Estimation of Growth Parameters for the Spiny Lobster (*Panulirus argus*) in Jamaican Waters

MILTON HAUGHTON AND WARREN SHAUL
Fisheries Division
Kingston, Jamaica

ABSTRACT

La langosta (*Panulirus argus*) es la pesquería más importante en Jamaica y es mercadeada por la industria de turismo local y se exporta hacia los Estados Unidos. Jamaica ganó aproximadamente 1.5 millones de dólares en intercambio extranjero de la exportación de langosta hacia los Estados Unidos, en 1985 (Departamento de Comercio de los Estados Unidos, 1986). El propósito de este estudio fue determinar los parámetros de crecimiento de Panulirus argus. Estos estimados son necesarios para determinar el tamaño óptimo de captura y determinar rendimiento óptimo. Los para ametros de crecimiento para hembra y macho de Panulirus argus fueron determinados por análisis de progresión modal de los datos sobre frecuencia de largos obtenidos de los desembarcos comerciales. Usamos el análisis de progresión modal contenidos en el método ELEFAN I (Pauly y David 1981; Pauly 1985; Thiam, sin publicar) y usando una computadora HP 87XM. El largo asintótico (Lala) obtenido fue de 184mm para las hembras y de 193mm para los machos. La tasa de crecimiento (K) a la cual la langosta llega a tamaño asintótico, fue de .48mm por año para las hembras y de .53mm por año para los machos.

INTRODUCTION

The common spiny lobster (*Panulirus argus*) is a very important marine resource in Jamaica. It is widely used in the local tourist industry and is becoming an increasingly important foreign exchange earner. In 1985, Jamaica earned approximately US $1.5 million from the exportation of lobster to the United States (U.S. Dept. of Commerce, 1986).

The substantial devaluations of the Jamaican dollar between 1983 and 1985 significantly improved the competitiveness of Jamaican spiny lobster in the U.S. market. As a direct consequence, local spiny lobsters, which until the early 1980's were harvested mainly by artisanal fishermen concurrently with reef fishes in Antillean Z traps (Munro, 1974), have now become the object of an industrialized fishery using specialized wooden lobster traps.

The purpose of this study was to estimate K and L_∞ for *Panulirus argus* in Jamaican waters. Estimates of growth parameters and growth curves are necessary in order to determine minimum harvest size of individual lobsters and provide estimates of optimum or maximum yield.

MATERIAL AND METHOD

The length frequency data analyzed in this paper were collected from both the industrial and artisanal fisheries that take place on the Pedro Bank. The two samples collected during November and December, 1985 were taken from the industrial fishing vessels while the five samples collected between January and April, 1986 came from artisanal fishermen.

The industrial fishing boats use between 1,500—2,000 wooden traps each and fish exclusively for lobster. As soon as the lobsters are taken on board the vessels, the tails are separated from the heads, washed with a dilute solution of sodium bisulphate, packed in plastic bags and refrigerated. The carapaces (heads) are usually discarded at sea. Since it was not possible to obtain carapace measurements, the length of the telsons (tails) were measured to the nearest millimeter on board the vessels as soon as they arrived at the landing sites. The length of the telson is the distance from its tip to the groove of its connection with the last tail segment. The tail is opened flat while being measured. Carapace lengths are reported by most researchers and resource managers, so all telson measurements were converted to carapace length by regression analyses. The regression equations were computed by taking measurements of both carapace and telson lengths of lobsters in samples from the commercial catches off the Pedro Bank and the South Jamaican shelf.

The artisanal fishermen use Antillean Z traps to capture lobsters concurrently with reef fishes. The traps are usually baited with cowhide. The fishermen report that the use of cowhide as bait significantly increases the number of lobsters caught. The lobsters caught by the artisanal fishermen are usually landed whole and alive. Measurement of the carapace lengths of these lobsters were done at Key West Caribbean Limited, a major lobster processing plant in Kingston, Jamaica. The length of the carapace is the distance from the front edge of the depression between the rostal horns to the back edge of the carapace. Most of the lobsters from the Pedro Bank are sold to this plant. Measurements were taken when either the fishermen, or the "middle men" who buy from the fishermen, arrived at the plant with the lobster.

The length frequency samples collected from the two fisheries differ in that large individuals were absent in the samples collected from the industrial fishing boats. The fact that both fisheries take place on the same fishing ground with the different traps set side by side at times (Clement Lue, pers. comm.), suggest that the wooden traps operated by the industrial boats are more selective than the Antillean Z traps with respect to the large individuals of *Panulirus argus*. This is not surprising because the lobster caught by these boats are for the export market which has a preference for medium size lobster.

The ELEFAN 1 method (Pauly and David, 1981; Pauly, 1985) was used to estimate the growth parameters of *Panulirus argus* using an HP 87 XM microcomputer in the North Sea Centre, Hirtshals, Denmark. The ELEFAN 1 programme is designed to eliminate the subjectivity that is inevitably involved when growth curves are fitted to length frequency samples by eye inspection. One of the main feature of ELEFAN 1 is that many (several thousand) different growth curves are tested on the data using different combinations of growth parameters and starting points (a fixed point through which the curve is forced to pass). The combination of growth parameters that produces the best growth curve is then selected.

LITERATURE REVIEW ON GROWTH

The biology, ecology, bionomics, and fisheries of *Panulirus argus* in Jamaican waters have been described by Munro (1974) and Aiken (1977 and 1983). The growth rate of *Panulirus argus* has been investigated in detail by several authors. Growth in spiny lobster is a function of two processes, the frequency of molt (the intermolt period) and the change in size during the molt

(molt increment) (Davis and Dodrill, 1979). On average, *Panulirus argus* molt four times per year with an intermolt increment in carapace length (CL) of between 5—8 mm (Munro, 1974; Gulf of Mexico and South Atlantic Fishery Management Councils, 1982). However there is no hard evidence suggesting that either the intermolt period or the molt increment remain the same over the life span of *Panulirus argus*. The smaller (younger) individuals would be expected to molt more frequently while the larger (older) individuals would be expected to molt less frequently (Munro, 1974). Witham, *et al.*, (1968; cited from Munro, 1974) observed, under aquarium conditions, a juvenile that grew from the puerulus stage to a juvenile of 15 mm CL in seven molts over 183 days. Davis (1978) found, during field investigations of tagged juvenile spiny lobsters, that the intermolt period of *Panulirus argus* between 34—84 mm CL was independent of size.

Male and female *Panulirus argus* have different growth patterns and growth rates. Davis and Dodrill (1979) reported that in Dry Tortugas, adult males had a mean growth rate of 22.9 mm CL per year, whereas adult females had a mean growth rate of 7.3 mm CL per year. The intermolt period was the same for both sexes; however, the molt increments in the females were much less than in the males possibly because of egg bearing. In juveniles, the growth rate appears to be independent of sex (Davis and Dodrill, 1979).

Growth rates are also affected by environmental factors, especially temperature (Gulf of Mexico and South Atlantic Fishery Management Councils, 1982). Tamm (1980) reported that experiments with various members of the Palinuridae family held in captivity demonstrated that growth rates could be improved by manipulating environmental factors, particularly temperature. In general growth was faster at higher temperatures.

Another important factor that affects growth rate in lobster is injury. Davis and Dodrill (1979) conducted a study on the effect of injury on the growth rate of *Panulirus argus* in Florida Bay and in Biscayne Bay in Florida. They found that in Biscayne Bay the growth rates for injured and uninjured juveniles were 16.1 mm CL per year and 26.5 mm CL per year respectively. In Florida, the growth rates were reported to be 38.5 mm CL and 40 mm CL per year for injured and uninjured juveniles lobsters respectively. Natural injury rates varied from 30 percent for juveniles in Biscayne Bay to 13 percent for juveniles in Florida Bay. Fishing increases injury rates in the population. Davis and Dodrill (1979) reported that during the fishing season in Biscayne Bay, the injury rate in the population increased from 30 percent to 50 percent.

Estimates of growth coefficient (K) found in the literature range from 0.10 per year to 0.44 per year (Gulf of Mexico and South Atlantic Fishery Management Councils, 1982). Waugh (1980; cited from Gulf of Mexico and South Atlantic Fishery Management Councils, 1982) working in the Bahamas computed K values by size class and sex. He obtained values of 0.10 per year for lobsters with carapace length greater than 76 mm and less than 86 mm and 0.26 per year for lobsters with carapace length greater than 50 mm and less than 76 mm.

Munro (1974) calculated growth parameters using the results of tagging experiments conducted in Florida by Little (1972), and in Belize by Miller (pers. comm. to Munro). Because the samples were small, Munro combined the two data sets and used the Ford-Walford plot to estimate growth parameters. Males and females were not treated separately because of the small size of the samples.

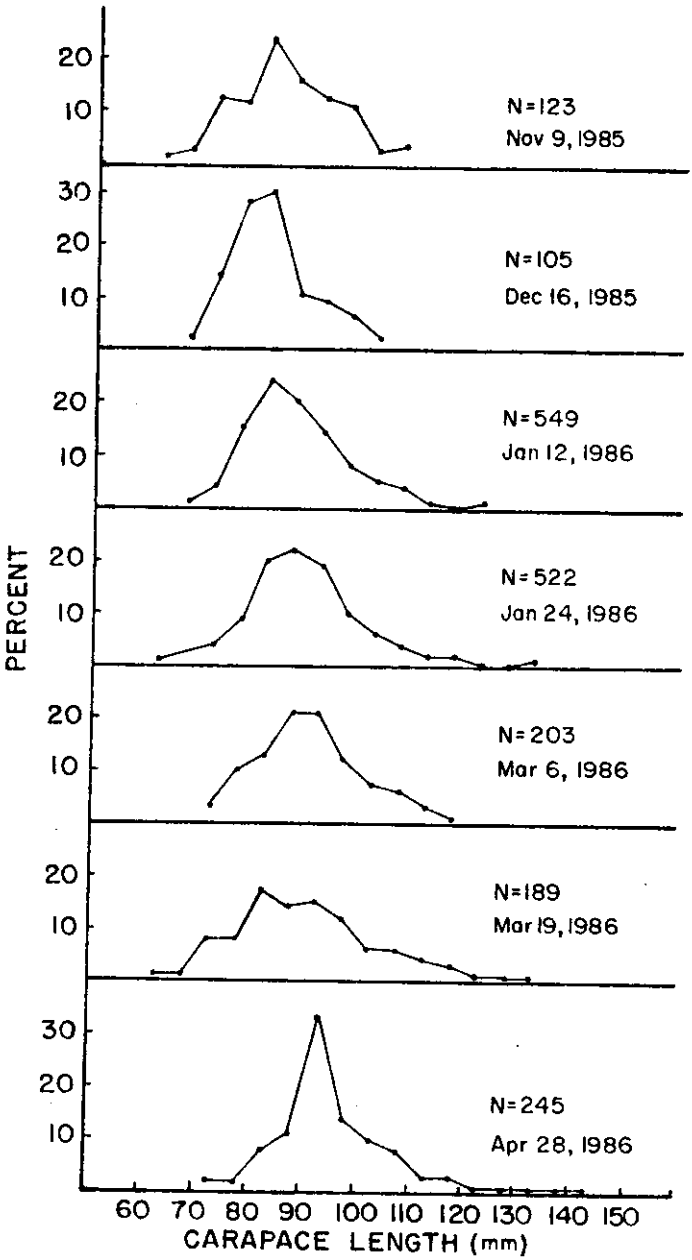
PERCENT
N=123
Nov 9, 1985
N=105
Dec 16, 1985
N=549
Jan 12, 1986
N=522
Jan 24, 1986
N=203
Mar 6, 1986
N=189
Mar 19, 1986
N=245
Apr 28, 1986
60 70 80 90 100 110 120 130 140 150
CARAPACE LENGTH (mm)

Figure 1.

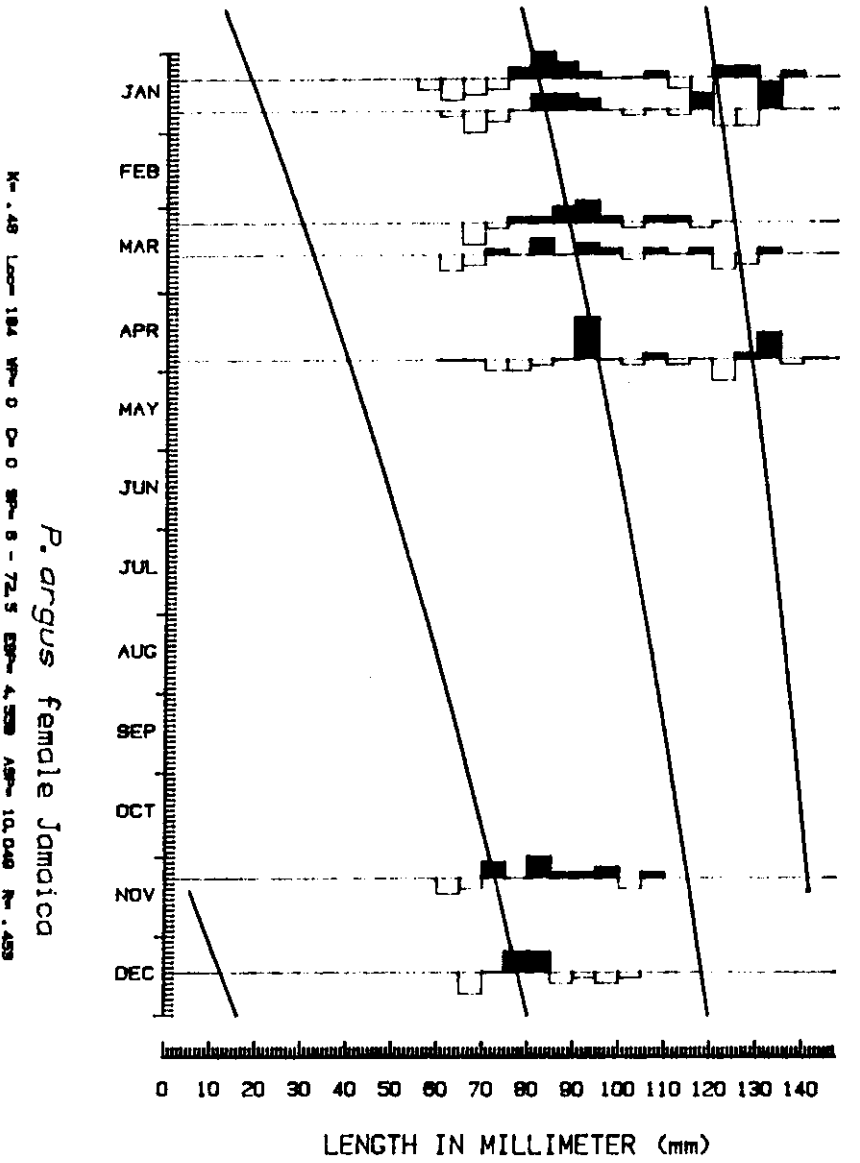
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
P. argus female Jamaica
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
LENGTH IN MILLIMETER (mm)

Figure 3.

DISCUSSION

The estimated growth parameters for *Panulirus argus* in Jamaican waters are high when compared with those reported in the literature from other areas within the WECAF Region. The literature does however suggest that growth in *Panulirus argus* varies significantly from place to place. Mean annual growth rates of 21.3 mm CL and 40.0 mm CL have been reported for juvenile *Panulirus argus* in Biscayne Bay and Florida Bay respectively (Davis and Dodrill, 1979). Growth parameters are stock specific parameters (Sparre, 1985) and are therefore expected to have different values in different stocks of lobsters.

The growth curves and parameters obtained represent a first approximation only and are not considered precise estimates. These parameters describe growth in that part of the population of *Panulirus argus* that is exploited by the fisheries. They do not describe the larval and perhaps the first juvenile stages in the life history. Finally they were computed from samples covering a relatively short time period.

The growth curves in Figures 3 and 4 describe the average growth of a cohort of *Panulirus argus* rather than the growth of an individual lobster. The growth curve of a particular individual would be represented by a "stepwise curve" as a consequence of the molting process.

The difficulty of separating the intermolt period and growth increment per molt has been cited as a major problem in obtaining accurate estimates of growth in *Panulirus argus* (Gulf of Mexico and South Atlantic Fishery Councils, 1982). Modal progression analysis using length frequency data is one way of overcoming this problem. The modal progression of the cohorts can be followed with time and used to estimate growth. Figures 1 and 2 show that there was a progression of modal lengths with time. Munro (1974) was able to follow cohorts of *Panulirus argus* from the Port Royal Reefs, as they increased from modal size of 67.5 mm CL in May - June 1970 and 1971 to 82.5 mm CL by November to December of the same year. Unfortunately Munro did not use this information to estimate growth.

ACKNOWLEDGEMENT

We wish to express our sincere appreciation to those persons who have assisted us in the preparation of this paper. Special mention is due to Djiby Thiam from the Centre de Recherces Océanographiques de Dakar - Thiaroye, Senegal, for his kind assistance with the computer processing of the data, Dr. Erik Ursin from the Danish Institute for Fisheries and Marine Research for his wise comments and encouragement, Karl Aiken from the U.W.I. for reviewing the manuscript, and Daniel Reifsteck from the Fisheries Division, Jamaica for his assistance in the collection of the data.

REFERENCES

Aiken, K.A. 1977. Jamaica spiny lobster investigations. FAO Fish Rep. 200: 11-22.

----------, K.A. 1983. Further investigation of the Jamaican spiny lobster fishery. Western Central Atlantic Fishery Commission (WECAFC). National reports and selected papers presented at the third session of the Working Party on Marine Fishery Resources, Kingston, Jamaica. 17-21 May 1982 FAO Fish Rep. **287**. Suppl.: 177-191.