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FISHERY AND BIOLOGY OF YELLOWFIN TUNA OCCURRING IN THE COASTAL FISHERY IN INDIAN SEAS

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In the recently convened Workshop on "Stock assessment of yellowfin tuna in the Indian Ocean" (FAO/IPTP, 1991) the present status of the fishery, biology and stock structure of yellowfin tuna taken by different countries bordering the Indian Ocean have been discussed, and recommednations on the development of the fishery for this species made. The status of yellowfin tuna fishery from the Indian EEZ have been dealt with by Sudarsan *et al.*, 1991; John *et al.*, 1991; James and Pillai, 1991; James and Jayaprakash, 1991 and Pillai *et al.*, 1991. Details of the yellowfin tuna fishery in the western Indian Ocean by the French and Ivory Coast purse seiners, Spanish purse seiners were also described in detail (Hallier, 1991; Marsac, 1991). The status of the coastal yellowfin tuna fishery have been discussed from different countries such as Maldives (Yesaki and Waheed, 1991 and Anderson and Hafiz, 1991); Sri Lanka (Dayaratne and Maldeniya, 1991); Mauritius (Norungee and Venkatasami, 1991); Indonesia (Naamin and Gafa, 1991); western Austrilia (Ward, 1991); Oman (Al-Abdisala, 1991) and Pakistan (Majeed, 1991). Further, the longline fishery for yellowfin tuna was discussed in detail by John *et. al.*, 1991, Sudarsan *et al.*, 1991 and FSI, 1992 (Indian EEZ); Bashmakov et al., 1991, Timochina *et al.*, 1991 and Zamorov *et al.*, 1991 (Russian longline fishery); Park *et al.*, 1991 (Korean longline fishery); Institute of Oceanography, National Taiwan University (Taiwanese longline fishery) and National Research Institute of Far Seas Fisheries (Japanese longline fishery).

The all India catch of yellowfin tuna fluctuated between 349.2 tonnes and 799.5 tonnes during the period 1987-91 as follows

Year	Effort (Units)	Catch (Kg)	C/E (Kg)
1987	389801	359259	0.92
1988	482990	349228	0.72
1989	525041	417453	0.79
1990	410371	359095	0.88
1991	403563	799468	1.98

The present production by the longline fishery both by chartered vessels and Govt. of India survey /training vessels during the period 1990 has been reported as 10,365 tonnes (chartered vessels 10352 tonnes and Govt. of India survey/training vessels 13 tonnes) (John *et al.*, 1991). Further, the catch statistics of yellowfin tuna along the east coast of Indian EEZ and Andaman sea during October-December, 1991 has been presented by FSI (1992). In the present study, the data collected from Veraval (1990-91), Cochin (1989-91), Minicoy (1989-91), Vizhinjam (1989-91) and Tuticorin (1989-91) were utilised to study the fishery, biology and stock structure of yellowfin tuna taken by the coastal fisheries. The catch, effort and C/E of this fishery at different centres of the above period are presented in Figs. 1-5.

Crafts and gears

Yellowfin tuna in the coastal fishery is chiefly taken by drift gillnets, pole and line and troll line fishery and by hooks and lines. Details of the craft and gears employed in the fishery have been presented earlier (James and Pillai, 1991).

In general, the yellowfin tuna from the Indian EEZ in recent years comprises of :

1. Seasonal landings of this species by the operation of drift gillnets, hooks and lines and troll lines, within 50m depth zone along the mainland of India.
2. Small scale pole and line fishery (live-bait) and troll line (surface) fishery in the Lakshadweep which take young yellowfin tunas, which constitute about 16% of the total tuna landings in the Island group.
3. The oceanic survey/training longline vessels of the Govt. of India and the foreign longline vessels operating in the Indian EEZ under charter agreement (Chartered vessels: 1985-90, average catch-2539 tonnes and Govt. of India survey/training vessels: 1983-90, average catch 92.8 tonnes).

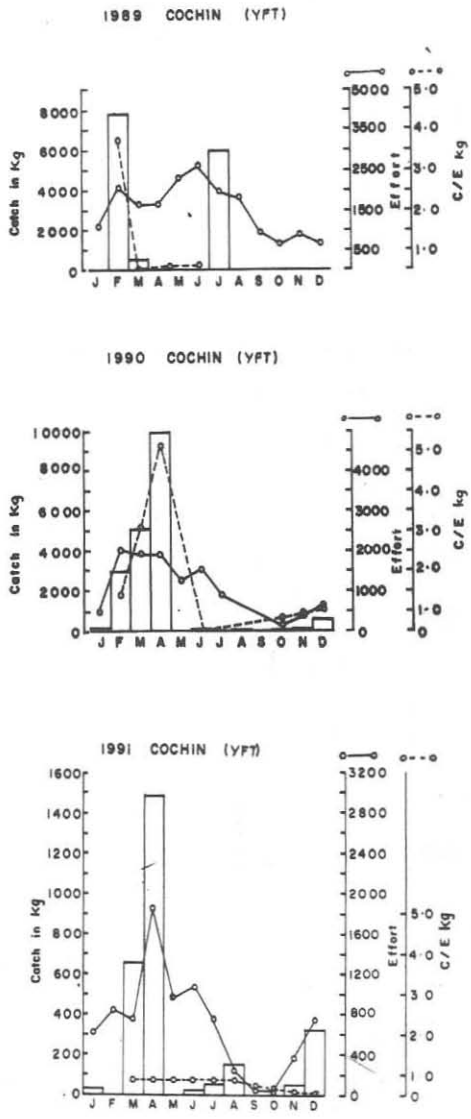

Fig 1. Catch, effort and c/f of Yellowfin tuna at Cochin, 1989-91

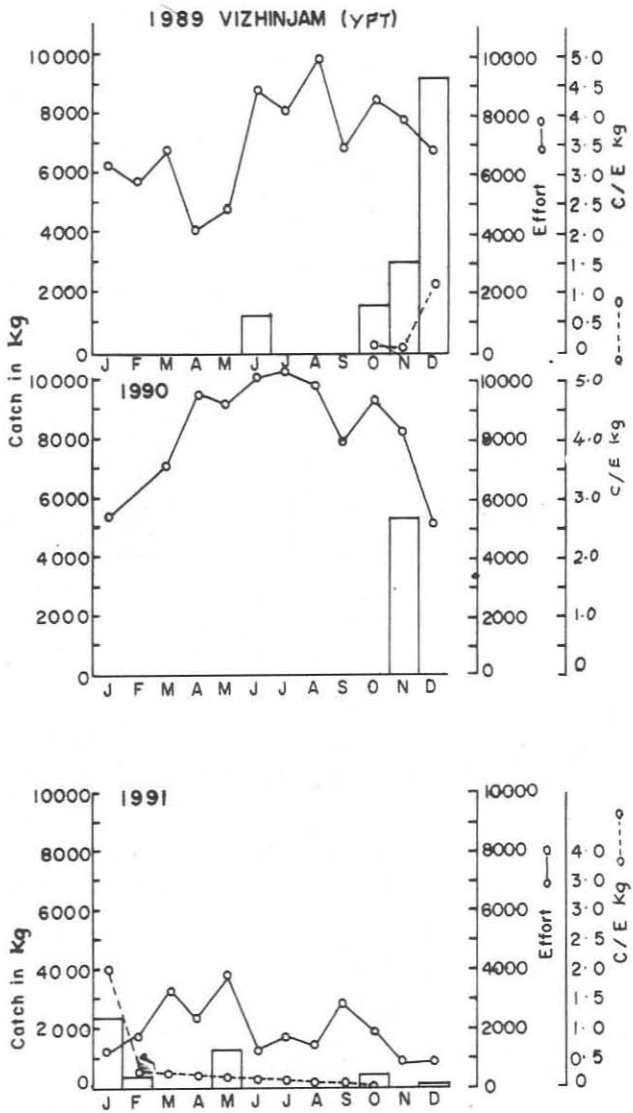

Fig 2. Catch, effort and c/f of yellowfin tuna at Vizhinjam, 1989-91

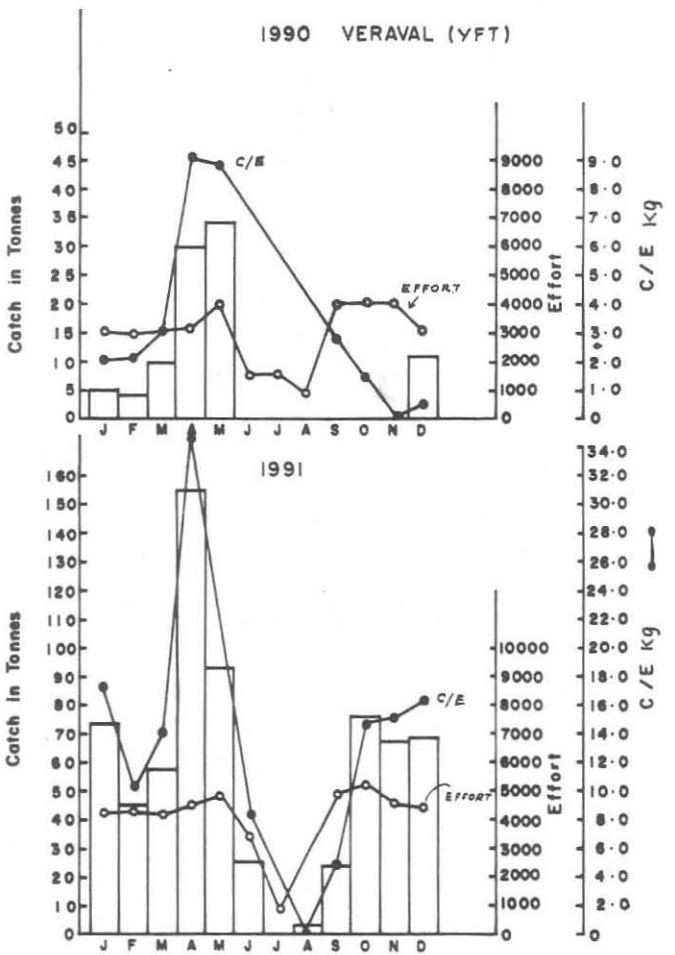

Fig 4. Catch, effort and c/f of yellowfin tuna at Veraval, 1990-91

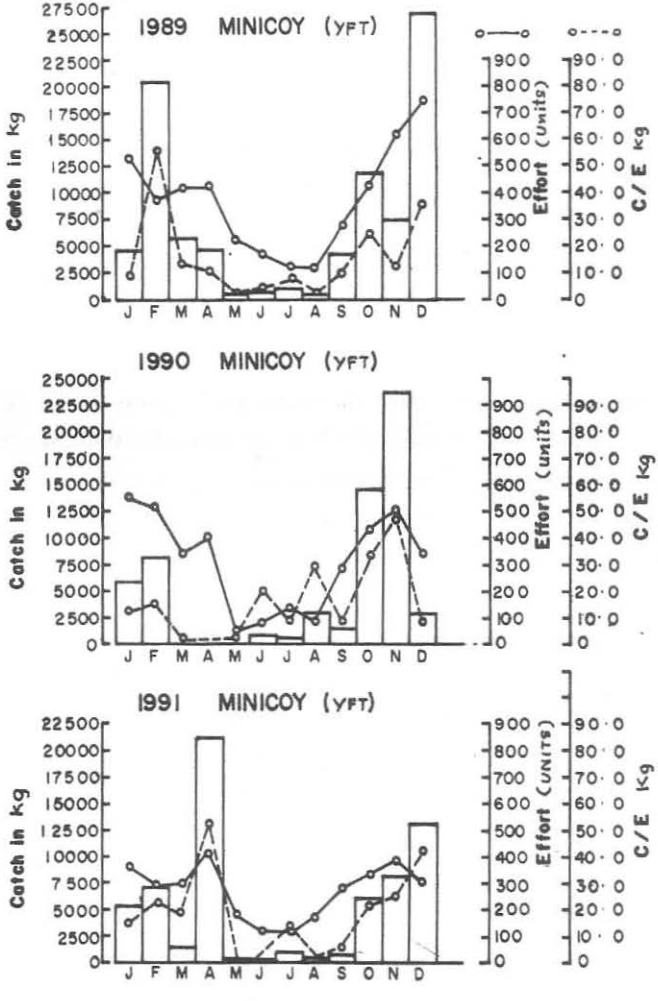

Fig 5. Catch, effort and c/f of yellowfin tuna at Minicoy, 1989-91

Biology

In veiw of the high seasonality of the fishery for yellowfin tuna in the coastal area of the mainland and around Lakshadweep, as observed earlier by Anderson and Hafiz (1986), Maldeniya and Joseph (1986), Anderson (1988) and Rochepeau and Hafiz (1991), there is limitation in the data on length frequency distribution of yellowfin tuna. However, the available data during the period 1989-91 from different centres are pooled and presented in Fig. 6. As observed, from the figure, the size of the fish ranged from 32 to 128 cm.

Length-weight relationship

Based on the relationship between length and weight of 682 specimens in the size range 32-128 cm, the relationship ($W = aL^b$) was calculated as

$$W = 0.00003852\ L^{2.7433}$$

Growth

As opined earlier, in view of the paucity of regular time series data on the monthly length frequency distribution, the available data was pooled into 4 monthly interval, and the growth parameters estimated were $L\infty = 144.06$ cm, $K = 0.44\ yr^{-1}$, $t_o = -0.44844$. The "ϕ' - prime index" (Pauly, 1980) indicates that the value is 3.96, which is in agreement with the findings of John and Reddy (1989) from the Indian EEZ. However, assuming $t_o = 0$ the size estimated for the species is as follows (Fig. 7).

Years	Size(cm)
1	51.3
2	84.4
3	105.6
4	119.3
5	128.1
6	133.8
7	137.5
8	139.8
9	141.3

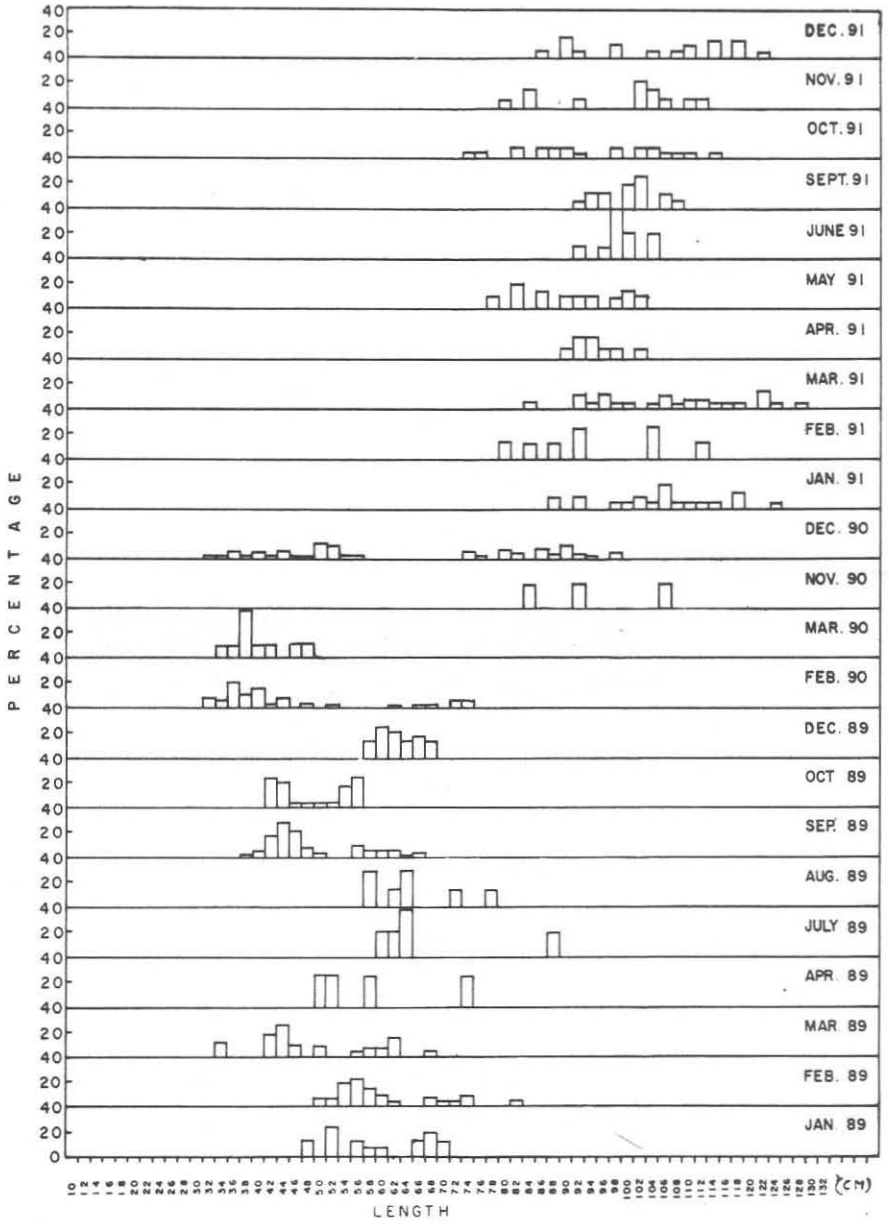

Fig 6. Pooled size distribution yellowfin tuna (January 1989- December 1991)

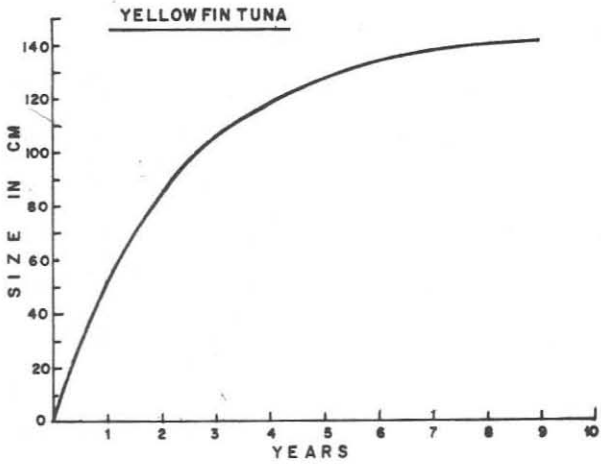

Fig. 7. Growth curve estimated for yellowfin tuna

Mortality estimates

As seen from figure, two major size groups were represented in the total catch during the period 1989-91. Hence, single estimation of 'Z' based on the entire data has not been attempted to for calculating 'Z' by Beverton and Holt (1957) method. Two sets of data were utilised *viz.*, 52-79 cm size group and 98-118 cm size group for the analysis. For the former, $\bar{L}$ was 67.0 cm and L_c 55.0 cm and for the latter $\bar{L}$ was 107.9 cm and L_c 99.0 cm. The average total mortality has been calculated as 5.21974.

Natural mortality (M) has been estimated using Rikhter and Effanov (1976) method and also *Tmax* principle. Both the methods gave an estimate of 0.6761, which has been considered here.

Stock estimate

Different methods were employed to estimate the stock structure of yellowfin tuna, such as Schaefer's model (1954, 1957), Fox model (1970) and Y/R model (Beverton & Holt, 1953) and results are presented in Fig. 8.

	Schaefer	Fox
MSY	619.5 t	700.6 t
FMSY	327844	215843

By estimating "limiting value of the function 'A" (asymptotic catch) as 1002 t, by interation method, the estimated value in the *"S & T" model* $Y = A\text{-}B\ e^{-kf}$ obtained were :

$B = 286515$

$K = 0.000001299$

$r^2 = 0.31165$

and the expected catch with effort input of 50,000 was observed to be 734 tonnes. However, in view of the low value of r^2, this result is not considered in this study.

The Yield/Recruit analysis has been carried out be employing the following parameters :

W_∞	: 31.99336 kg
K	: 0.44
t_o	: 0.448
M	: 0.6761
M/K	: 1.54
$L\ \infty$	: 144.06
L_r	: 32
L_c	: 77
T_r	: 0.122
T_c	: 1.288
Present F	: 4.54
Z	: 5.22
Y/R – MSY	: 2.419895
B/R – MSY	: 1.052128
F–MSY	: 2.3
Y/R at F	: 2.378866
Average catch (t)	: 456.9
MSY (t)	: 464.8

By taking the average catch of yellowfin tuna in the coastal fishery, for the period 1987-1991 as 456.9 tonnes, the MSY estimated was 464.8 tonnes, and the corresponding F as 2.38 which is approximately half of the present F. As the young ones of yellowfin tuna are taken in the coastal fishery mainly by pole and line and troll line gears in Lakshadweep and by drift gillnets along the mainland of India (especially southeast and northwest coasts) segregation of size (fork length) has been observed (Fig. 6). Further, the length-weight relationship estimated was based mainly on the young

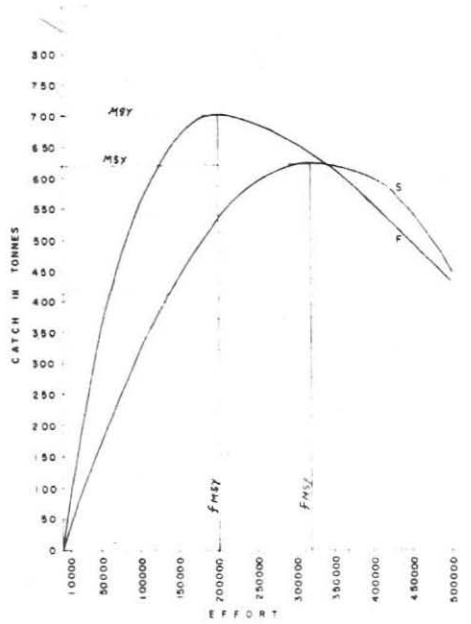

Fig. 8. MSY and FMSY of yellowfin tuna estimated by Schaefer's (S) and Fox's model (F)

yellowfin tunas taken by pole and line fishery at Minicoy. In view of the above facts, the results obtained in the Y/R analysis is not considered in this study.

Discussion

Anderson (1988) has discussed the seasonality in the catch rate and migratory pattern of Yellowfin tuna in the Maldives-Minicoy area. The appearance of yellowfin tuna along the west coast of India throws more light on the migration in the EEZ of India. James and Jayaprakash (1991) discussed in detail the probable link in the migration pattern of this species in the Indian EEZ. Further, Sivaprakasam and Patil (1986) based on tuna longline surveys in the Arabian Sea off southwest coast of India indicated a northerly migration of this species from lower latitudes to higher latitudes.

The spawning aggregation of *S. gracilis* in the Angria Bank (lat. 16°30'-16°40'N) and also concentration of *Caesio* spp. (live-bait) on the San Pedro Bank further south had been reported by UNDP/FAO/PFP (No. 6, 1974). The high hook rates of this species in the north west coast during the period October to December and also the high fishing intensity towards the middle east coast of mainland of India during January-March period (John *et al.*, 1991) by chartered vessels may be due to the concentration of forage organisms during different seasons. Recent findings by FSI (1992) of the high hooking rate of yellowfin tuna in the area 14°-80° along the east coast of the Indian EEZ (Table 1) during Nov.-Dec., 1991 is noteworthy.

Table 1. Results of Oceanic Tuna Resources Survey along the east coast and Andaman Sea by FSI vessels

Area (Latitude)	Hooking rate of YFT (%)	Vessel (Long liner)	Size (cm)	Season
13-14	1.3	Yellowfin	–	Nov-Dec 91
14-15	5.8			
15-16	0.1			
16-17	–			
17-18	–			
18-19	0.1			
16-17	0.4	Matsya Harini	91.5-138	Oct - Dec 91
17-18	0.1			
18-19	0.3			
19-20	0.4			
Andaman Sea		Blue Marlin	106-155	Oct - Dec 91
9-10	1.2			
10-11	2.2			
11-12	1.3			
12-13	1.5			
13-14	1.3			

As opined by James and Jayaprakash (1991) the yellowfin tunas are carried to the west with the north east monsoon current and returned to the east with the south west monsoon current, and also there is indication of a steady and slow northward movement during the two monsoons. Anderson (1988) and Pillai *et al.* (1991) have discussed the east-west concentration of this species along Maldive and Lakshadweep areas.

Anderson (1988) opined that the growth rate of 2.9 ± 0.4 cm/month is

nearest to the 'true rate'. According to John and Reddy (1989) the growth rate estimated was 2.74 cm/month. Reviewing the various estimates, the growth rate of 2.75 cm obtained in the present study also fall within the suggested range.

Results of stock analysis of yellowfin tuna synthesised by different models, indicate that by diversification and modification of the present pole and line fishing techniques in Lakshadweep, installation of FADs, intensification of troll line fishery, enhancement of the area of operation of gill netters and purse seiners along the mainland coast of India would assist in the expansion of the fishery of this species in the small scale sector.

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