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Occurrence of juvenile fishes on the seagrass beds of Kavaratti Atoll, Lakshadweep, India

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ABSTRACT

In the atolls of Lakshadweep, juveniles of Acanthuridae and Labridae were most abundant on seagrass beds, the former during pre-monsoon and post-monsoon periods and the latter in pre-monsoon. Schooling species showed variable recruitment. Non-schooling species were rare. Peak settlement was observed during pre-monsoon and post-monsoon seasons. Continuous occurrence of juveniles in different size ranges confirms the continuous spawning habits. Chaetodontids and holocentrids occurred consistently round the year. Seasonality in occurrence was most pronounced in Carangidae and Siganidae, but not so in Apogonidae, Lutjanidae and Mullidae. Seasonal abundance of juveniles was influenced by summer peaks, timing and magnitude of settlement, adult spawning and local migrations. Abundance of larvae increased with salinity. Juvenile abundance, independent of environmental parameters seemed to be controlled by seasons, tides and currents. Lunar phases and abundance of juveniles were found to be co-related.

Introduction

The Union Territory of Lakshadweep is a group of 36 islands, scattered in the Arabian Sea off the south-west coast of India, forming the northern part of the Laccadive-Chagos ridge (8 to 12° N and 71° 45' to 73° 45' E). Kavaratti is one of the 11 major atolls of Lakshadweep.

During the course of a study on the biology and ecology of coral reef fishes of Lakshadweep, seven sub-habitats have been identified in the atolls of which seagrass beds form an important zone. These zones are conspicuous in lagoons of all atolls except Bitra and Kiltan islands forming dense beds along the islands in calm areas (0.50 to 3 m depth). Six species of seagrasses, namely *Cymodocea rotundata*, *C. serrulata*, *Halodule uninervis*, *Halophyla ovata*, *Syringodium isoetifolium* and *Thalssia hemprichii* occur on the atolls of which the latter species dominated. The seagrasses form raised tables due to efficient sediment trapping by the rhizomes in lagoon areas experiencing considerable wave action. The surrounding sand areas are unstable being continuously subject to transportation by currents.

A large number of juveniles of several species of coral reef fishes were found in the seagrass beds. As very little information is available on the early life histories of reef fishes from India, a study based on collections of juveniles from

seagrass beds of Kavaratti atoll during the period January to December 1991 was undertaken. The results of this study are presented in this paper.

Materials and methods

Nocturnal collections of juvenile fishes from seagrass beds of Kavaratti atoll were made for a 12-month period using a velon screen of 10 m wide and 2 m high on a towing length of 25 m.

To determine the relative abundance of juveniles belonging to each family, monthly data were pooled and the percentage of each family was calculated. Total number of juveniles recorded in each monthly sample was used to study the monthly fluctuations in the occurrence of juveniles on seagrass beds.

Salinity was analysed on a monthly basis (Strickland and Parsons, 1972). Rank correlation was used to test juvenile abundances against salinity and temperature. The same in relation to moon phases was tested using ANOVA (Bakus, 1990).

Results

The monthly abundance, size range, total abundance, percentage of juveniles belonging to each of the 28 reef fish families collected on seagrass beds is as follows:

Acanthuridae:

Acanthurids contributed to the highest juvenile abundance recording 316 post-larval stages forming 13.62% of juveniles from seagrass beds. They occurred in size ranging between 18 and 72 mm. Maximum number of individuals were recorded in January, February and September (39, 43 and 41 nos. respectively), while least counts were observed during the monsoon months of May, June, July and August with 20, 12, 21 and 17 nos. respectively.

Apogonidae:

Juvenile apogonids forming 4.57% (106 nos) of juveniles were recorded. They occurred in size ranges between 15 and 52 mm. Higher counts were registered in May (17 nos.) and September (19 nos.), while the least were recorded in March, June and July (3, 3 and 2 nos.). Apogonid juveniles generally occurred in all months.

Balistidae:

Only 12 balistid juveniles (0.52%) were observed in the size range of 43 to 64 mm recording a monthly count of one to three individuals. They were generally rare on seagrass beds.

Carangidae:

Juvenile carangids formed one of the dominant groups of seagrass beds recording a total of 190 individuals (8.19%). Common size range was between 75 and 100 mm, maximum counts were observed in March, April and August (31, 41 and 45 nos. respectively). Only 2 individuals were recorded in June. The occurrence of this group was seasonal.

Chaetodontidae:

Chaetodontids forming 5.22% of (121 nos.) juveniles were recorded in sizes between 14 and 62 mm. Juvenile counts were high in March, July and December (15, 14 and 15 nos. respectively), while it was least in February, August, and October (6 and 5 nos. respectively). Juveniles of *Chaetodon auriga*, *C. falcula*, *C. lunula*, *C. melannotus* and *C. trifasciatus* were commonly observed round the year, while young ones of other species were rare.

Diodontidae:

Twenty juveniles (0.86%) in the size range of 80 to 88 mm belonging to *Diodon histrix* were recorded. Juvenile representation of this family on seagrass beds was rare.

Platacidae:

Only 6 juveniles (0.26%) measuring from 80 to 89 mm were recorded.

Exocoetidae:

Fortytwo juveniles (1.81%) in the size range of 40 to 45 mm were recorded with maximum counts in July and October (10 and 19 nos.). Occurrence was rare and seasonal.

Fistulariidae:

Ninetytwo juvenile fistulariids (3.24%) in the size range of 120 to 169 mm were recorded. Maximum counts were observed in April (15 nos.), July (18 nos.) and October (15 nos.). Juveniles belonging to *Fistularia petimba* were common on seagrass beds.

Haemulidae:

Six juveniles (0.26%) in the size range of 100 to 110 mm were observed. Occurrence was rare.

Hemiramphidae:

Seventynine juvenile hemiramphids (3.41%) in the size range of 80 to 123 mm were observed with maximum counts (17 Nos.) in February. Occurrence of juveniles was seasonal.

Holocentridae:

Juveniles (147 nos, 6.34%) in the size range of 32 to 83 mm were observed. Maximum counts were registered in

TABLE 1. *Month-wise total number of juveniles in relation to salinity and temperature from January to December 1991 on seagrass beds (values in parentheses indicate ranks*

Month	Salinity ppt		Temperature °C		Total Juveniles	
January	34.65	(4)	28.50	(6)	236	(2)
February	33.00	(12)	28.00	(8)	204	(6.5)
March	34.00	(6.5)	30.70	(2)	198	(8)
April	36.00	(2)	30.00	(4)	276	(1)
May	33.00	(9)	29.50	(5)	153	(10)
June	33.60	(10)	26.30	(7)	98	(12)
July	33.90	(8)	26.30	(11)	191	(9)
August	33.50	(11)	26.20	(12)	204	(6.5)
September	36.50	(1)	27.50	(9)	210	(5)
October	34.60	(5)	27.30	(10)	218	(4)
November	34.00	(6.5)	30.60	(3)	105	(11)
December	35.20	(3)	32.00	(1)	227	(3)

Rank correlation values:

Salinity	x	abundance	-	0.647	Degrees of freedom-10	Significant at 5% level
Temperature	x	abundance	-	0.065	Degrees of freedom-10	Not significant

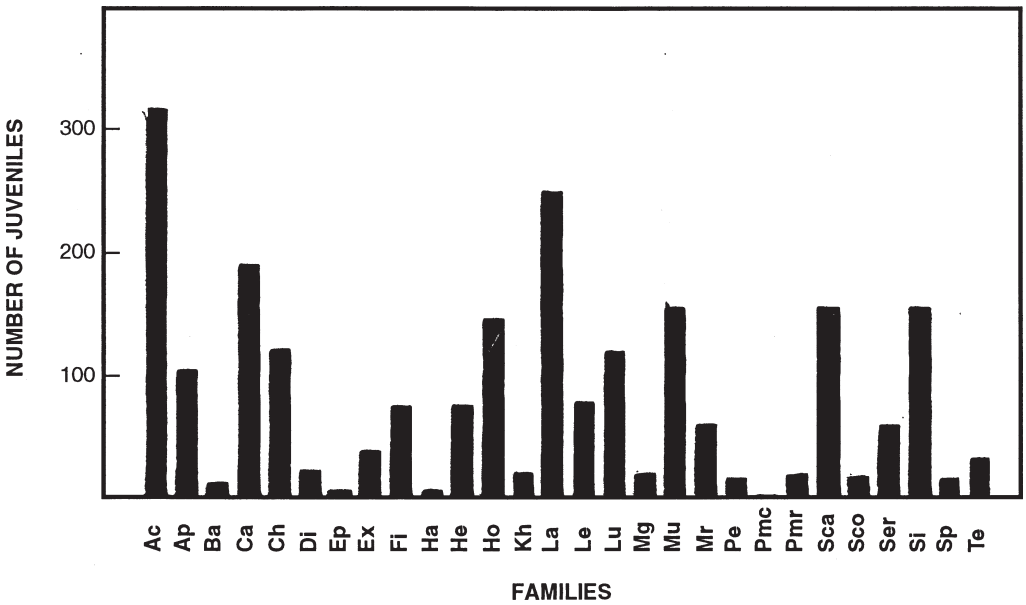

Fig. 1 Abundance of juveniles of various families on seagrass beds (January to December 1991). Ac-Acanthuridae; Ap-Apogonidae; Ba-Balistidae; Ca-Carangidae; Ch-Chaetododntidae; Dt-Diodontidae; Pl-Platacidae; Ex-Exocoetidae; Fi-Fistulariidae; Ha-Haemulidae; He-Hemiramphidae; Ho-Holocentridae; Kh-Kuhlidae; La-Labridae; Le-Lethrinidae; Lu-Lutjanidae; Mg-Mugilidae; Mu-Mullidae; Mr-Muraenidae; Sca-Scaridae; Sco-Scorpaenidae; Ser-Serranidae; Si-Siganidae; Sp-Sphyraenidae; Te-Tetraodontidae

January, February and April (21, 19 and 19 respectively), while a least count (3 nos.) was recorded in May. Juveniles were mainly composed of *Myripristis murdjan*, *M. adusta* and *Neoniphon sammara*.

Kuhlidae:

Twentyone juveniles (0.91%) measuring between 50 and 75 mm were observed. Occurrence of juveniles was seasonal and rare.

Labridae:

Labrids contributed significantly to juvenile abundance on seagrass beds recording 250 nos. accounting for 10.78%.

Lethrindiae:

Seventynine individuals (3.41%) in the size range of 20 to 65 mm were recorded. Maximum counts were observed in January (16 nos), while a least count occurred in November (2 nos). Juveniles were present in almost all months.

Lutjanidae:

Lutjanid juveniles were relatively abundant on seagrass beds recording 123 individuals (5.30%) in the size range of 30 to 83 mm. They occurred in higher numbers in January, April, July and October (20, 16, 17 and 18 nos. respectively), while least counts were observed in March and November (2 nos. each). Juveniles generally occurred round the year, the dominant species being *Lutjanus kasmira* and *L. bohar*.

Mugilidae:

Twentythree individuals (0.99%) in

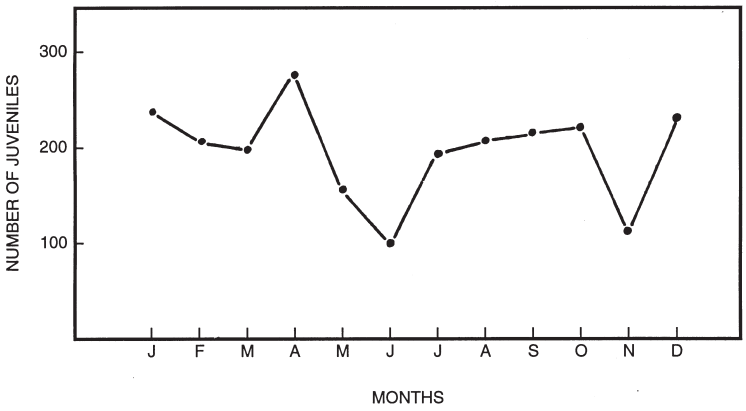

Fig. 2 Month-wise occurrence of all juveniles on seagrass beds (January to December 1991)

the size range of 70 to 75 mm were observed. Maximum counts were recorded in August (11 nos.). Juveniles occurred seasonally.

Mullidae:

Juveniles of mullids were observed in relatively more numbers recording 156 individuals (6.72%) in the size range of 28 to 64 mm. Counts were high in January (31 nos), while they were least in August (3 nos). Juveniles of *Parupenaeus pleurostigma* were particularly dominant, though other species were also common round the year.

Muraenidae:

Sixty-one muraenids (2.63%) in the size range of 80 to 150 mm were observed. Highest count was registered in January (12 nos). Juveniles were seasonal and rare on seagrass beds, the dominant species being *Gymnothorax undulatus*.

Pemphridae:

Sixteen juveniles (0.69%) in the size range of 50 to 70 mm were observed. Juvenile pemphrids were rare on seagrass beds.

Pomacanthidae:

Only two individuals measuring 80 and 82 mm were recorded. Juveniles were rare on seagrass beds.

Pomacentridae:

Twentyfour juveniles (1.03%) were recorded in the size range of 18 to 43 mm. *Abudefduf sexfasciatus* was the only species noted.

Scaridae:

Scarids formed one of the dominant groups of juveniles on seagrass beds recording 157 nos (6.77%) in the size range of 30 to 83 mm. Counts were high in August (23 nos.), while they were least in March (2 nos.). In general scarid juveniles occurred on seagrass beds in all months.

Scorpaenidae:

Eighteen individuals (0.78%) in the size range 60 to 100 mm were recorded. Juveniles were rare on seagrass beds.

Serranidae:

Sixtyone individuals (2.63%) in the size range of 40 to 83 mm were recorded. Juveniles were rare on seagrass beds.

Siganidae:

One hundered fifty seven individuals (6.77%) were observed in the size range of 30 to 82 mm. Maximum counts were recorded in December (38 nos), while least counts were observed in April, June and August (4, 3 and 3 nos. respectively). Juveniles were recorded in all months.

Sphyraenidae:

Seventeen juveniles (0.73%) in the size

range 60 to 90 mm were recorded. They were rare on seagrass beds.

Tetraodontidae:

Thirtyfour juveniles (1.47%) in the size range 50 to 120 mm were recorded. They were rare on seagrass beds.

The most dominant families that occurred on seagrass beds in their juvenile stages were Acanthuridae, Apogonidae, Carangidae, Chaetodontidae, Holocentridae, Labridae, Lutjanidae, Mullidae, Scaridae and Siganidae. Of these 10 families, Acanthuridae, Carangidae and Labridae were abundant. Pomacentridae indicated least counts followed by Haemulidae and Platacidae (Fig. 1).

Monthly juvenile abundance:

Fig. 2 shows monthly juvenile abundance on seagrass beds. Total juvenile counts were highest in April (276 nos) and January (236 nos). Relatively more juveniles were observed in December (227 nos). February, August, September and October recorded counts above 200 individuals. Lowest number of juveniles were recorded in June (98 nos). Juvenile abundance in March and July were comparable (198 and 191 nos respectively). May and November registered counts of 153 and 105 individuals respectively.

Effect of temperature and salinity on juveniles abundance:

Effect of salinity on juvenile abundance in seagrass beds was found to be significant at 5% level, while that of temperature on abundance was not significant. An increase in salinity regime in the area was observed with increase in juvenile fish, while there existed no relationship between temperature and abundance. At the highest temperature (32°C), 227 individuals were recorded, while at a temperature of 30.00°C the maximum number of 276 individuals were recorded (Table 1).

Effect of moon phases on juvenile abundance:

Juvenile abundance between moon phases (new and full moon) was found to be significant when the least count of 98 individuals was omitted for calculation purposes. In general, the new moon phase (dark nights) recorded higher juvenile counts (204 to 276 nos), while the full moon phase (bright nights) recorded relatively lower counts between 105 and 204 individuals.

Discussion

Seagrass beds act as nurseries for new recruits, post-larvae and juvenile fishes. The 'nursery phase' with direct dependence on seagrass beds consisted of newly settled post-larvae and juveniles. Considering juvenile fishes at the highest trophic level and trapped nutrients in seagrass beds at the lowest level, a short food chain is evident. Seagrasses act as a safe habitat for young fishes and they generally occur in shallow waters in Lakshadweep. Large predators normally keep away from shallow waters. In the 'transitional phase' juveniles migrate from seagrass beds to adult habitats (rubble, massive coral, live coral etc.,) after they have transformed enough to cope up with an 'outer world' with regard to food, competitors, predator escape and shelter. As observed from size ranges of juveniles, fish beyond a certain size were not observed indicating that their association with seagrass beds is only temporary.

In the present study, 28 reef fish families were represented by new recruits or juveniles on seagrass beds on

Kavaratti atoll. Of these, juveniles belonging to Acanthuridae and Labridae were most dominant. Victor (1987) observed labrid larvae to have long larval lives and larvae of different ages occurred within the same water mass and young cohorts of larvae appeared continuously over the sampling period. The extended larval lives perhaps explain inclusion of labrids in almost all samples in Lakshadweep. Schooling species showed clumped, highly variable recruitment that presumably resulted from aggregative settlement (Shulman, 1985 b) and this can be related to the high occurrence of juveniles of Acanthuridae, Carangidae, Holocentridae, Mullidae, Scaridae and Siganidae all of whose adults exhibited schooling behaviour. The observation of Shulman (1985 b) on non-schooling species that showed random, less variable recruitment patterns could be probably applied to those families in the present study that were relatively low in representation.

It was observed that adjacent bare sand flats were almost devoid of juveniles, while they were abundant on seagrass beds. This indicated their preference for shelter. Various size ranges recorded for each group suggested that certain families remain on seagrass beds for a relatively longer duration of time and are represented by post-larvae, advanced post-larvae and juveniles. No apparent order seems to be imposed on the variety of settlement sizes (Victor, 1991). This long-duration association could mainly be due to abundant food resources available for juveniles.

Juvenile settlement of dominant families on seagrass beds was generally observed to be continuous. Victor (1991) found that species of fish larvae appear somewhat regularly, in random or periodic short cycles; a few species tend to settle in large numbers on rare occasions. Acanthurid juveniles steadily occurred on seagrass beds with peak settlements during pre-monsoon and post-monsoon months. Juveniles and sub-adults of chaetodontids were generally more abundant in shallow areas whether it be coral reefs or seagrass beds (Fricke, 1973). Though juvenile chaetodontids were not very abundant on seagrass beds they occurred consistently round the year. A similar trend was seen in the case of Holocentridae. Occurrence of juveniles of Apogonidae, Lutjanidae and Mullidae was moderately seasonal, while carangids and siganids exhibited a remarkable seasonality. Labrids clearly indicated summer peaks in settlement.

Juveniles of most reef fish families in Lakshadweep appeared less abundant during monsoon months, possibly because of avoidance of this season by adult spawners. However, some juveniles observed during monsoon seasons could result from the pre-monsoon spawning. The continuous occurrence of juveniles in a variety of size ranges confirms the continuous spawning habits in most species examined. Juvenile abundance was generally high during pre-monsoon and post-monsoon seasons. The low spawning output and juvenile occurrence during monsoon is perhaps due to unfavourable environmental conditions. Summer peaks in recruitment are possibly related to temperature. Seasonal differences in larval fish assemblages were observed in the Great Barrier Reef (Shulman, 1985 b; Leis and Goldman, 1987). Summer peaks in larval recruitment and seasonal variations in abundance of juveniles were reported by Williams and Sale (1981) and Williams *et al*., (1984) while

Middleton *et al*., (1984) stated that recruitment of temporary residents was the main cause of seasonal variation. Apart from these reasons that contribute to variations in larval abundance on seagrass beds, timing of adult spawning, timing of settlement, total number settling at a given time and shifting to adult habitats also influence the numerical abundance.

In the present study, the abundance of juveniles on seagrass beds was not affected by temperature while on the other hand, increased salinity was coupled with increased juvenile occurrence. Conventionally, salinity increases with temperature and highest temperatures were recorded in the pre-monsoon period (summer months). Though these two parameters are related, a distinction made by juveniles suggests that neither of the two parameters influenced their abundance but are perhaps dependent on other factors like monsoon seasons, currents and tides. Vijay Anand (1990 a) and Suresh (1991) found variations in water temperatures and salinity on Kavaratti atoll to be low. In general, fluctuations in environmental parameters were only slight perhaps due to the oceanic conditions. The coincidence of juvenile abundance during pre-monsoon and post-monsoon seasons (which show relatively higher temperature and salinity regimes compared to monsoon) may possibly be related to higher salinities.

Lunar cycles influence the return of juveniles to adult habitat at the end of the planktonic phase (Johannes, 1978; Thresher, 1984; Robertson *et al*., 1990). Occurrence of more juveniles during the new moon phases (dark nights) is perhaps advantageous for settlers to combat predation. Lower settlement rates during week around the full moon (brighter nights) were reported by Robertson *et al*. (1988). In the present study, this adaptive significance could have increased the number of post-larvae settling on seagrass beds during the new moon phase.

In conclusion, seagrasses at Lakshadweep have emerged as dynamic sub-habitats with one of their important functions as nurseries for a wide variety of reef fishes. These zones steadily supplied juveniles and subadults to other habitats. Juveniles of certain families characteristically used seagrass beds as nurseries, while others perhaps had different specific habitat requirements. Environmental parameters had little influence on their abundance, while the phenomenal monsoon seemed to affect their abundance either directly or indirectly by providing unfavourable or favourable environmental conditions for settlement.

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References

Bakus, G.J. 1990. *Quantitative Ecology and Marine Biology*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 157 pp.

Fricke, H.W. 1973. Behaviour as part of ecological adaptation: *In situ* studies in the coral reef *Helogolander wills*. *Meercsunters*, **24**: 120-144.

Johannes, R.E. 1978. Reproductive strategies of coastal marine fishes in the tropics. *Environ. Biol. Fishes*, **3**: 65-84.

Leis, J.M. and B. Goldman 1987. Composition and distribution of larval fish assemblages in the Great Barrier Reef Lagoon, near Lizard Island, Australia. *Aust. J. Mar. Freshwater Res.*, **38**: 211-223.

Middleton, M.J., J.D. Bell, J.J. Burchmore, D.A. Pollard and B.C. Pease 1984. Structural differences in the fish communities of *Zostera capricorni* and *Posidonia australis* seagrass meadow in Botany Bay, New South Wales. *Aquat. Bot.*, **18**: 89-109.

Robertson, D.R., D.G. Green and B.C. Victor 1988. Temporal coupling of production and recruitment of larvae of a Caribbean reef fish. *Ecology*, **69**: 370-381.

Robertson, D.R., C.W. Peterson and J.D. Brawn 1990. Lunar reproductive cycles of benthic–brooding reef fishes: Reflections of larval biology or adult biology? *Ecol. Monogr.*, **60** : 311-329.

Shulman, M.J. 1985b. Recruitment of coral reef fishes: Effects of distribution of predators and shelter. *Ecology*, **66**: 1056-1066.

Strickland, J.D.H. and T.R. Parsons 1972. *A practical Handbook of Seawater Analysis.*

Suresh, V.R. 1991. *Studies on the coral reefs of Lakshadweep*. Ph.D. Thesis. Cochin University of Science and Technology, Cochin, 123 pp.

Thresher, R.E. 1984. *Reproduction of Reef Fishes*, TFH Publications; Neptune City, New Jersey, U.S.A.

Victor, B.C. 1987. Growth, dispersal and identification of planktonic labrid and pomacentrid reef – fish larvae in the eastern Pacific Ocean. *Mar. Biol.*, **95** : 145-152.

Victor, B.C. 1991. Settlement strategies and biogeography in reef fishes. In: *The Ecology of Fishes on Coral Reefs* P.F. Sale(Ed.) p. 231-260. Academic Press INC. San Diego, California.

Vijay Anand, P.E. 1990 a. *Bionomics of three marine ornamental fishes of Lakshadweep with notes on habitat, feeding trials and packaging.* M.F.Sc. Thesis, Department of Aquaculture, College of Fisheries, Mangalore University of Agricultural Sciences, Bangalore, 158 pp.

Williams, D. M. B. and P.F. Sale 1981. Spatial and temporal patterns of recruitment of juvenile coral reef fishes to coral habitats within "One Tree Lagoon". Great Barrier Reef. *Mar. Biol.*, **65**: 245-253.

Williams, D. McB., E. Wolanski and J.C. Andrews 1984. Transport mechanisms and the potential movement of planktonic larvae in the central region of the Great Barrier Reef. *Coral Reefs*, **3**, 229-236.

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