Population Dynamics of *Saurida elongata* and *S. undosquamis* (Synodontidae) in the Southern Gulf of Thailand*

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Abstract

Length-frequency data on *Saurida elongata* and *S. undosquamis* (Synodontidae) from bottom trawl survey conducted in 1984 in the Southern Gulf of Thailand were analyzed using the Compleat ELEFAN software. The seasonal pattern of recruitment suggests two uneven pulses per year, one stronger than the other. Yield-per-recruit analyses suggested that the investigated stocks are presently overexploited. Possible sources of bias for the analyses presented here are discussed.

Introduction

The lizard fishes, *Saurida* elongata and *S. undosquamis* (Synodontidae) are commercially important species of the Gulf of Thailand. The fishes are exploited by a trawl fishery using 20-25 mm mesh size. The southern part of the Gulf, from Suratthani to Narathiwat is a well-established fishing ground. In 1980, about 40% of the total landings in the Gulf originated from there (DOF 1983).

Length-weight relationships of *S. elongata* were given by Charnprasertporn (1979). Boonwanich and Amornchairojkul (1982) estimated growth parameters and mortality of both species, based on samples taken from the upper part of the Gulf of Thailand. This area was also sampled by Sirapakhavanich (1990) who studied the population dynamics of *S. undosquamis* and by Tungkaseranee (1980) who reported on the spawning season of Synodontidae based the abundance of larvae in the plankton.

This study utilizes data from a bottom trawl survey in the southern part of the Gulf to estimate growth parameters, mortalities, recruitment and yield per recruit of both species.

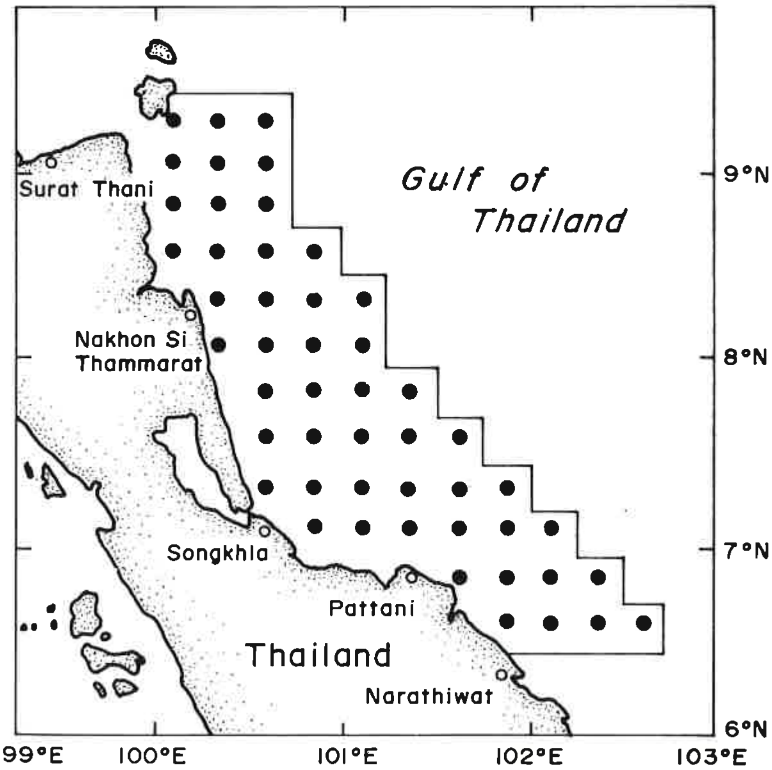

Fig. 1. Sampling area for the length-frequency data on *Saurida elongata* and *S. undosquamis* analyzed in this contribution.

Materials and Methods

Monthly length-frequency data were collected by the research vessel R/V Pramong 9 with the otterboard trawl and mesh size 25 mm, from January to September 1984 in the area defined in Fig. 1. The catches were sorted into species and the total catch of each species was recorded. The length-frequency data (total length) were grouped in 2-cm intervals from 0.5 cm entries on the punch cards used in Thailand.

A first estimate of asymptotic length (L_∞) was obtained by plotting $\bar{L}$-L′ on L′ (Wetherall 1986 as modified by Pauly 1986a), i.e.,

$$\bar{L} - L' = a + bL'$$

where $L_\infty = a/-b$

and $Z/K = (1+b)/-b$

where $\bar{L}$ is defined as the mean length, computed from L′ upward, in a given length-frequency

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sample while L′ is the limit of the first length class used in computing a value of L.

The values obtained were used to facilitate the estimation of parameters L_∞ and K of von Bertalanffy growth formula through the ELEFAN I program (Pauly 1987). Seasonal oscillations of growth were not considered.

The growth performance of different synodontid populations in terms of length growth was compared using the index of Pauly and Munro (1984):

$$\phi' = \log_{10}K + 2\log_{10}L_\infty$$

Length-converted catch curves, based on pooling of per cent samples, were used to estimate total mortality (Z). The value of Z was obtained from length-frequency data representative of a steady-state population and the equation:

$$\ln (N/(1-\exp(-Z\Delta t))) = a + bt' \quad ...1)$$

where N is the number of fully recruited and vulnerable animals of a given relative age (t′), where the slope (b), with sign changed, is equal to Z and Δt is the time needed for the fish to grow through a length class (P. Sparre, pers. comm. to Pauly 1983).

Natural mortality, M, was estimated using the empirical equation of Pauly (1980):

$$\log_{10}M = 0.0066 - 0.279\log_{10}L_\infty + 0.6543\log_{10}K + 0.4634\log_{10}T \quad ...2)$$

for a mean sea surface temperature T = 29°C.

Fishing mortality, F was then computed as F = Z - M while exploitation rate, i.e., the ratio of fishing mortality to total mortality, was computed from E = F/Z; note that F = M*E*(1-E).

The recruitment pattern was obtained by projecting the length-frequency data backward onto the time axis using the growth equation to show the number of recruitment pulses per year (Pauly 1986b) by normal separation.

Probabilities of capture were estimated via a logistic curve fitted to the probabilities obtained from the left hand side of a length-converted catch curve (Pauly 1987).

The estimation of yield per recruit (Y/R) and biomass per recruit (B/R) was done using the model of Beverton and Holt (1964, 1966) as modified by Pauly and Soriano (1986). The relative yield-per-recruit (Y′/R) and biomass-per-recruit (B′/R) curves were computed twice, once using logistic selection ogives, then assuming knife-edge selection. E_{max}, associated with maximum Y′/R was then estimated, along with $E_{0.1}$, the rate at which the marginal increase of Y′/R is 1/10 of its value at E = 0 (see also Patterson, this issue) and the value of E corresponding to 50% of unexploited B′/R ($E'_{0.5}$).

Results and Discussion

Growth Parameters

The input data for the estimation of the growth parameters of *S. elongata* are the monthly length-frequency data in Table 1. The Wetherall plot provided a preliminary estimate of L_∞ = 46.3 (Fig. 2A) subsequently refined to L_∞ = 46.1 and K = 0.94 $year^{-1}$ (Fig. 3A).

For *S. undosquamis*, the Wetherall plot gave L_∞ = 41.8 cm (Fig. 2B); subsequent refining using the ELEFAN I program led to L_∞ 40.6 cm and K = 0.6 $year^{-1}$ (Fig. 3B).

The growth parameters L_∞ = 46.1 cm and K = 0.94 of *S. elongata* compare well with the results of other authors. The index ϕ for *S. undosquamis* (ϕ′ = 3.00) is well within the range of 2.84-3.42 observed in this species (Table 3). Similarly, for *S. elongata*, where ϕ′ = 3.30 value as obtained here is within the reported range of 2.29-3.35. Thus, the growth pattern estimates reported here appear reasonable.

Mortalities, Length at First Capture and Exploitation Rate

The length-converted catch curve for *S. elongata* led to Z = 3.53 $year^{-1}$; the estimate of M obtained was 1.55 $year^{-1}$, and hence F = 1.98 $year^{-1}$ and E = 0.56. The estimated mean length at first capture was L_c = 5.9 cm.

For *S. undosquamis*, the corresponding values are Z = 4.10 $year^{-1}$, M = 1.19, F = 2.91 $year^{-1}$ and E = 0.71. Mean length at first capture was estimated as 9.4 cm. Siripakhavanich (1990) reported estimates of Z = 6.83 $year^{-1}$ for male and female *S. undosquamis* for the inner Gulf of Thailand, about twice the values found here.

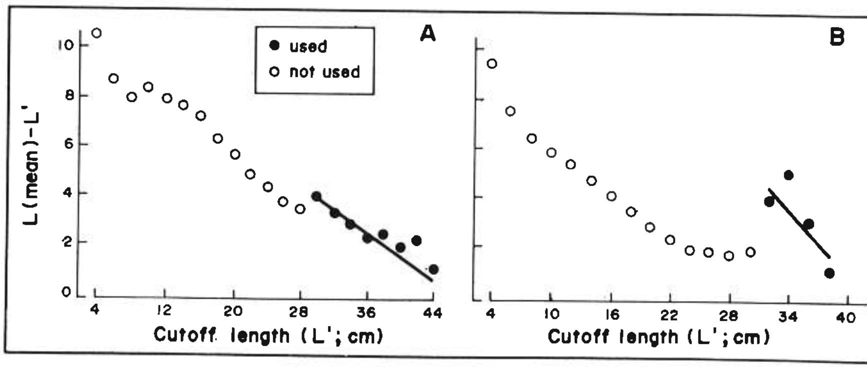

Fig. 2. Wetherall plots for data in Tables 1 (*Saurida elongata*) and 2 (*S. undosquamis*); the estimated values of L_∞ and Z/K are 46.3 cm, 3.22 and 41.8 cm, 1.2, respectively (see text).

Table 1. Monthly length-frequency data of *S. elongata* in the Southern Gulf of Thailand, January to September 1984.

Mid-length (cm)	1/15	2/15	3/15	4/15	5/15	6/15	7/15	8/15	9/15	Prob. of Capture
5	3	1	70	8	13	2	1	0	0	0.046
7	10	38	123	276	197	181	51	7	23	0.977
9	23	41	86	448	443	125	199	33	41	1.000
11	10	68	28	90	168	93	174	46	61	1.000
13	1	99	13	37	74	109	138	97	80	1.000
15	2	47	15	23	30	119	74	108	76	1.000
17	3	26	17	5	15	83	42	59	52	1.000
19	5	20	17	7	9	63	99	101	58	1.000
21	5	18	5	4	6	37	98	67	54	1.000
23	31	16	3	13	9	12	68	80	45	1.000
25	12	28	13	20	6	3	25	68	41	1.000
27	6	46	29	22	31	3	7	29	27	1.000
29	7	27	15	24	26	3	16	21	27	1.000
31	1	8	17	5	5	1	4	4	2	1.000
33	0	10	12	6	9	1	3	3	1	1.000
35	0	2	2	7	6	3	5	6	1	1.000
37	0	3	5	0	4	0	9	4	1	1.000
39	0	1	2	2	0	0	0	2	0	1.000
41	0	1	1	0	0	0	3	0	0	1.000
43	0	0	0	0	0	0	1	0	0	1.000
45	0	0	0	0	0	0	0	0	1	1.000
Number	119	500	473	997	1051	838	1017	735	591	
Wt.(kg)	8.74	32.69	24.97	27.07	29.26	22.10	47.26	50.75	37.50	

*Probabilities of capture and/or recruitment from left side of catch curve.

Table 2. Monthly length-frequency data of *S. undosquamis* in the Southern Gulf of Thailand, January to September 1984.

Mid-length (cm)	J	F	M	A	M	J	J	A	S	Prob. of Capture*
5		15	126	4			16		7	0.018
7	3	121	550	439	231	16	240	99	38	0.103
9	13	183	484	686	536	100	261	229	90	0.414
11	2	190	316	368	424	208	285	220	138	0.814
13	7	171	262	166	246	72	360	218	225	0.964
15	12	130	118	155	163	36	362	254	255	0.994
17	10	83	100	114	126	28	373	167	173	0.999
19	18	57	103	86	91	25	249	181	162	1.000
21	3	48	72	56	65	6	65	103	123	1.000
23	3	24	21	24	43	5	31	47	81	1.000
27	0	15	5	6	15	2	17	13	20	1.000
29	1	6	2	5	4	0	3	2	7	1.000
31		1	0		0	1	1	5		1.000
33			0		1					1.000
35			0							1.000
37			0							1.000
39			1							1.000
										1.000
Number	79	1103	2239	2206	2002	516	2296	1693	1488	
Wt.(kg)	3.26	32.84	38.64	40.17	44.91	10.12	66.28	59.67	68.16	

*Probabilities of capture and/or recruitment from left side of catch curve.

Recruitment Pattern

The recruitment patterns (not shown) suggest that, for both species, annual recruitment consists of two uneven seasonal pulses. This confirms Sinoda and Intong (1978), who found two pulses of recruitment in *S. undosquamis*, in March-April and November-December.

Yield per Recruit and Biomass per Recruit

Fig. 4 shows the results of the Y'/R and B'/R analysis for *S. elongata* (A, B) and *S. undosquamis* (C, D). The computed optimal exploitation rates and corresponding fishing mortalities are given in Table 4. F_{max} values were 1.09 for *S. elongata* and 0.95 for *S. undosquamis*, well below present values of 1.98 and 2.91 $year^{-1}$, respectively. These two fish species thus appear to be overexploited in terms of both Y'/R and B'/R.

Although the bottom trawl survey may not have given a good absolute indication of the state of the stock, these results may be still useful for a better understanding of the dynamics for two species studied here. Particularly, the need for decreasing fishing effort at the corresponding fishing mortality has been made evident.

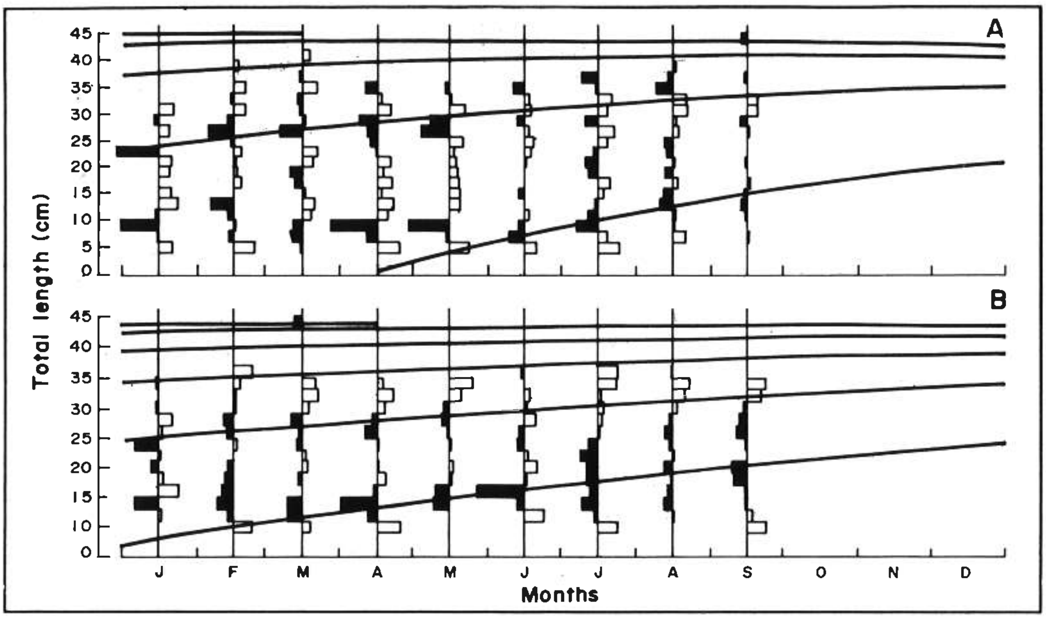

Fig. 3. "Restructured" length-frequency data on superimposed growth curves for *Saurida elongata* (A) and *S. undosquamis* (B) from the Southern Gulf of Thailand (see text for parameter estimates).

Table 3. Available estimates of growth parameters and ϕ' for various *Saurida* species.

Area	Sex	L_∞ (cm)	K (year^{-1})	ϕ'	Source
S. elongata					
Upper part of the Gulf, Thailand	M	37.70	1.24	3.25	Boonwanich and Amornchairojkul (1982)
	F	41.60	1.19	3.31	
Gulf of Thailand	M	40.00	1.22	3.29	Sommani (1989)
	F	42.40	1.24	3.35	
Southern Gulf, Thailand	-	46.10	0.94	3.30	This study
S. undosquamis					
Inner Gulf of Thailand	-	37.90	0.89	3.11	Pauly (1978), based on Kühlmorgen-Hille (1970)
Gulf of Thailand, off Prachuap-Khirikhan	-	41.30	1.13	3.28	Pauly (1978), based on Kühlmorgen-Hille (1970)
Mediterranean, Israel Coast	-	31.50	0.70	2.84	Pauly (1978), based on Ben Yami and Glaser (1974)
Upper part of the Gulf, Thailand	M	31.00	1.89	3.26	Boonwanich and Amornchairojkul (1982)
	F	36.00	1.64	3.33	
Inner Gulf, Thailand	M	32.50	1.60	3.23	Sommani (1989)
	F	42.30	1.02	3.26	
Gulf of Thailand	M	31.80	1.62	3.21	Sommani (1989)
	F	43.00	0.96	3.25	
Upper part of the Gulf, Thailand	M	30.30	2.34	3.33	Siripakhavanich (1990)
	F	35.20	2.13	3.42	
Southern Gulf Thailand	-	40.60	0.60	3.00	This study
S. tumbil					
Manila Bay, East China Sea	-	43.60	0.43	2.91	Pauly (1978), based on Tiews et al. (1972)
East China Sea, Taiwan	M	68.70	0.12	2.75	Yeh et al. (1977)
	F	74.20	0.10	2.74	
Gulf of Tonkin, Vietnam	M	78.30	0.08	2.69	Yeh et al. (1977)
	F	79.50	0.10	2.80	

Table 4. Estimation of the optimum level of the exploitation rates and fishing mortalities of *S. elongata* (TL_∞ = 46.1 cm, K = 0.94 year^{-1}, M = 1.55 year^{-1}) and *S. undosquamis* (TL_∞ = 40.6 cm, K = 0.60 year^{-1}, M = 1.19 year^{-1}).

Species/selection type	E_{max}	$E_{0.1}$	$E_{0.5}$	F_{max}	$F_{0.1}$	$F_{0.5}$
S. elongata						
Selection ogive	0.413	0.353	0.264	1.091	0.846	0.556
Knife-edge selection	0.415	0.352	0.264	1.100	0.842	0.556
S. undosquamis						
Selection ogive	0.444	0.423	0.272	0.950	0.872	0.445
Knife-edge selection	0.447	0.429	0.272	0.962	0.894	0.445

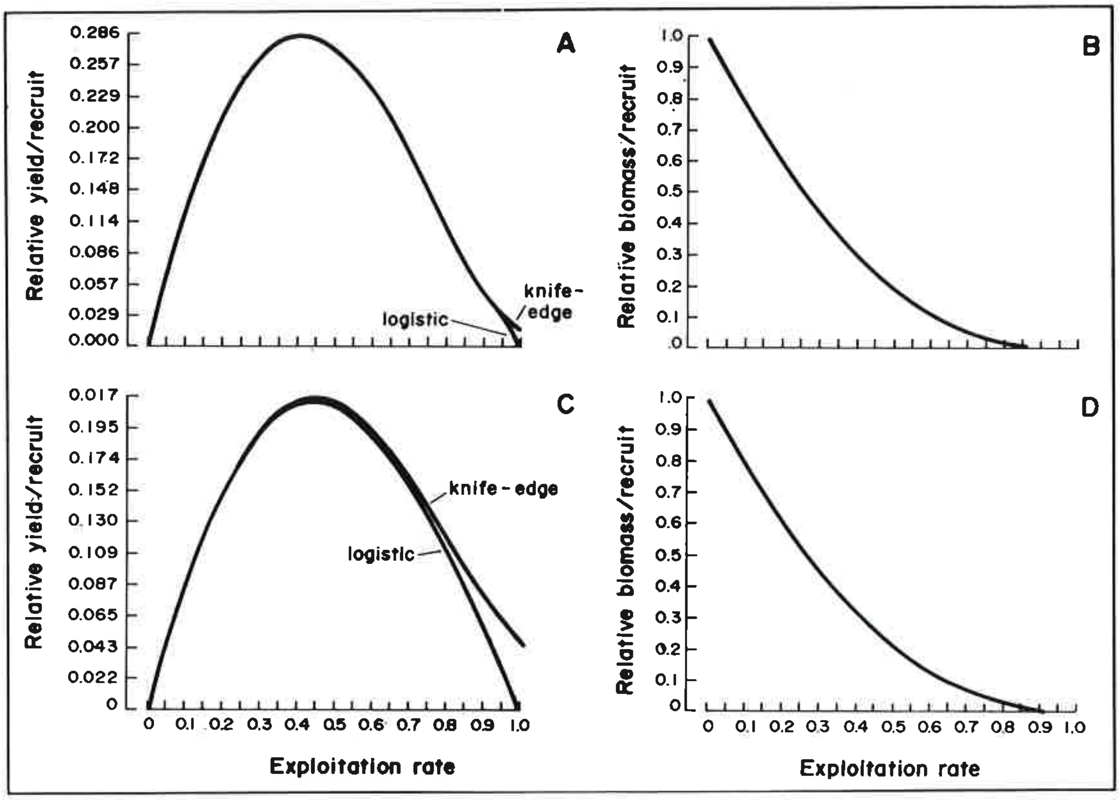

Fig. 4. Relative yield-per-recruit (A, C) and relative biomass-per-recruit (B, D) analyses for *Saurida elongata* (A, B) and *S. undosquamis* (C, D) in the Southern Gulf of Thailand for two types of selection curves. Note similarity of estimates (especially for B, C).

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