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STUDIES ON MORPHOMETRY, FEEDING BIOLOGY AND SEX RATIO OF *Saurida undosquamis* (RICHARDSON, 1848) (FAM: SYNODONTIDAE) FROM NEENDAKARA AREA, KOLLAM, SOUTH WEST COAST OF INDIA

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ABSTRACT

The feeding biology, spawning season, size at first maturity, sex ratio and fecundity of the commercially important lizardfish (*Saurida undosquamis*) from Neendakara area, south west coast of India were studied. Fishes formed the predominant food item. Diversity of the prey items showed maximum value (H'log 2-3.61±0.11) during the post monsoon season and minimum during the monsoon season (2.89±0.17). The richness (1-lambda') also showed a similar of trend and varied from 0.81±0.13 (monsoon) to 0.91±0.01 (post monsoon). The size at first maturity (50% incidence of mature fish) was 195 mm. But when the size at first maturity was calculated by adjusting the proportion of maturity percentages, the maturity size was found to be 140 mm. This method is advantageous from the point of view of fisheries management as above 140 mm species can be exploited rather than above 195 mm. The gastro somatic index was found maximum during postmonsoon and minimum during the monsoon season showing an inverse relationship between feeding and spawning. This species was found to spawn from August to January with a peak in November. The fecundity values ranged from 19, 856 in a fish measuring from 20.1 cm in length (97 g) to 79,282 in a fish of 29 cm (290 g). The overall sex ratio (1:1.2) was found to deviate significantly from the expected 1:1 ratio. ($\chi 2 = 19.1$, $p<0.005$). High gonadosomatic index values were observed during October-December and that can be attributed to the spawning activity of the fish during the period.

KEYWORDS : Fecundity, Gastrosomatic Index, Maturity, Neendakara

Lizard fishes belonging to the family Synodontidae contribute their mite to the demersal fishery resource of India. They range in size from 25 (*S. longimanus*) to 67 cm (*S. tumbil*). They feed chiefly on teleost fishes, cephalopods and crustaceans. Among the four species of lizard fishes belonging to the genus *Saurida* occurring in the Indian waters (Jaiswer et al., 2002), *S. undosquamis*, the brushtooth lizardfish is the second dominant one. The maximum body size is 36 cm (Nandha, 1980). It is found to inhabit muddy bottoms of the continental shelf down to about 100 m deep(FAO, 1974).This species is exploited by a variety of gears, however the majority comes from the bottom trawls (FAO, 1974).

Earlier research on the lizard fishes of the Indian waters includes studies by (Kuthalingam, 1959), Nair and (Raghu, 1990), (Muthiah, 1996 and Sivakami et al., 2003) which were mostly qualitative in nature and did not cover all the aspects of biology. Some biological aspects of lizard fishes occurring in Parangipettai waters were reported by (Nandha, 1980). However a detailed investigation has not been undertaken on this species from Kerala and therefore, this paper focus on the feeding and reproductive aspects of *S. undosquamis.*

MATERIALS AND METHODS

The specimens for the present study were collected from the commercial trawlers operated from the Neendakara landing centre, Kollam, Kerala during January to December 2004. Specimens of *S. undosquamis* were placed in an insulated box with ice and brought to the laboratory for biological analysis. During the study, a total of 492 fish specimens of different length groups were examined to study the feeding biology of *S. undosquamis.* The data on sex, stages of maturity in females and feeding conditions were collected from fresh specimens. The feeding intensity was assessed by visual estimation based on the distension of the gut and the quantity of food contained in it. The various stomach conditions were based on degree of fullness are expressed as grossed, full, ¾ full, ½ full, ¼ full, trace and empty as suggested by (Pillay, 1952). In order to both qualitative and quantitative estimations were taken together, Index of Preponderance was employed for the quantification of the food items (Natarajan and Jhingran, 1961).The diversity of prey items was calculated using PRIMER v6. For determining the size at first maturity, females in stages of III-V of maturation were used by grouping them into 10 mm length groups and their frequencies scaled to percentage. Size at first sexual

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Table 1 : Monthly Distribution of Food Items (%) of *Saurida undosquamis*

Food items	Jan-04	Feb	Mar	Apr	May	june	July	Aug	Sep	Oct	Nov	Dec-04
Fish	27.41	31.52	65.99	77.36	58.07	57.54	46.52	58.26	64.73	75.15	77.71	58.17
Shrimp	27.18	22.48	24.23	13.81	0	0	10	10.12	0	0	0	16.48
Mollusc	16.61	18.45	1.15	5.31	11.63	11.63	20.36	11.52	5.51	0	0	6.37
Digested matter	28.8	27.55	8.63	3.34	30.3	30.47	23.12	20.1	29.76	24.85	22.29	18.98

Table 2 : Different Food Items (%) of *Saurida undosquamis*

Food items	Vol (Vi)mL	Occ(Oi)mL	Vi (%)	Oi (%)	ViOi	ViOi/∑ ViOi*100
Fish	262.4	63	50.24	31.34	1575	58.47
Shrimp	124	54	23.74	266.8	637.9	23.68
Mollusc	70.8	35	13.55	17.41	176.96	6.56
Digested matters	65	49	12.44	24.37	33.4	11.26
Total	522.2	201			2693	

maturity was also calculated by adjusted proportion of maturity percentages following King (1995).Chi square analysis was used to find out the sex ratio of the species. Fecundity was estimated by the gravimetric method (MacGregor, 1957), which involves counting the number of mature ova from a known weight of mature ovary and the fecundity was estimated. Gonado somatic index (GSI) was calculated employing the method of June (1953) and Yuen (1955).

RESULTS AND DISCUSSION

The food composition of *Saurida undosquamis* were analyzed and the mouth shown that small fishes was found to be the dominant food item during most of the months (Table, 1). Among the eight species of fishes found in the gut, *Nemipterus* sp. was dominant. Size of food fishes observed in the stomachs varied from 35 to 90 mm in length. Largest fish (90 mm) encountered in the gut was *Cynoglossus* sp., in the month of March. Highest quantity of fish was recorded in the gut content during November (77.71%) followed by April (77.14%) and October (75.15%). Lowest percentage was recorded in January (27.41%). Fishes identified for the food included *Nemipterus japonicus*, *Priacanthus harmur*, *Cynoglossus* sp., *Coilia dussummieri*, *Carangids*, *Bregmaceros mcclellandi* and *Rastrelliger kanagurta* (Table 2).

Gut contents of *Saurida undosquamis* also showed the presence of shrimps and that formed the second dominant group. Shrimps were found to be dominant during January (27.18%). Molluscs formed the third dominant group and were represented by squids and cuttlefishes. Other miscellaneous digested matter which could not be identified. Percentage of digested matter which was found during all the months varied from the lowest of 3.34% in April to the highest of 30.48% in June..

Among the gut contents of *Saurida undosquamis*, fishes ranked first (58.47%) followed by shrimps (23.68%), molluscs were found to be the third dominant group (6.56%) and the percentage of digested matter was 11.26%. Ggonado somatic Month-wise feeding intensity in males fishes showed low feeding intensity as high percentage of empty stomachs was observed during various months (Table 3). Percentage of low feeding (quarter full stomachs) varied from 8.42% in September to 27.01% in February. Percentage of high feeding (full stomach) was highest in March (46.36%) and lowest in the month of July (2.75%). Highest feeding intensity (gorged stomachs-20%) was found in January, followed by 17.25% in September, 16.55% in August and 16.29% in December. (Table 3)

Month -wise feeding intensity in females showed highest percentage of empty stomachs was found in September (55.45%) and the lowest in March (8.26%) (Table 4). About 60% of females appeared to have not fed during September followed by 32.84% in October and 25.27% in April. Cessation of feeding coincided with the breeding season. Percentage of low feeding (quarter full stomachs) varied from 4.05% in the month of December to 23.26% in January. Percentage of high feeding (full

Table 3. Month Wise Feeding Intensity in Males of *Saurida undosquamis*

Fullness of stomach	Jan-04	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Empty	10.15	7.21	8.26	25.27	20.03	27.63	22.3	35.56	25.45	37.84	34.42	20.28
Trace	6.62	4.62	0	0	0	26	5.37	2.44	20.55	26.32	7.15	4.05
¼	23.26	12.57	17.74	15.64	13.29	11.28	13.39	14.26	17.7	4.26	17.42	17.22
½	9.74	21.07	34.5	22.27	22.24	10.11	12.61	16.74	11.3	6.27	15.29	21.44
¾	15	23.73	0	18.64	8	8.4	7.12	10.12	10	10.52	9.42	10.15
Full	18.18	20.35	32.5	7.09	12.15	21.88	20.88	20.84	4.32	9.27	7.15	0
Grossed	17.05	10.45	7	11.09	12.03	11.23	12	3	5.68	5.52	9.15	26.86

Table 4 : Month Wise Feeding Intensity in Females of *Surida undosquamis*

Fullness of stomach	Jan-04	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Empty	0	14.2	7.09	17.36	7.09	34.36	22.3	12.27	16.34	69.42	20.85	40.85
Trace	0	15.6	0	22.64	27.01	20.19	17.7	11.21	10.41	0	47.62	0
¼	10	27.01	17.28	10.27	15.6	11.09	11.24	10.16	8.4	16.29	11.25	25.57
½	30	0	18.18	19.73	10	25.27	26.76	27.2	24	0	8.63	0
¾	10	17.66	11.09	8.21	18.18	0	19.25	12.35	14.35	14.29	11.65	17.29
Full	30	25.01	46.36	21.79	17.28	9.09	2.75	10.26	9.25	0	0	0
Grossed	20	0	0	0	8.21	0	0	16.55	17.25	0	0	16.29

Table 5. Gastrosomatic Index of*S. undosquamis*

Months	GSI (%)
Jan-04	9.383+ 1.278
Feb	11.2+ 1.234
Mar	12.133+ 0.294
Apr	8.8+ 0.521
May	10.366+ 0.760
Jun	9.1+ 0.346
Jul	10.366+ 0.760
Aug	9.066+0.697
Sep	8.416+0.741
Oct	1.533+0.871
Nov	1+0.460
Dec-04	2.3+0.750

Table 6. Season Wise Diversity Indices of the Food Items of *S. undosquamis*

Seasons	Shannon- Wiener inde (H' log 2)	(Simpson richness l, lambda)
Post monsoon	3.6106+0.1058	0.9097+0.0072
Summer	3.2889+0.1581	0.8071+0.1328
Pre monsoon	3.3187+0.2955	0.8861+0.0334
Monsoon	2.8936+0.1753	0.8325 +0.024

Table 7. Monthly Occurrence of Females(%) of *S. undosquamis* in Various Stages of Maturity

		Percentage of maturity stages					
Months	No. of fishes examined	I	II	III	IV	V	VI
Jan-04	34	20	42.2	6.1	7.8	6.8	17.1
Feb	90	45.2	43	5.3	6.5	0	0
Mar	85	46.7	51.3	1	1	0	0
Apr	61	37.7	62.3	0	0	0	0
May	70	22.4	22	10	16.5	11.9	15.2
Jun	20	56.4	43.6	0	0	0	0
Jul	19	36.5	63.5	0	0	0	0
Aug	54	20.7	25.1	18.1	9	11.1	16
Sep	72	23	22	10	16.8	12.9	15.3
Oct	120	15	21.4	7	12.5	20.4	23.7
Nov	65	10.2	12	22.3	20.3	16.2	19
Dec	78	14.1	33	5.8	12	4.1	31

Table 8. Fecundity in Various Size Groups of *S. undosquamis*

No.of fishes examined	Total length intervals (cm)	Mean total length (cm)	Mean weight (g)	Mean weight of ovary (g)	No. of eggs
6	19.5-20.4	20.1	103	6.526	19586
4	20.5-21.4	21.2	119	4.843	25951
4	21.5-22.4	22	97	5.217	22897
5	22.5-23.4	23.2	105	4.709	30590
5	23.5-24.4	24	120	5.573	29885
4	24.5-25.4	24.9	108	5.787	32869
5	25.5-26.4	26	129	5.903	39106
6	26.5-27.4	27.1	196	6.831	39359
4	27.5-28.4	27.9	215	10.207	57190
7	28.5-29.4	29	210	12.138	79282
5	29.5-30.4	30.1	280	12.828	67988
4	30.5-31.4	30.6	242	13.269	76110
5	31.5-32.4	32	290	8.215	69305

Table 9 : Month Wise Sex Ratio of *S. undosquamis*

Months	GSI (%)
Jan-04	3.28+0.22
Feb	3.09 +1.81
Mar	4.15 +2.94
Apr	4.71 + 1.06
May	5.17 + 2.34
Jun	5.12 + 2.37
Jul	5.94 + 1.53
Aug	6.07 + 2.49
Sep	6.10 + 1.93
Oct	8.27 + 2.07
Nov	10.46 + 1.64
Dec	9.30 + 1.14

stomach) varied considerably from 4.32% (September) to 31.32% during October. Similarly highest feeding (gorged stomachs) was observed in the month of December (32.86 %).

Data on diversity of prey items in the gut contents (Table 5) showed maximum value (Shannon-Wiener Index) during the postmonsoon season (3.6106±0.1058) and the minimum during the monsoon season (2.8936±0.1753). Simpson richness (1-lambda′) also showed a similar trend and the values varied from 0.8071±0.1328 (monsoon) to 0.9097±0.0072 (post monsoon) seasons. The gastro somatic index obtained for *S. undosquamis* is shown in Table 6. The index was found maximum during postmonsoon and premonsoon seasons and was found maximum in March-2011 (12.133±0.294), July (10.366±0.760) and the minimum value was observed in November (1±0.460). The females in mature conditions were observed first at 127 mm. The size at which 50% of the fish attains maturity was at 195 mm and this may be considered as the length at first sexual maturity of the population of *S. undosquamis*.

When the spawning season is considered mature and ripe females (stages IV and V) were present more during August-November with a peak in November. Females with partly spent ovaries (Stage VI) occurred from August to January with their percentage reaching maximum in December (Table 7). From these results, it was apparent that this species spawns during August to January with a peak in November. The recruitment of juveniles (from 70 mm) to the fishery was observed from February onwards.

The fecundity study reveal that the number of ova of *S. undosquamis* ranged from 19, 856 in a fish measuring from 20.1 cm in length to 79,282 in a fish of 29 cm (Table 8).The weight of above fishes ranged from 97 to 290 g. The relationship between fecundity and total length was determined by plotting the observed values in a scatter diagram (Figure 1). The relationship between fecundity and total length was found linear indicating that the fecundity increases with increase in total length. The relationship between fecundity and body weight was determined by plotting the observed values in a scatter diagram (Figure 2).The linear relationship between fecundity and body weight showed that the fecundity was increased in direct proportion to total weight.

The relationship between fecundity and ovary weight was determined by plotting the observed values in a scatter diagram (Figure 3). The relationship between

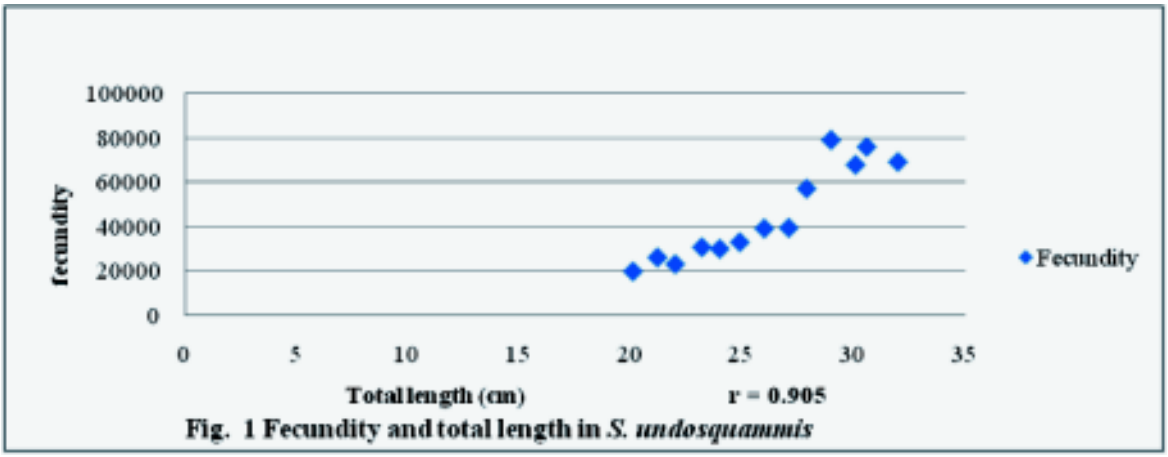

Fig. 1 Fecundity and total length in *S. undosquamis*

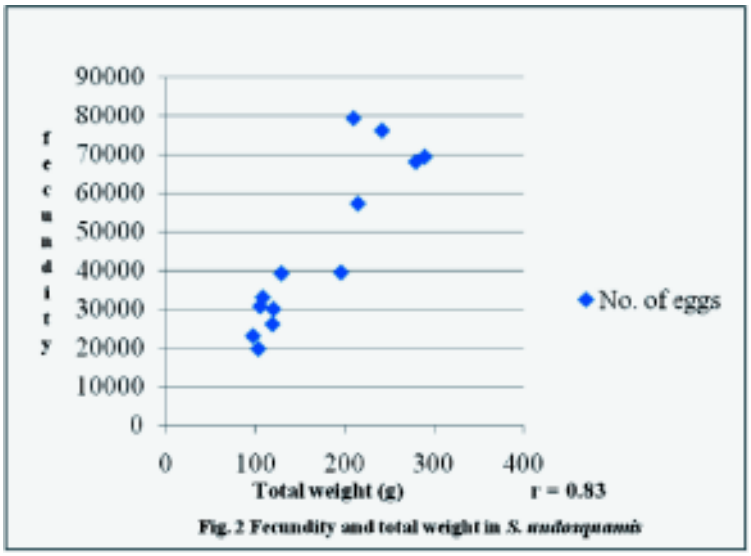

Fig. 2 Fecundity and total weight in *S. undosquamis*

fecundity and ovary weight was found linear. It was found that fecundity generally increased with increase in ovary weight. But significant differences were also observed in the fecundity of ovaries having the same weight. The fish being a total spawner, the correlation co-effecient values obtained were positive and highly significant. A total of 1,121 fishes were examined of which 510 were males and 611 females. The overall sex ratio (1:1.2) was found to deviate significantly from the expected 1:1 ratio. (Table 9). Results on gonado somatic index (Table-10) showed an increasing trend from March 2004 onwards, however, the values were more during October to December 2004with the peak during November. The higher GSI values obtained during November (10.46±1.64) indicated high spawning activity during this month. Results also revealed that *S. undosquamis* was found to be a carnivore, feeding on fishes, shrimps and molluscs (squids and cuttlefish). The gut content results showed that fish was found to be high as compared to shrimps and molluscs, indicating fish to be the preferred food item. The digested matter was also found to have fish scales, fish bones and eyeballs. Cynoglossidae (*Cynoglossus macrolepidotus*), Nemipteridae (*Nemipterus japonicus* and N. tolu), Leiognathidae(*Leiognathus* sp.,), Clupeidae (*Ilisha indica*) and Carangidae (Caranx leptolepis). They reported that Decapterus sp., was the predominant food item followed by *Nemipterus* sp., *Saurida tumbil* and *Apogon* sp.The present study results attest the earlier report of Raj kumar et al. (2003). Highest

Table 10. Gonado Somatic Index of *S. undosquamis*

Months	Male	Female	Total	Sex ratio (M:F)	Chi-square
Jan-04	44	26	70	01:01.5	6.6122
Feb	57	89	146	01:01.6	0.404
Mar	48	51	99	01:01.1	1.924
Apr	50	52	102	01:01.0	2.647
May	48	51	99	01:01.1	1.924
Jun	55	78	133	01:01.1	3.9771
Jul	48	58	106	01:01.4	0.943
Aug	54	76	130	01:01.0	3.723
Sep	40	62	102	01:01.5	4.7451
Oct	42	59	101	01:01.4	2.861
Nov	38	60	98	01:01.6	4.9371
Dec	34	54	88	01:01.6	5.1652
Overall	510	611	1121	01:01.2	19.1003

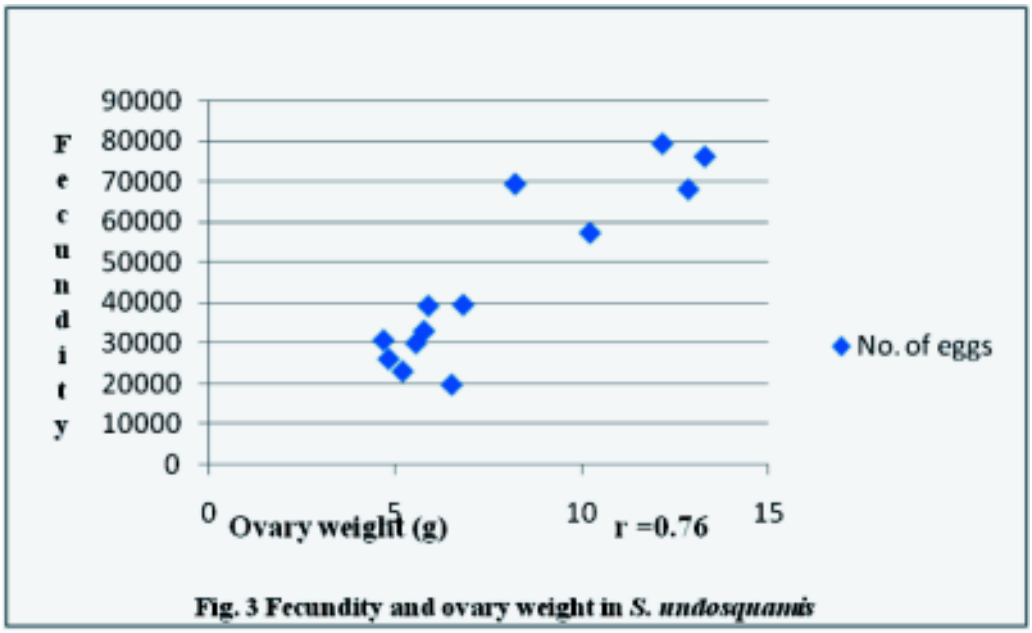

Fig. 3 Fecundity and ovary weight in *S. undosquamis*

percentage of empty stomachs was observed in October (37.84%) and the lowest in January (5.15%). It is a common fact that in most of the fishes, feeding is found to be very low during the breeding season. Thomas (1969) observed that the feeding in mature fishes declines during the breeding season, as the ovaries are enlarged and densely packed with ova, spreading out and occupying a lion share of the abdominal cavity, exerting quite a lot of pressure on the stomach.

The peak spawning season was found to be October and November. This agrees with the findings of Annigeri (1963) who reported that the peak spawning period of this fish occurring in Mangalore coast commences from October and ends in December. Thus the results obtained during the present study agree with the findings of the above workers. The length at first maturity of *S. undosquamis* in the present study was 195 mm and this agrees with the previous work of (Nandha, 1980). However, Rajkumar et al. (2003) reported the values of 230 and 240 mm, respectively from the north-western Bay of Bengal and Visakhapatnam waters. In the present study the size at first maturity was found to be lower (140 mm) than 195 mm. As this has an important bearing on the fisheries management (more than 140 mm can be caught, that way it is beneficial to fishermen with more catch) and this method is found to be advantageous.

Nikolsky (1963) pointed out that availability of food is an important factor determining the sex ratio. It was further mentioned that when food is abundant, females became more predominate, with the situation inverting in regions where food is limited. Feeding activity, in this case, would be influencing metabolism through hormonal activity, resulting in production of individuals of a given sex. Females require better environmental conditions than males, for the developments of ovary (Taghavi Motlabh et al., 2012). Females were found to dominant over males. Young males were less in number than females. However in higher age groups, females were more dominant. Both males and females were similar in the median age groups. The dominance of females over males was uniform throughout the year. The fecundity in the present study ranged from 19,856 to 79,282 eggs. Bagenal (1963) concluded that the variation in fecundity was not related to changes in hydrographic conditions, but this may be due to the variations in food availability.

In the present study, maximum values of gonado somatic Index (GSI) were observed in the months of October and November, afterwards it decreased gradually due to the cessation of spawning activity. No plant material was found in the stomachs of *S. undosquamis*. This suggests that this fish is strictly a carnivore, predominantly a piscivore. However, this fish is not a ravenous feeder and

most of them sustain themselves to low feeding intensities particularly during the spawning season (September to December).

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