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Diel patterns of abundance of presettlement reef fishes and pelagic larvae on a coral reef

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Abstract Most presettlement reef fish settled at night at One Tree Island, Great Barrier Reef. Fish were sampled day and night using channel nets located on the reef crest, and a plankton-mesh purse-seine net in the lagoon (1992–1994). Catches of fish at night were generally tens to hundreds of times greater than those taken during the day. Preflexion fish, as well as postflexion and pelagic juveniles, were taken in greater numbers at night. Preflexion forms were a combination of those that had hatched from demersal eggs and later stages that had been transported over the reef crest. Highest numbers of postflexion and pelagic juvenile forms of Apogonidae, Blenniidae, Gobiesocidae, Gobiidae, Labridae, Lutjanidae, Mugilidae, Mullidae, Pomacentridae, Scaridae, Serranidae and Tripteriguidae were found at night. Observations, while SCUBA diving, and purse-seine samples in the lagoon indicated that the only resident larvae were of the genera Spratelloides and Hypoherina; most of the fishes caught in nets, therefore, were immigrants. Patch reefs, sampled for new settlers early in the morning and late in the day, indicated that the majority of apogonids (Apogon doederleini, >95%) settled at night. Although greater numbers of pomacentrids were found in morning counts (e.g. Pomacentrus wardi), if data were converted to an hourly rate, many pomacentrids showed a similar hourly rate of settlement day and night. Depth-stratified sampling in waters near One Tree Island (to 20 m) indicated that some taxa rise to the surface at night. This behaviour, perhaps combined with avoidance of diurnal predators may explain on-reef movement of potential settlers soon after dark. Studies on settlement cues, therefore, need to focus on night-related phenomena.

Introduction

In contrast to the benthic phases of reef fishes (Sale 1991), there are few data on the presettlement phase (Leis 1991; Victor 1991). Recently, however, information has been published on the early life history stages including the following: taxonomy (e.g. Leis and Rennis 1983; Leis and Trnski 1989); horizontal and vertical distribution patterns (Leis 1986, 1991); the influence of oceanography (Kingsford et al. 1991; Milicich 1994); condition (McCormick and Maloney 1992) and swimming abilities (Stobutzki and Bellwood 1994; Leis and Carson-Ewart 1997). Conventional ichthyoplankton nets (e.g. Leis and Goldman 1987), purse seines (Kingsford et al. 1991) and light traps (Doherty 1987; Milicich 1994) have been used to collect these data.

The arrival of potential settlers at a reef and the process of settlement is a subject of intense interest to scientists, particularly given that many assumptions on the availability of potential settlers underpin models of the population dynamics and assemblages of fishes (Doherty and Williams 1988). Attempts have been made to compare the abundance patterns of larvae with patterns of recruitment to reefs (Stephens et al. 1986), but a major problem has been selecting sampling equipment that provides accurate assessments of the abundance of presettlement fish. Light traps have revolutionised the sampling of fish that are close to settlement (Doherty 1987). Moreover, these devices have been used to describe patterns of abundance of potential settlers adjacent to reefs over most of the recruitment season of some fishes and among years (Milicich et al. 1992).

A potential limitation of light traps that are used to measure the abundance of potential settlers is that it must be assumed that all larvae approaching a reef do so at night. Although there is some evidence from patterns of settlement on reefs that this is generally the case (Robertson et al. 1988; Sweatman and St John 1990;...
Booth 1992), the assumption is largely untested. A notable exception is the work of Shenker et al. (1993, Bahamas), who used tethered nets to determine that 97% of reef fish were collected on flood tides at night. From a methodological point of view, the knowledge that light traps and other methods that are only used at night can provide accurate information on abundance of potential settlers is a prerequisite for broader-scale applications of these methods to measure the replenishment of reefs.

The timing of the arrival of fish at a coral reef is interesting in terms of behaviour, the processes influencing survivorship and the complexities of finding suitable habitat in which to settle (Robertson 1991; Victor 1991). Although some potential settlers may be close to reefs (Doherty et al. 1996) and have good swimming abilities (Leis et al. 1996), approaching a reef is fraught with problems. Firstly, fish must remain close enough to the reef to be able to settle. Secondly, they face a so-called ‘wall of mouths’ around the perimeter of the reef during the day (Hamner et al. 1988; Kingsford and MacDiarmid 1988) and potentially at night from fish (e.g. apogonids, pempredids, holocenoids, lutjanids; Hiatt and Strasberg 1960; Gladfelter 1979; Hobson 1991) and invertebrates (e.g. corals). Once they reach the reef complex they must also avoid demersal fishes and predatory invertebrates. Settlers may initially hide in the sand, as for some labrids (Victor 1983), settle away from hard substrata and move to them at a later time (Finn and Kingsford 1996), seek out the coral matrix and the presence or absence of adults (Sweatman 1983, 1985) or settle directly on continuous reef (Williams 1983). More information, however, is required on the nature of the timing of settlement so that a better resolution of this period in the life history of fishes can be gained.

The objective of this work was to determine the diel patterns of supply of potential settlers to a coral reef. The approach was to sample day and night using different types of sampling equipment, so that conclusions could be made without major confounding problems such as net avoidance (e.g. Murphy and Clutter 1972). The specific aims were to: (1) collect fish using channel nets on the flood tide entering the One Tree Island lagoon during the day and at night; (2) sample lagoonal waters during the day and at night with a plankton-mesh purse seine that would reduce problems of avoidance that are generally encountered with more traditional ichthyoplankton nets (Kingsford and Choa 1985); (3) count numbers of recruits early and late in the day on patch reef; (4) identify fishes in aggregations of larvae that are resident in the lagoon during the day, because it is possible that some types of larvae are resident in the lagoon regardless of time of day (Leis 1994); (5) collect data on the vertical distribution patterns of presettlement fishes outside the lagoon at One Tree Island so that the results could be related to the findings from nets that were tethered on the crest of the reef.

### Study area

One Tree Island is unique in that it has the only ponding lagoon on the Great Barrier Reef. The lagoon is generally isolated from the surrounding ocean for a half of each tidal cycle (Ludington 1979). The level of the tide (2.0–3.5 m to breach the reef crest) and wind velocity determines the duration and water velocity of the flood-tide pulse. Only when the crest is covered, therefore, can settlers enter the lagoon. Current speeds of up to 130 cm/s were measured on the reef crest with a flowmeter.

![Map of One Tree Island](image)

**Fig. 1** Map of One Tree Island showing the shape of the ponding lagoon (land/rubble banks are in black) and the position of channel nets (CN), purse seine sampling sites (S1–S3) and, sites A–C for patch reefs. Open squares indicate the areas in which searches were made for aggregations of presettlement fishes. The inset shows the location of One Tree Island in relation to the mainland and other reefs of the Capricorn Bunker Group on the southern Great Barrier Reef of Australia. True north is indicated.