregation formation and spawning suggest that *K. sectatrix*, an herbivore, may also be a transient aggregating species. On several occasions chubs were observed both pair spawning and mass spawning, and represents the first report of a Kyphosid species aggregating to spawn.

KEY WORDS: Reef fish spawning aggregation, Virgin Islands, Eastern Caribbean, spawning site characteristics, Kyphosidae

INTRODUCTION

Over 160 species in 20 fish families are known to form spawning aggregations and include diverse trophic groups such as predators, herbivores, planktivores, invertivores, spongivores, coralivores, and detritivores (Sadovy de Mitcheson and Colin 2012 – Appendix 1). Reef fish spawning aggregations are typically categorized as resident or transient (Domeier and Colin 1997), with resident species moving relatively short distances from feeding sites and aggregating to spawn on a daily basis over a lengthy reproductive season, while transient species migrate tens to hundreds of kilometres during very specific seasons and lunar periods (Nemeth 2009). The number of published accounts of spawning aggregations has been increasing, but there remains a lack of information on the reproductive behaviour of many fish species suspected of forming aggregations. One family of fishes for which the reproductive biology remains poorly described is the Kyphosidae. Here we highlight the first description of the behavioural patterns of reproduction of *Kyphosus sectatrix* in the western Atlantic (see Nemeth and Kadison 2013 for a full description).

METHODS

Underwater visual surveys on the abundance of *K. sectatrix* were collected opportunistically at the Grammanik Bank, a multi-species spawning aggregation site located on the Puerto Rican shelf edge, 10 km south of St. Thomas in the United States Virgin Islands (Nemeth et al. 2006). Divers using technical NITROX or Megalodon closed circuit re-breathers (Innerspace Corp.) conducted belt transects and point counts from the full moon to 10 days after full moon (dafm) in February, March, and April each year from 2003 to 2012. Because *K. sectatrix* typically occur in schools, the total number of fish was counted or numbers estimated to the nearest five fish if group size exceeded 100.

RESULTS AND DISCUSSION

From 2002 through 2013, 866 fish surveys were conducted during 749 dives. Bermuda chubs were recorded on 96 fish surveys (11%) and occupied the Grammanik Bank from January to April with peak abundance from late February to mid-March when seawater temperatures are at their lowest (range 25.9 to 27 °C) at 40 m (bottom) depth. Chubs were most abundant from the day of the full moon to about 11 days after full moon (dafm). Timing of spawning differs from some Pacific Kyphosidae from Japan and the Eastern Pacific which were reproductively active and formed spawning aggregations during summer and fall when seasonal water temperatures are high (Yamaguchi et al. 2011, B. Erisman, pers. Comm.).

The reproductive mode of *K. sectatrix* consisted of pair spawning by a few individuals followed by mass spawning of the entire aggregation. With the exception of pair spawning, the mass spawning of *K. sectatrix* is similar to that described for *Lutjanus jocu* and *L. cyanopterus* (Carter and Perrine 1994, Heyman et al. 2005). Bermuda chubs on the Grammanik

Bank were commonly seen schooling in groups of 35 to 150 fish often splitting into smaller groups and then reforming. Small groups of 10 to 20 fish were often seen feeding on benthic macroalgae. Bermuda chubs were observed pair spawning from 15:43 and 15:44 hours and mass spawning between 17:42 and 17:44 hours on 16th February 2012, nine dafm. Pair spawning was observed twice as the aggregation swam approximately 10 m above the bottom in a loose elongated group. Two chubs (presumably a male and female) ascended rapidly 5 m above the school in a spawning rush, released gametes, and descended back into the aggregation. This was repeated by a second pair of fish about a minute later. Prior to pair spawning, courtship consisted of one fish (presumably a male) approaching a second fish (presumably female) from below and pressing its head against the vent of the presumed female while remaining fish swam in a loose school around the pair. Mass spawning was observed and videotaped three times. Mass spawning consisted of the entire aggregation ascending to the middle of the water column (about 15 - 20 m depth or 20 - 25 m above the bottom), in a loosely formed oval. A few seconds before

spawning the fish formed into a tight ball 2 m in diameter at the apex of the ascent followed by spawning that produced a large gamete cloud, which obscured nearly all the spawning fish (Figure 1f). Immediately after spawning all fish descended rapidly in a long column to the bottom.

In the hours preceding group spawning Bermuda chubs schools coalesced to over 200 fish, swimming became more synchronized, and fish coloration intensified. The normal coloration of chubs appeared bronze to light grey with dull yellow horizontal stripes on the body and dusky colored fins. Body coloration changed progressively to silver and the dorsal and anal fins darkening (Figures 1a, b). Next the caudal fin transitioned from dusky to black and a bright white stripe appeared posterior to the dorsal fin (Figure 1c). On some individuals, black coloration became more intense on the caudal fin and spread anteriorly over the caudal peduncle (Figure 1d) and finally to the posterior margin of the body and dorsal and anal fins (Figure 1e). Interestingly, most small groups of *K. sectatrix* were led by individuals who displayed black pigment on the caudal peduncle and posterior margins of body. As the spawning time approached, the percentage of individuals

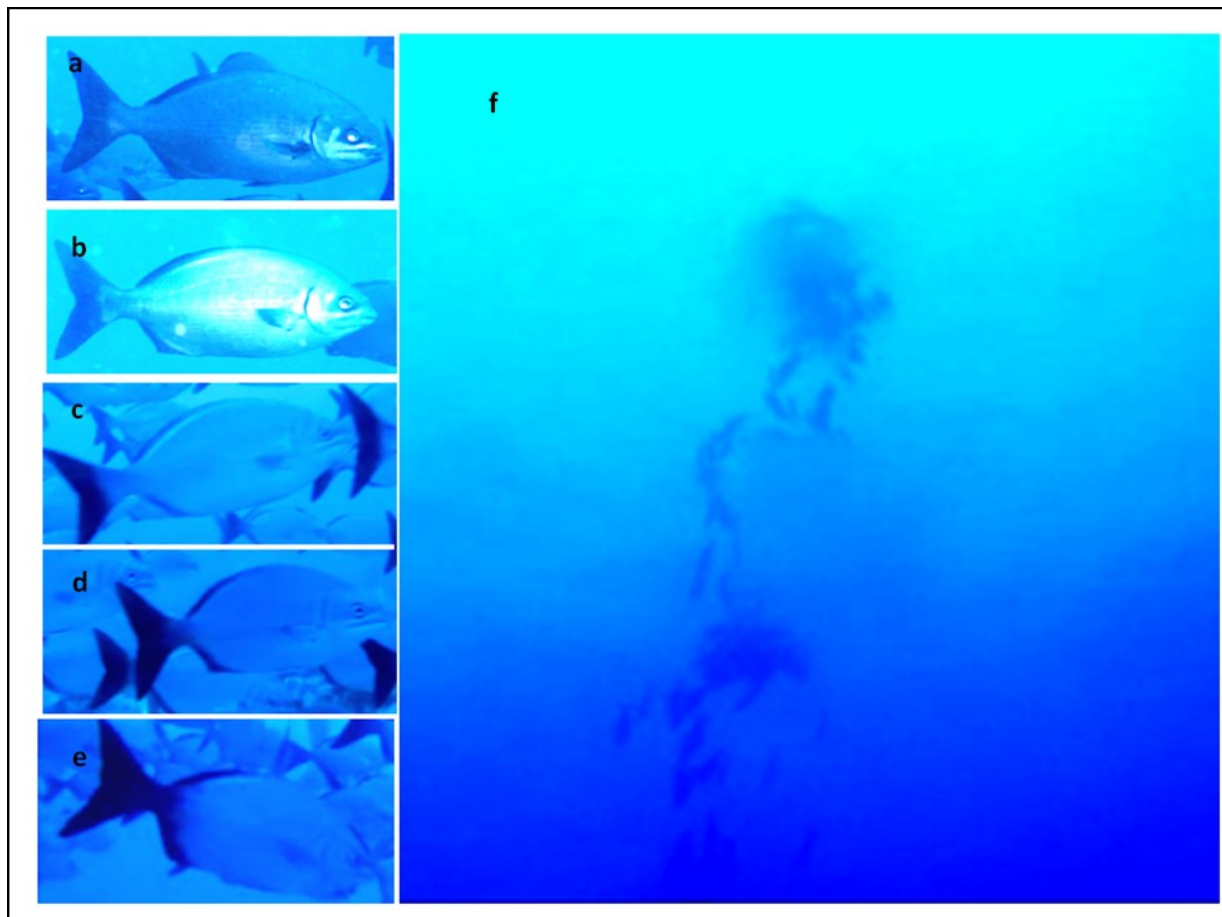


Figure 1. *Kyphosis sectatrix* progressive color phases displayed during spawning aggregation at Grammanik Bank: a) normal bronze or grey; b) bright silver; c) black caudal fin; d) dusky peduncle; e) black posterior margin; f) group spawning rush of approximately 200 *K. sectatrix* at 17:42 showing two gamete clouds. Note fish at bottom of image have already spawned and are descending to reef (from Nemeth and Kadison 2013).

that displayed normal dusky fins decreased from 82% to 40%, while fish with black caudal fins increased from 18% to 45%, and fish with black body margins increased from 0% to 12%.

The greater contrast in body coloration, with black against a white or light background, is also a common feature of several Caribbean groupers such as *Epinephelus striatus* (Whaylen et al. 2004), *Mycteroperca venenosa* (Nemeth et al. 2006), and *M. tigris* (Sadovy et al. 1994). Moreover, the progressively greater proportion of the spawning population which displayed the contrasting color pattern just prior to mass spawning is also a unique feature of *E. striatus* during spawning (Archer et al. 2012).

However, courtship coloration of *K. sectatrix* differed from *K. elegans* in the Sea of Cortez which displayed a light grey body covered with black spots (B. Erisman, pers. Comm.). These reports and observations highlight the considerable variation in spawning coloration within and among families of fish that form spawning aggregations.

The formation of seasonal spawning aggregations of *K. sectatrix* on the deep shelf reef (transient spawners) suggests that they migrate from nearshore reefs (Eristhee and Oxenford 2001) to offshore spawning sites. This differs from spawning behaviour reported in Caribbean scarids and acanthurids (resident spawners), which spawn year round and migrate short distances from home ranges (Colin and Clavijo 1988, Nemeth 2009, Domeier 2012). *K. sectatrix* is unusual in that the occurrence of herbivorous transient spawners has rarely been reported (although see Bijoux et al. 2013). Most transient spawners are characterized by large bodied carnivorous species which occur at low densities. Moreover, body morphology (i.e., lateral compression) and long intestines typical of herbivorous fishes reduce the space available for development of large ovaries (Choat 1991) and storage of lipids for energy, key requirements for long migrations and capital breeding (Stephens et al. 2009, Choat 2012). Capital breeding relies on energy reserves accumulated over periods of time prior to spawning at infrequent intervals. In contrast, income breeding relies on continuous feeding to support daily reproduction (Warner 1995). Adult *K. sectatrix* are considered roving herbivores whose diet consists of *Dictyota* and *Sargassum* algae (Moore 1962, Randall 1967, Silvano and Güth 2006). Two individuals collected on the Grammanik Bank had full stomachs of *Lobophora varigata*, a common algae on deep reefs (Herzlieb et al. 2006, Smith et al. 2008), that may provide the nutritional requirements to fulfil a transient aggregation reproductive strategy. Further analysis of these key physiological elements will be required to determine if *K. sectatrix* and other members of the Kyphosidae fall within the ecological and morphological constraints of herbivorous species or more closely resemble grouper and snapper in terms of successful spawning characteristics.

ACKNOWLEDGEMENTS

This project was partially funded by Puerto Rico Sea Grant (#R-31-1-06), NOAA Saltonstall-Kennedy program (#NA09NMF4270068), Virgin Islands Experimental Program to Stimulate Competitive Research (VI-EPSCoR #NSF-814417) and the Lana Vento Charitable Trust. This is contribution #to the University of the Virgin Islands' Center for Marine and Environmental Studies. Thanks to support personnel Steve Prosterman, Ian Byrne and Charmane Joseph and divers Steve Herzlieb, Elizabeth Whiteman, Jeremiah Blondeau, Kenny Turbe, Tyler Smith, Jacqui Calnan, Anne Tagini, Bryan Legare, Steven McCauley, Marilyn Brandt, Justin Martens, Leslie Henderson and Robert Brewer. This is contribution # 102 to the University of the Virgin Islands' Center for Marine and Environmental Studies.

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