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Influence of Light on Diurnal Behaviour of Carangids in the Wadge Bank Trawl Fishery

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Introduction

Some species of fish, like the Carangids, which constitute a commercially important group are migratory and partly pelagic and partly demersal in habit. They are present in appreciable numbers in bottom trawl catches from the Wadge bank, mainly during May to October. Changes in the [and] hydrography of the environment due to monsoon activity occur during this season. These changes are generally believed to influence the migration, aggregation and dispersion of Carangids in the bank.

Adequate data on the Wadge bank fishery relating to several groups of fish, including Carangids, taken in bottom trawls are available for study. Analysis of this data indicated that the variation in Carangid catches was related to the time of day. In this paper, the available Wadge bank fishery data is analysed and discussed to show the diurnal changes in Carangid catches and the probable influence of light in affecting these changes.

Data on Carangid Catches

The data sheets for three calendar years, 1957 to 1959 when two trawlers were operated on the Wadge bank at maximum capacity have been examined in this study. The data sheets or trawlef returns contain amongst other details, the time and duration of a haul and the group composition or the catch in respect of each haul. The catch is separated into groups of one or more species and the quantity in each group recorded separately (Munasinghe 1969). The Carangids fall into two sections, (*a*) the " Paraw " (Carangids over 30 centimetres in length) and (*b*) the " Parati " (Carangids below 30 centimetres in length). The Paraw are represented by a few species notably *Carangoides chrysophrys* (Cuvier), *Caranx carangus* (Bloch) and *Gnathanodon speciosus* (Forskal). The Parati notably sby the above three species and *Carangoides malabaricus* (Bloch).

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TABLE I

Variation with time of day in apparent Density and relative Abundance of large Carangids (Paraw) in bottom trawl catches from the Wadge Bank (1957—1959)

Hours between which trawl was shot	Hour before which trawl was hauled	Apparent Density (CPUE-lbs./hr.) for Carangids	Relative Abundance (% in Catch) of Large Carangids
0000 — 0100	0545	23	2
0100 — 0200	0600	28	3
0200 — 0300	0700	2	0
0300 — 0400	0800	34	8
0400 — 0500	0900	99	5
0500 — 0600	0930	307	16
0600 — 0700	1100	183	8
0700 — 0800	1200	339	17
0800 — 0900	1300	213	10
0900 — 1000	1345	377	15
1000 — 1100	1500	251	18
1100 — 1200	1600	260	14
1200 — 1300	1700	173	8
1300 — 1400	1800	445	12
1400 — 1500	1900	184	13

TABLE I—*contd.*

Hours between which trawl was shot	Hour before which trawl was hauled	Apparent Density (CPUE-lbs./hr.) for Carangids	Relative Abundance (% in Catch) of Large Carangids
1500 — 1600	2000	385	15
1600 — 1700	2100	77	5
1700 — 1800	2200	66	4
1800 — 1900	2300	15	3

TABLE II

Variation with time of day in the Apparent Density and Relative abundance of small Carangids (Paraw) in bottom trawl catches from the Wadge Bank (1957-1959)

Hours between which trawl was shot	Hour before which trawl was hauled	Apparent Density (CPUE-lb./hr.) for small Carangids	Relative Abundance (% in Catch) of small Carangids
0000 — 0100	0545	75	10
0100 — 0200	0600	108	12
0200 — 0300	0700	78	8
0300 — 0400	0800	266	20
0400 — 0500	0900	305	22
0500 — 0600	0945	183	19
0600 — 0700	1100	553	22
0700 — 0800	1200	413	23

TABLE II—*contd.*

Hours between which trawl was shot	Hour before which trawl was hauled	Apparent Density (CPUE-lbs./hr.) for small Carangids	Relative Abundance (% in Catch) of small Carangids
0800 — 0900	1300	375	20
0900 — 1000	1345	725	28
1000 — 1100	1500	435	18
1100 — 1200	1600	572	23
1200 — 1300	1700	362	23
1300 — 1400	1800	890	29
1400 — 1500	1900	343	19
1500 — 1600	2000	482	24
1600 — 1700	2100	239	16
1700 — 1800	2200	196	11
1800 — 1900	2300	90	13
1900 — 2000	0100	206	12
2100 — 2200	0200	30	5

Analysis of the data on Carangid Catches

Fishing goes on continuously throughout the day and night with a break at fairly regular intervals for hauling and shooting the trawl. The duration of a haul lasts between 2 to 4 hours. The size of the catch in consecutive hauls varied in magnitude during the course of a day. This was true for all days of a month and all months of an year. The variation was more marked in all three years when Carangids were present.

As a follow through of this observation, a closer study of the data seemed necessary in order to establish whether a correlation did exist between magnitude of catch and time of day. The data for all three years, therefore, was condensed into a catch size, time of day relationship. The catch per unit effort (lbs. per hour) which is an index to apparent density and percentage in the catch an index to relative abundance has been analysed in relation to time of day by dividing the day into several well defined constituent periods.

A period of day for this purpose has its upper limit as the time of shooting the first trawl within this period and its lower limit as the time at which a trawl shot within this period was last to be hauled. The results have been tabulated separately for large and small Carangids in Tables I and II respectively. The processed data for each group is represented diagramatically in figs. 1 and 2. Table III shows the frequency of occurrence of each hour of the day within the periods with densities over 100 lbs./hr. and abundance over 8% for large Carangids. Similarly Table IV is for densities over 300 lbs./hr. and abundance of over 18% for small Carangids.

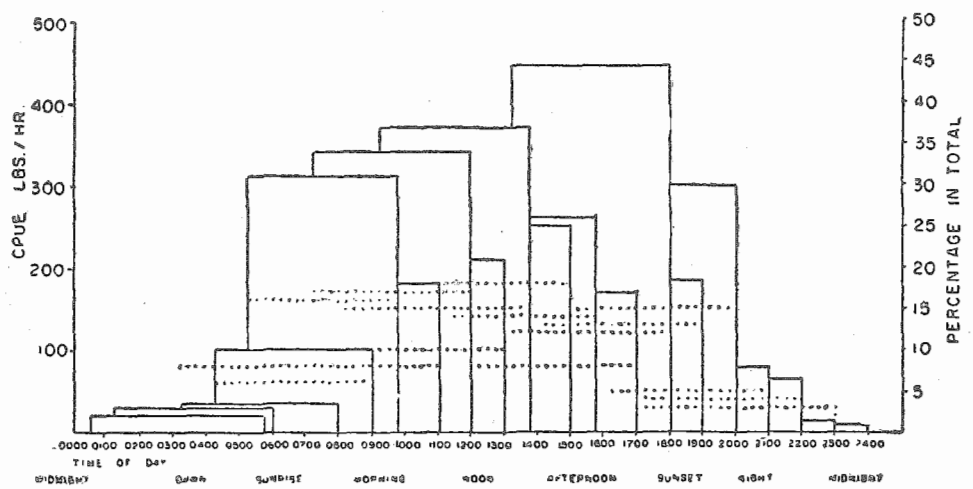

Fig 1 Apparent Density and Relative Abundance in Relation to time of day for Large Carangids in Bottom Trawl Catches from the Wadge Bank.

Large Carangids

The apparent density and relative abundance of this group in the fishing grounds appear to be very low during the periods before sunrise. From sunrise onwards up to sunset both density and abundance increase more or less proportionately and decrease rapidly during the periods of darkness. The peaks in density and abundance are between afternoon and sunset (Fig. 1). Variation in both density and abundance for this group during the periods of daylight is not very marked. However the periods of high density and great abundance appear to be between 1000 hours and 1500 hours (Table III).

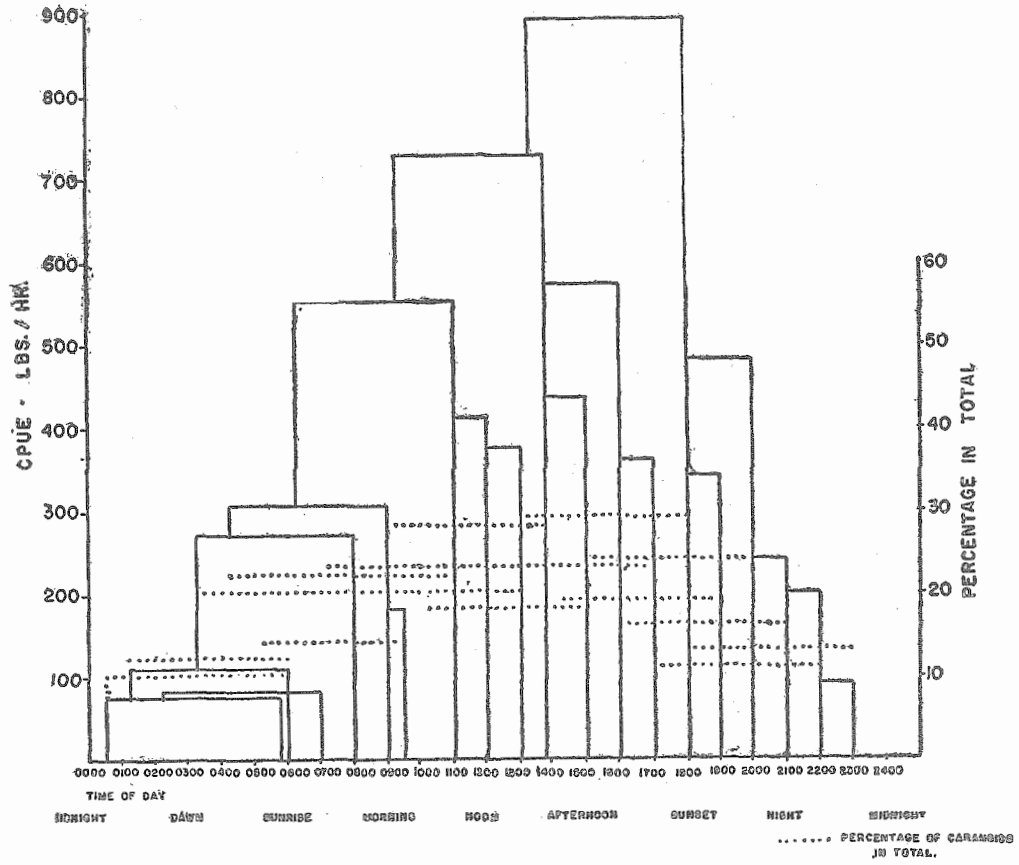

Fig. 2 Apparent Density and Relative Abundance in Relation to time of day for small Carangids in Bottom Trawl Catches from the Wadge Bank

Small Carangids

As in the case of large Carangids the density and abundance are low in the periods before sunrise. There is a rapid increase in both density and abundance from the period of sunrise up to sunset. A rapid decrease is observed during the periods of darkness. The peak in density and abundance is between afternoon and suset (Fig. 2). In this group variation in density is more marked than the variation in abundance. However, the periods of high density and abundance appear to be between 0900 hours and 1500 hours (Table IV).

For both groups the rise and fall in both density and abundance are irregular. However, a definitive trend is apparent from both figs. 1 and 2. The trend in density and abundance for both groups is similar with a peak between afternoon and sunset, and the dis-similarity is only in the degrees of density and abundance which are higher for the small Carangids.

TABLE III

Frequency Distribution of each hour in periods of day with Densities above 100 and Abundance above 8% for Large Carangids

Period of Day	Hours of Day within each period of day															
0500–0930	0500	0600	0700	0800	0900	0930	—	—	—	—	—	—	—	—	—	—
0600–1100	—	0600	0700	0800	0900	1000	1100	—	—	—	—	—	—	—	—	—
0700–1200	—	—	0700	0800	0900	1000	1100	1200	—	—	—	—	—	—	—	—
0800–1300	—	—	—	0800	0900	1000	1100	1200	1300	—	—	—	—	—	—	—
0900–1345	—	—	—	—	0900	1000	1100	1200	1300	1345	—	—	—	—	—	—
1000–1500	—	—	—	—	—	1000	1100	1200	1300	1400	1500	—	—	—	—	—
1100–1600	—	—	—	—	—	—	1100	1200	1300	1400	1500	1600	—	—	—	—
1200–1700	—	—	—	—	—	—	—	1200	1300	1400	1500	1600	1700	—	—	—
1300–1800	—	—	—	—	—	—	—	—	1300	1400	1500	1600	1700	1800	—	—
1400–1900	—	—	—	—	—	—	—	—	—	1400	1500	1600	1700	1800	1900	—
1500–2000	—	—	—	—	—	—	—	—	—	—	1500	1600	1700	1800	1900	2000
Total Frequency ..	1	2	3	4	5	6	6	6	6	6	6	5	4	3	2	1

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TABLE IV

Frequency Distribution of each hour in period of day with Densities above 300 and Abundance above 18% for small Carangids

Period of Day	Hours of Day within each Period of Day																
0400–0900 ..	0400	0500	0600	0700	0800	0900	—	—	—	—	—	—	—	—	—	—	—
0500–0945 ..	—	0500	0600	0700	0800	0900	0945	—	—	—	—	—	—	—	—	—	—
0600–1100 ..	—	—	0600	0700	0800	0900	1000	1100	—	—	—	—	—	—	—	—	—
0700–1200 ..	—	—	—	0700	0800	0900	1000	1100	1200	—	—	—	—	—	—	—	—
0800–1300 ..	—	—	—	—	0800	0900	1000	1100	1200	1300	—	—	—	—	—	—	—
0900–1345 ..	—	—	—	—	—	0900	1000	1100	1200	1300	1345	—	—	—	—	—	—
1000–1500 ..	—	—	—	—	—	—	1000	1100	1200	1300	1400	1500	—	—	—	—	—
1100–1600 ..	—	—	—	—	—	—	—	1100	1200	1300	1400	1500	1600	—	—	—	—
1200–1700 ..	—	—	—	—	—	—	—	—	1200	1300	1400	1500	1600	1700	—	—	—
1300–1800 ..	—	—	—	—	—	—	—	—	—	1300	1400	1500	1600	1700	1800	—	—
1400–1900 ..	—	—	—	—	—	—	—	—	—	—	1400	1500	1600	1700	1800	1900	—
1500–2000 ..	—	—	—	—	—	—	—	—	—	—	—	1500	1600	1700	1800	1900	2000
Total Frequency ..	1	2	3	4	5	6	6	6	6	6	6	6	5	4	3	2	1

Discussion

The Carangids both large and small become increasingly vulnerable to capture by a bottom trawl from dawn to dusk, in other words during daylight hours. As figs. 1 and 2 show they are more or less unavailable for capture at the sea bottom during the periods of darkness. The rapid drop in both apparent density and relative abundance soon after sunset seems to indicate a movement out of range of a bottom trawl. These fish though partially pelagic, Shabotinets (1969) are mainly bottom feeders. An examination of stomach contents showed that their food generally consisted of bottom dwelling forms such as crabs, shrimps, and bivalve molluscs (Fernando 1968). Generally, after sunset, when the light intensity falls below critical limits for feeding activity, the fish move away from the bottom as shown by the relatively low densities indicated in the Tables. As the apparent density and relative abundance tend to increase from dawn to dusk, it may be assumed that there is a movement of these fish from the surface to the bottom for feeding. This diurnal rhythm or up and down movement is for feeding at depths of a preferred light intensity. In a recent review of herring biology, Parrish and Saville (1965), state that it is generally accepted that the diurnal behaviour pattern results from the fish following a preferred light intensity. In the Carangids, therefore, greatest activity is generally between dawn and dusk. These fish remain at or near the bottom of the fishing grounds, which is their feeding ground making themselves vulnerable to capture by the bottom trawl. The peak in vulnerability for Carangids appears to be before sunset, suggestive of greater activity while feeding together with the pressing action of the light (Balls 1950) which under normal conditions is more intense at this time of day forcing them nearer the sea bottom. This explanation could account for the peaks in density and abundance before sunset.

The time at which both density and abundance of Carangids increase and decrease appear to coincide very closely with the times at which light intensities are likely to increase and decrease. The highest intensities will be between 0900 hours and 1500 hours. This intensity will decrease proportionately from surface to bottom. The lowest intensity will be at the sea bottom. The fish will remain at a depth in which the light intensity is at an optimum for their comfort and feeding activity. The data analysed in this paper have been obtained from the Wadge Bank within a depth range of 10–30 fathoms (Munasinghe 1969) and it has now been shown that densities and abundance vary with the time of day. Chestnoy (1970) refers to the influence of hydro-optical conditions in availability of fish for capture. In other words, the visual acuity of the fish is conditioned by the light intensity prevailing at that depth of water. From the above evidence it may be assumed that light intensity plays an important role in influencing diurnal changes in Carangid catches taken by bottom trawls in the Wadge Bank.

Summary

Carangid catches in bottom trawls operated in the Wadge Bank have shown variation within the course of a day. This variation is governed by the apparent density and relative abundance of these fish within a limited time and space. The results show a diurnal rhythm in behaviour of these fishes indicating a descent to the bottom commencing at dawn and an ascent to the surface at sunset. Both density and abundance increase from sunrise to sunset with a peak between afternoon and sunset. This is explained as due to greater activity while feeding at depths with a preferred light intensity with the result that these fishes remain nearer the bottom, and consequently, are more vulnerable to capture by a bottom trawl. A striking feature of the diurnal rhythm in behaviour is that it coincdes very closely with the times at which light intensity generally increases and decreases underlying the importance of this factor in the behaviour of Carangids in the Wadge Bank.

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