Estimation of Growth Parameters in *Panulirus penicillatus* Using a Wetherall Plot and Comparisons with Other Lobsters

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Introduction

Growth parameters are the basic inputs into various models for assessing the status of fishery resources. These parameters can be derived from three basic types of observations: a) tagging, b) reading of periodic markings on skeletal parts such as scales, otoliths or bones, and c) size-frequency data (Pauly 1983). Because of the common difficulty of determining the age in crustaceans, periodic marking on skeletal parts of the body cannot be used and hence length-frequency data are the most common data used in the estimation of growth parameters.

Length-frequency data may be analyzed using, among others: a) the Bhattacharya method, b) modal progression analysis, c) Cassie's method, d) the parabola method, or e) the ELEFAN I Program. Several of those methods require expertise in separating samples into their component distribution and fitting of growth curves (Sparre 1985). One of the most recent methods of estimating L_∞ is the use of Wetherall's method (Wetherall 1986). The present contribution shows an application of this method to the lobster *Panulirus penicillatus.*

Materials and Methods

Length-frequency data were collected in San Vicente, Cagayan from March 1987 to February 1988. Carapace length measurements were done every time when *P. penicillatus* were landed by fishermen who had picked then by hand ("mandarakma") and by spearfishermen ("panero" or "compressoran").

Table 1 summarizes the length-frequency data that were collected.

The Wetherall plot can be expressed by:

$$L_i = a + b\,L'_i \qquad \text{... 1)}$$

Table 1. Data for estimating L_∞ and Z/K of *Panilurus penicillatus* from San Vicente, Santa Ana, Cagayan, Philippines, 1987-1988, using Wetherall's (1986) method.

Lower class limit (mm)	Frequency Distribution (%) Females	Males
20	0.0896	0.1644
25	-	0.0548
30	0.1344	0.0548
35	0.3584	0.4384
40	6.3172	3.5068
45	11.6487	9.3699
50	16.7114	12.5479
55	14.8746	13.7534
60	14.8746	15.1233
65	9.7670	9.6438
70	9.0502	9.8082
75	5.0179	6.6885
80	3.0914	4.1096
85	2.6434	3.3973
90	2.3297	2.0822
95	0.9857	2.2466
100	1.0753	2.1370
105	0.5376	1.6986
110	0.3136	1.5890
115	0.0896	0.7671
120	-	0.2192
125	0.0448	0.2740
130	0.0448	0.1644
135	-	0.0548
140	-	0.1096

where L_i are successive mean lengths, computed from successive cut-off lengths (L'_i). From equation (1), L_∞ and Z/K can be computed from:

$$L_\infty = a/(1-b) \qquad \text{... 2)}$$

and

$$Z/K = b/(1-b) \qquad \text{... 3)}$$

respectively.

To separate Z/K into Z and K, the growth performance index (ϕ') was used, i.e.,

$$\phi' = \log_{10}K + 2\log_{10}L_\infty \quad ...4)$$

(Pauly and Munro 1984); estimates of ϕ' for male and female palinurids were obtained from literature data.

Results and Discussion

Fig. 1 presents the Wetherall plots for male and female *P. penicillatus;* Table 2 presents the numerical results. Note the values of L_∞ = 161 mm for males and 153 mm for females. Table 3 presents growth parameters and ϕ' values for some palinurids; the approximate values of K estimated via ϕ' are 0.131 year^{-1} for the males and 0.172 year^{-1} for the females.

Table 2. Parameter estimates of Wetherall plots in Fig. 1 for *Panilurus penicillatus.*

Parameter	Females	Males
a	23.7	31.4
b	0.8453	0.804
r2	0.998	0.998
L_∞	153	161
Z/K	5.46	4.12

Multiplying the values of Z/K in Table 2 with these estimates of K gives Z = 0.54 year^{-1} for males and Z = 0.94 year^{-1} for female *P. penicillatus* in Sta. Ana, Cagayan, Philippines.

An appropriate interpretation of these results and their implication for management of the fishery requires a detailed knowledge of the biology and fishery of this lobster (Arellano 1988), themes not followed upon here.

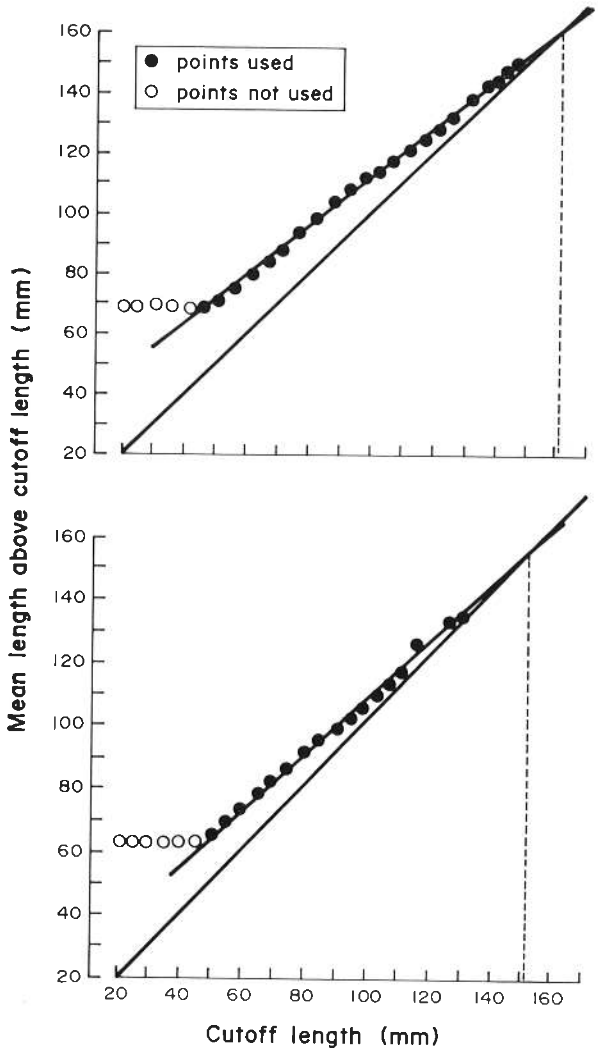

Fig. 1. Wetherall plots used to estimate L_∞ and Z/K in males (above) and females *Panulirus penicillatus* from Sta. Ana, Cagayan, Philippines.

Table 3. Comparison of growth parameters and growth performance (ϕ') in *Panilurus* spp., as used to estimate K in *P. penicillatus* from Sta. Ana, Cagayan, Philippines.

Species	Sex	Location	L_∞(mm)	K(year^{-1})	ϕ'[a]	Source
P. longiceps	both	Aquaria/Australia	113	0.459	3.768	Chittleborough (1976)
P. homarus	M	Durban, S. Africa	120	0.177	3.406	Smale (1978)
	F	Durban, S. Africa	94.2	0.337	3.476	Smale (1978)
P. penicillatus	M	Enewetok Atoll,	146	0.211	3.653	Ebert and Ford (1986)
	F	Marshall Islands	96.5	0.580	3.732	Ebert and Ford (1986)
P. penicillatus	M	Sta. Ana, Cagayan,	161	0.131[d]	3.530[b]	This study
	F	Philippines	153	0.172[e]	3.604[c]	This study

[a] $\phi' = \log10K + 2\log10L$ (Pauly and Munro 1984)
[b] Mean of two other male values
[c] Mean of two other female values
[d] Estimated from L_∞ = 161 and ϕ' = 3.530
[e] Estimated from L_∞ = 153 and ϕ' = 3.604

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Indicators of Fishing Pressure in the Deepsea Snapper Fishery of the Kingdom of Tonga*

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Introduction

The commercial development of the bottom fishery in Tonga began in 1980. It is now Tonga's largest commercial fishery. Currently, there are 43 boats in the fleet, ranging in size from 6 to 11 m. These boats use the FAO-designed Western Samoan hand reel with a multiple hook terminal rig (Mead 1979). The boats fish both the shallower fishing banks and the deeper seamounts at depths ranging from 50 to 450 m. Only the seamount fishery is examined here. As an estimate of size of fishing grounds, the length of the 200 m isobath on the seamounts alone was found to be 294 nautical miles (Fig. 1).

In October 1986, the Fisheries Division of Tonga implemented a 5-year resource assessment program on the commercial fishery for deepwater snappers and groupers in Tonga.

The most recent analysis of the catch and effort data showed that although the fishery shows no signs of overexploitation when viewed as a whole, and the level of fishing mortality is relatively low ($F = 0.3$ year^{-1}), depletion has occurred at individual seamounts (Langi et al., MS).

We examined the data on length and species composition with the aim of finding signals of overexploitation.

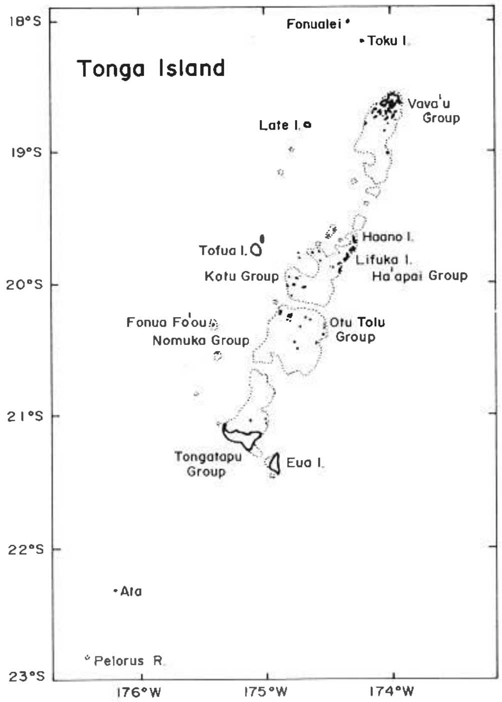

Fig. 1. Fishing groups for bottom fish: Kingdom of Tonga.

*Preliminary results based on a paper written during a Workshop on Length-Based Methods in Fisheries Analysis, 5-17 Dec. 1988, Honiara, Solomon Islands (see Fishbyte 7(1):11-12).