

A SPAWNING AGGREGATION OF DOG SNAPPER,
LUTJANUS JOCU (PISCES: LUTJANIDAE) IN
BELIZE, CENTRAL AMERICA

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ABSTRACT

A spawning aggregation of dog snapper, *Lutjanus jocu*, was observed on the outer forereef of a promontory along the central province of the Belize barrier reef. We provide new information documenting the reproductive behavior of this species. Recent data on reproductive biology characterizes Lutjanids as r-strategists, highly fecund broadcast spawners releasing several batches of eggs over an extended period of time. In addition continental and insular populations and species are believed to exhibit distinctive patterns of reproductive seasonality. *Lutjanus jocu*, like other Lutjanids, exhibits a number of reproductive mechanisms that presumably are adaptive and have survival value to their local populations. Evolutionary rationales to explain reproductive strategies in snappers and other similar reef fishes are discussed as they relate to the spawning behavior of *L. jocu* in Belize.

Snappers (Lutjanidae) are common members of tropical reef communities and are represented by 6 genera and 15 species in the western Atlantic (Anderson, 1986). Snappers are highly substrate oriented and are usually associated with reefs and rocky outcroppings. During the day adults gather along channels, rockledges, and deeper or outer reefs in great numbers (Robins et al., 1986). They are an important food and game fish. Worldwide landings are estimated to be about 60,000 metric tons (FAO, 1984). Commercial, recreational, and artisanal fishermen throughout the tropics land snappers with bottom longlines, hook and line, traps, spears, and occasionally bottom trawls (Grimes, 1986). Available information on the biology of the Lutjanidae provides information primarily on taxonomy (Anderson, 1986), habitat preference and movement (Arcero and Garzon, 1985; Luckhurst and Ward, 1983), age and growth (Manooch, 1986), food habits (Parrish, 1986), fisheries management (Huntsman and Waters, 1986) and reproduction (Grimes, 1986). According to data provided by these and other studies the Lutjanids are gonochoristic with a tendency for females to be preponderant at larger sizes due to differential longevity of the sexes (Grimes and Huntsman, 1980). Sexual maturity occurs at approximately 40–50% of maximum length with populations and species associated with islands maturing at a higher proportion of maximum length than those inhabiting continental margins (Grimes, 1986). Sexual dimorphism is apparently rare among the snappers.

Data on reproductive biology characterizes Lutjanids as r-strategist, highly fecund broadcast spawners releasing several batches of eggs over an extended period of time (Erhardt, 1977; Everson, 1984; Suzuki and Hioki, 1979). Grimes (1986) describes two patterns of reproductive seasonality. Continental populations and species exhibit extended summer spawning, whereas insular populations and species reproduce year round with pulses in spring and fall. The actual timing of reproduction appears correlated with several environmental cues. For example reproduction is positively correlated with temperature and photoperiod (Grimes and Huntsman, 1980) and may also be timed to coincide with spring tides at new and full moons (Stark and Schroeder, 1970; McFarland, 1982).

Actual spawning of Lutjanids has rarely been observed in the wild and little is known of the behavior associated with this event. Spawning in Snappers in gen-

eral is presumed to occur at dusk or later near open water. Wicklund (1969) witnessed a spawning aggregation of *L. synagris* off southeast Florida. Courtship began near sunset (1930–2000) when fish gathered near the bottom in small groups of 5–10 individuals and began to chase each other. Several darkly-colored males chased and nuzzled the vent of a single lighter colored female. Eventually the aggregation condensed and moved slowly off the bottom. After a 2 m ascent, individuals became very active, then suddenly darted in several directions releasing eggs and milt in the open water column. Spawning was completed prior to sunset. In this paper we provide new information documenting the spawning behavior of the dog snapper, *L. jocu*, along the Belize barrier reef and relate these findings to our present knowledge of Lutjanid reproductive strategy.

On 10 January 1989 a group of 500–1,000 individuals of *L. jocu* were observed mass spawning at Cay Glory along the central province of the Belize barrier reef (Fig. 1). From field observations and photographs we visually estimated the fish were between 250–350 mm standard length. Due to the unexpected nature of the event we were unable to collect any specimens. The spawning occurred approximately 100–200 m south of a chevron-shaped promontory of the reef. The aggregation was first observed at a depth of 27–30 m near the seaward end of a broad, relatively low relief coral shelf extending approximately 200 m eastward of the exposed reef crest. From this depth, the shelf drops away steeply to another “ledge” at approximately 50 m. Beyond this point the ledge drops away vertically to abyssal depths. The bottom consisted primarily of sand with scattered patches of hard and soft corals. Water temperature was 25.8°C and observations were made from 1400–1500. There were scattered clouds and moderate winds and seas. Interestingly, the spawning of *L. jocu* was observed within 200 m of a well known location where mass spawning of the Nassau grouper, *Epinephelus striatus*, occurs annually. In fact, we were on location attempting to film a Nassau grouper spawning aggregation when we happened to encounter the school of dog snappers. The importance of Cay Glory reef promontory as a historical spawning bank for Nassau grouper in Belize has been intensively studied (Craig, 1969; Carter et al., 1991). In addition the black grouper, *Mycteroperca bonaci* and the red hind, *Epinephelus guttatus*, are also known to utilize the Cay Glory reef promontory as an annual spawning aggregation site during the winter months. And although we have never before witnessed a spawning aggregation of *L. jocu*, local fishermen and Belize fisheries personnel report having seen in past years large schools of running ripe dog snapper on the fishing bank.

At approximately 1400 a large school of *L. jocu* were observed milling about over the bottom, parallel to the contour of the reef, in a north-north east direction (Fig. 2a). At this point there was approximately 200 m between the school of snapper and a smaller spawning aggregation of Nassau grouper to the north. No unusual color patterns similar to that described for *L. synagris* (Wicklund, 1969) were exhibited by individuals within the spawning aggregation. Fish exhibited a silvery steel gray body coloration with a distinct white triangular patch directly below the mid-line of the eye. A few individuals appeared darker than others but the two-toned pattern common in spawning Nassau groupers was not evident. As divers approached the school, the loosely packed dog snapper aggregation descended over the drop-off to a depth of 50 m, then rapidly ascended to an estimated depth of 10 m, where they formed a comet shaped cluster (Fig. 2b). Between 5–10 m depth the school condensed further into a dense ball, apparently releasing eggs and milt in the water column (Fig. 2c). Immediately following the rush towards the surface the aggregation descended over the drop-off and swam out of view in a south-southeast direction. It is interesting to note that a few

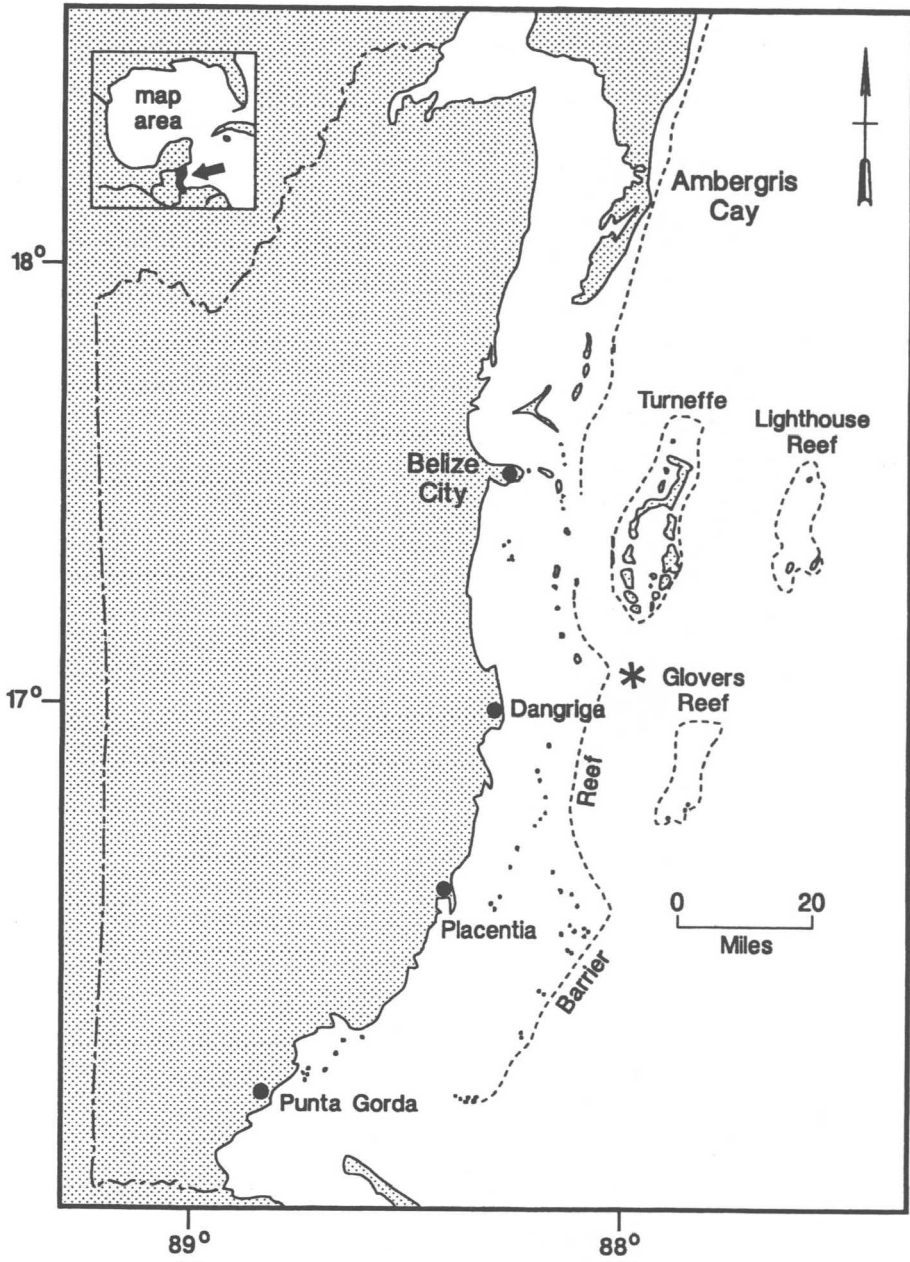


Figure 1. Geographical map of Belize depicting spawning aggregation site along barrier reef (asterisk denotes location of grouper/snapper spawning ground).

individual Nassau groupers in typical bi-colored mating colors were observed within the snapper school (Fig. 2a). These individuals mimicked the spawning behavior of the dog snapper and joined in the spawning rush to the surface. It is not known whether grouper gametes were released within the dog snapper aggregation. It is presumed groupers were strays from the Nassau grouper spawning aggregation further north in the area.

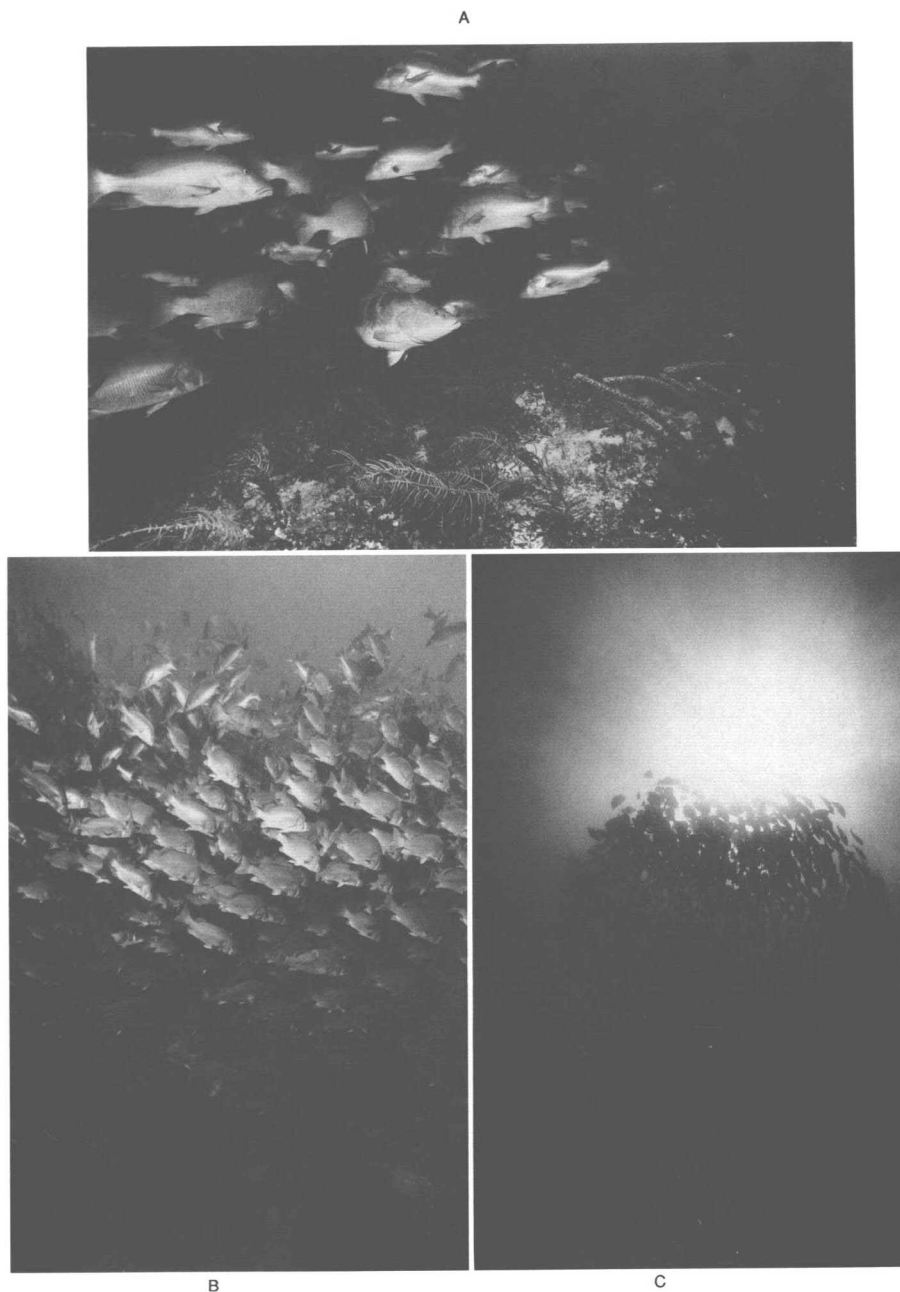


Figure 2. Photographic sequence of spawning by *Lutjanus jocu* at approximately 30 m depth at Cay Glory aggregation site, Belize barrier reef, 10 January 1989: (A) dog snapper spawning aggregation over bottom just prior to spawning rush towards surface. Note Nassau grouper, *Epinephelus striatus* in typical bi-colored mating pattern, in center of snapper school; (B) dog snapper spawning aggregation coalesced into dense comet shaped cluster; (C) dog snapper spawning aggregation apparently releasing gametes near surface at apex of spawning rush. Immediately afterwards aggregation descends over drop-off and swims out of view.

In the general context of life history tactics (Pianka, 1988) *Lutjanus jocu*, like most species of Lutjanidae, can be characterized as r-strategists. They are quick maturing, rapidly growing, highly fecund, broadcast spawners that produce typical pelagic eggs and disperse pelagic larvae with relatively short larval development time (Grimes, 1986). Furthermore their habitat could be characterized as temporarily constant, but patchy, where predation is believed to be an important structuring force. *Lutjanus jocu*, like other lutjanids, exhibits a number of reproductive mechanisms that presumably are adaptive and have survival value to their local population. Johannes (1978) suggests that reproductive activities, such as spawning site selection, lunar and diel spawning periodicity, seasonality, frequency of spawning and duration of spawning, are all adaptations to reduce predation on the young. An alternative view argues that many of these aspects of reproduction have less impact on the fate of larvae and instead serve the needs of adults (Colin et al., 1987).

However despite such theories, the long-term evolutionary rationale for these observed reproductive mechanisms is still unclear for these fishes and with few exceptions, remains untested. Several evolutionary arguments have been proposed to explain reproductive strategies in snappers and other similar reef fishes (Sale, 1978; Colin, 1982; Smith, 1982; Thresher, 1984) but with each, there are exceptions to the general pattern. Perhaps the key to understanding Lutjanid reproductive strategy lies not so much with the predominant patterns, but rather with the exceptions to these rules.

According to Grimes (1986) two patterns of reproductive seasonality are evident for Lutjanids. Continental and large island populations and species exhibit extended summer spawning, and smaller insular populations and species reproduce year round with pulses in spring and fall. The rationale given for these patterns suggests spawning in continental snapper populations may be timed to coincide with pulses in production cycles and associated plankton densities, while those associated with small islands reproduce year round because of lower and more unpredictable plankton densities and production cycles. Furthermore, in most Lutjanids spawning appears to be positively correlated with water temperature and photoperiod (Grimes and Huntsman, 1980) and timed to coincide with new or full moon (Randall and Brock, 1960; Mizenko, 1984).

Based on our recent observations, the spawning behavior of *L. jocu* in Belize does not necessarily conform to these generalized patterns regardless of whether we characterize *L. jocu* as a continental, large island or small island species. Although it is not known if *L. jocu* spawns at other times of the year in Belize, it is clear from our observations that it is not restricted to summer spawning nor peaks in the spring and fall. *L. jocu* in Belize spawned in the middle of the northern hemisphere's winter. Furthermore unlike many reef fishes, spawning was negatively correlated with water temperature and photoperiod, occurring when both water temperature and available daylight reach their seasonal minimum (Carter et al., 1991). Neither is spawning in this species timed to take advantage of local productivity and plankton density patterns associated with the seasonal rains. The wet season in Belize occurs during the late spring and summer months. January is windy but relatively dry except for occasional winter storms from the north. Spawning within the aggregation followed the full moon by one week, but whether such alignment is timed to take advantage of favorable tidal conditions is questionable. The western shore of the Caribbean sea does not experience the dramatic increase in tidal amplitudes and stronger currents commonly associated with full and new moons reported for regions in the tropical Pacific (Johannes, 1978; Lobel, 1978). However, the moon may be important in other ways. There

is a need to experimentally test whether highly visual fish such as snappers and groupers may detect cyclical changes in lunar isolume duration and intensity, which in turn may act to "physiologically ready" individuals for group spawning and at some critical point trigger the release of gametes.

Reasons why *L. jocu* in Belize does not conform to several of the typical reproductive patterns described for Lutjanids world-wide are not obvious. Perhaps the reproductive strategy of *L. jocu* can best be explained as an evolutionary compromise between competing selection pressures. Aspects of fish spawning behavior represent a combination of adaptations responding to major problems facing both larvae and adults. Reef fishes can and do exhibit considerable plasticity with respect to reproductive strategies they employ. Since the force and direction of natural selection differs by geographical locality, it follows there may be subsequent modification in the reproductive mechanisms employed. What may be a strong selection pressure in the Pacific (i.e., tidal currents), may be absent or diminished in importance in the Caribbean. We believe as a consequence of these differences, there continue to be exceptions to our biological rules.

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