

# LENGTH STRUCTURE OF MONKFISH, *LOPHIUS GASTROPHYSUS* (LOPHIIFORMES, LOPHIIDAE), LANDED IN RIO DE JANEIRO

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## ABSTRACT

Valentim, M.F.M.; Vianna, M. & Caramaschi, E.P. 2007. Length structure of monkfish, *Lophius gastrophysus* (LOPHIIFORMES, LOPHIIDAE), landed in Rio de Janeiro. *Braz. J. Aquat. Sci. Technol.* 11(1):31-36. ISSN 1808-7035. A total of 13.927 individuals of *Lophius gastrophysus* landed by the shrimp fishing fleet at a fishing port of Niteroi, state of Rio de Janeiro, were measured. The fish were landed separately in two commercial categories: small (individuals less than 1 kg) and large (over 1 kg). Two sampling periods were distinguished: from March 2004 to February 2005 (first period) and from March 2005 to February 2006 (second period). The length-class structure was completely dominated by small-sized individuals, even in the "large" category, over the entire sampling period, and showed the large catch of young individuals. It is concluded that this fleet impacts heavily on the stock of *L. gastrophysus*, because it acts basically on the population stratum of juveniles, because of the poor selectivity of the trawl nets used and the area of the continental shelf where the fleet fishes. We recommend the implementation of measures to reduce this catch, so as not to compromise the development of a sustainable fishery for *L. gastrophysus*.

**Key-words:** Trawl fishery, Demersal resources, Tamboril, Predatory fishery

## INTRODUCTION

Because of the lack of knowledge of the availability of fishery resources on the outer continental shelf and slope, allied to the high costs and risks of operating in that area, the commercial fishery of southeastern and southern Brazil remained concentrated on the inner continental shelf until the end of the 1990s, in spite of a trend toward overfishing the main resources there (Perez *et al.*, 2001). With the sharp decline in coastal production, equally concentrated efforts were directed toward previously unexploited resources on the outer shelf and slope, with unknown potential for sustainability (Perez *et al.*, 2002c).

In 1998, the Ministry of Agriculture, Cattle Raising and Supply instituted an ocean-fishery program based on the chartering of foreign vessels by national companies, in an attempt to increase the supply of fish, learn fishing techniques, improve manpower skills, generate employment in the sector, improve knowledge of the potential fishery resources, and rationally occupy the EEZ (Brazilian Exclusive Economic Zone). This program was implemented in 2000, when chartered vessels began to operate at depths of 200 to 900 m, using traps, longlines, gill nets, and trawl nets (Perez & Pezzuto, 2006). One of the studies originating from this program focused on the management plan of the fishery

for the monkfish or blackfin goosefin, *Lophius gastrophysus* Miranda-Ribeiro, 1915 (Lophiiformes, Lophiidae). Since mid-2000 this species has been one of the main targets in the process of expansion of the demersal fishery to the deeper areas of the EEZ, due to its high commercial value (Perez *et al.*, 2002c). The average catch increased from 135 t/year (1986-1995) to 2358 t/year (1996-2003) (Perez & Pezzuto, 2006).

The family Lophiidae embraces four genera and 25 species (Caruso, 1983); *Lophius* is the genus of greatest commercial value. Along Brazilian coast, *Lophius gastrophysus* is caught between Cabo Frio (23° S) and Cabo de Santa Marta (28° 30' S), and is the main target species of the fleet that operates in depths greater than 200 m (Perez *et al.*, 2002c). Although *L. gastrophysus* is under strong fishing pressure, information on its biology and fishery is still incomplete, although it is the target species for the deepwater gillnet fishery (Wahrlich *et al.*, 2004) and a component of the bycatch of the commercial shrimp-trawler industry (Vianna & Almeida, 2005).

The intent of the present study was to generate information that will aid in the management of the *L. gastrophysus* fishery in southern and southeastern Brazil, through the analysis of data on the specimens landed by the industrial trawl fleet in the State of Rio de Janeiro.

## MATERIAL AND METHODS

### Data Collection

A total of 39 samplings of the trawl fleet landings were conducted during two consecutive years, from March 2004 to February 2005 (first period) and from March 2005 to February 2006 (second period). Fish was sampled from the catch of selected landings within two commercial size categories as previously sorted on board (small <1.0 kg and large >1.0 kg). After a pilot sampling period, a standardized stratified sampling procedure was established in which three boxes of the large category was sampled for every box of fish in the small category. From each specimen the total length (TL, in cm) was obtained and the total weights of the monkfish landings were recovered in kg.

The Niterói harbor was the sampling site choice because it concentrates most of Rio de Janeiro State landings. This harbor is the most important fishing market of the metropolitan area of the State, which incorporates both the local fleet production and that landed by vessels from other States of southeastern and southern Brazil. All trawlers that landed the monkfish operated double-rig trawls commonly used in the traditional pink shrimp (*Farfantepenaeus* spp.) fishery with a wingspread of approximately 24 m. These trawlers were about 20 m long, powered by 300 HP engines and carried a six-fisherman crew. Fishing trips were, on average, 12 days long. Around four six-hour long hauls were conducted per day mainly along the 80 m isobath on the outer shelf.

### Data Analysis

Size structure of *Lophius gastrophysus* catches were analysed from seasonal frequency of individuals in the small and large size commercial categories as well as from size frequency distributions using six total length classes: <19; 20-29; 30-39; 40-49; 50-59; >60 cm. Possible differences between the frequency of occurrence of commercial size classes were tested using a chi-square test applied with a 95% significance level (Zar, 1996). Seasonal abundance variability was accessed through the analysis of mean CPUE (Catch Per Unit Effort) calculated by dividing the sum of monkfish catches of all monitored landings within each season by the total number of monitored landings. This analysis assumed that all fishing trips had the same fishing efficiency and CPUE values were also expressed by commercial size category.

## RESULTS

A total of 13.926 specimens were measured during the overall sampling period. Total length (TL)

ranged from 15.6 to 83.0 cm (mean  $40.6 \pm 11.0$  SD). TL ranges in the first ( $n = 5.940$ ) and the second ( $n = 7.987$ ) periods were 18.0 -83.0 cm (mean  $42.3 \pm 10.3$  SD) and 15.6 - 75.5 cm (mean  $39.2 \pm 11.3$  SD) respectively.

In the first period, 37.3% were classified as small, and 62.7% as large. In the second period, this pattern was repeated, with 46.3% small and 53.7% large (Table 1). The proportion between the commercial categories landed differed significantly between the two periods and in almost all the bimesters of the first period, always with large fish predominating. During the second period, there were no significant differences in the March-April bimester, in most cases because of the sharp increase in the catch of small individuals.

Landings of small *L. gastrophysus* (Figure 1) were completely (100%) composed of individuals that were probably juveniles, because they were smaller than the estimated size at first maturation for this species: ( $L_{50}$  females= 51.0 cm) by Lopes (2005) and ( $L_{50}$  females= 50.0 cm) by Valentim (unpublished). The modes fell between the 30-39 cm length classes. The second year differed from the first year in the sharp increase in the proportion of smaller individuals; and the appearance of individuals in the <19 cm length class.

In regard to large *L. gastrophysus* landed (Figure 2), more than 50% of the individuals caught were probably juveniles, with the length modes in the 40 -49 cm class. However landings of individuals above  $L_{50}$ , increased sharply between September and February in the first

Table 1 – Percentage frequency of *Lophius gastrophysus*, in the small (%S) and large (%L) commercial categories per sampling bimester. Size of sample in parentheses; asterisk indicates non-significant difference.

Bimester	(%S)	(%L)
	First Period	
Mar-Apr	49.7 (659)	50.3 (668)*
May-Jun	32.1 (355)	67.9 (751)
Jul-Aug	27.6 (229)	72.4 (601)
Sep-Oct	31.5 (301)	68.5 (654)
Nov-Dec	35.2 (357)	64.8 (657)
Jan-Feb	44.1 (312)	55.9 (396)
<b>Total</b>	<b>37.3 (2213)</b>	<b>62.3 (3727)</b>
	Second Period	
Mar-Apr	51.2 (312)	48.8 (297)*
May-Jun	58.9 (1307)	41.1 (913)
Jul-Aug	39.7 (652)	60.3 (991)
Sep-Oct	39.8 (441)	60.2 (666)
Nov-Dec	45.0 (679)	55.0 (830)
Jan-Feb	34.2 (308)	65.8 (591)
<b>Total</b>	<b>46.3 (3699)</b>	<b>53.7 (4288)</b>
<b>Overall</b>	<b>42.4 (5912)</b>	<b>57.6 (8015)</b>

period. When about 47% of the fishing effort was concentrated on the stock of individuals above the estimated size at first sexual maturity, declining to 42% in the second. There was a slight decline in landings of individuals of this size from the first to the second year of collection, except for July-August 2004, when landings increased from 37.4% to 42.8% for the July-August 2005 period.

Analyzing the distributions of the frequencies of the commercial categories of *L. gastrophysus* among the length classes, we observed slight mixture between the small and large categories in landings for the 30-39 cm to 40-49 cm classes. In general, there was little variation in this mixture during the studied periods. However that of the individuals classified as large only 20.6% presented a higher mean size at first sexual maturity estimated for females, that is, they were adults (Figure 3).

Seasonality and percentage frequency of occurrence of small and large categories is shown in Figure 4. In the first period, there was slight increase on large landing in July-August, although 30% were adults. During the second period, the percentages remained approximately the same, except in May-June when there was an increase of small individuals (58%) and in January-February of large individuals (65.7%). However only 10.2% and 41% were adults, respectively. Individuals over 76.0 cm were recorded only during the first collection period. In the second period, individuals over 71.0 cm occurred only between September and December. We note that these categories are simply commercial and somewhat subjective.

In regard to the estimation of abundance from the CPUE (kg/landing) for the two study periods, we observed a peak in the large category at the end of

spring (November-December); a similar but sharper increase occurred in the second period. The abundance of small fish remained constant in both periods, with a similar but less pronounced increase in November-December. The production landed was an estimate of the 160 landings and the CPUE average value was of  $618.5 \pm S.D. 474.6$  kg for small and  $3.224.06 \pm 1.626.6$  kg for large categories. The production landed was an estimate of the 160 landings and the CPUE average value was of  $618.5 \pm S.D. 474.6$  kg for small and  $3.224.06 \pm 1.626.6$  kg for large categories (Figure 5).

## DISCUSSION

Different catch patterns for young and adults result from interactions between the different selectivities of the various fishing methods and the biological characteristics of the species, including depth stratification and the different growth rhythms between sexes and ages (Perez *et al.*, 2002a). Studies on the catch of *Lophius piscatorius* in Spain by different fishing methods were conducted by Bruno *et al.* (2001), who showed that the gillnet caught basically adults, whereas the trawl net caught mainly juveniles. In Brazil, Lopes (2005), working with *L. gastrophysus*, observed that adult individuals predominated in the samples taken with a gillnet, suggesting that the capture of larger fish is associated with the high selectivity of this fishing net, which differs from trawling, where most of the fish caught are juveniles.

In the present study, the nearly total dominance of young individuals of *L. gastrophysus* may reflect the low selectivity of the trawl net used by the shrimp fishing

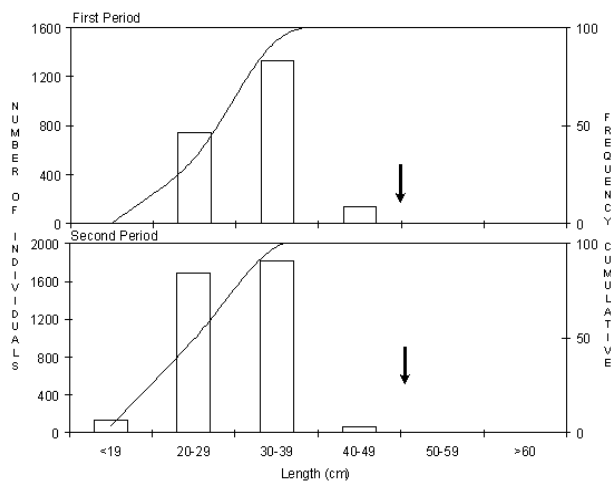


Figure 1 – Numeric and cumulative frequencies (%) of *Lophius gastrophysus*, in the small category, per size class, from March 2004 to February 2006. Arrow indicates mean size at first sexual maturation for females.

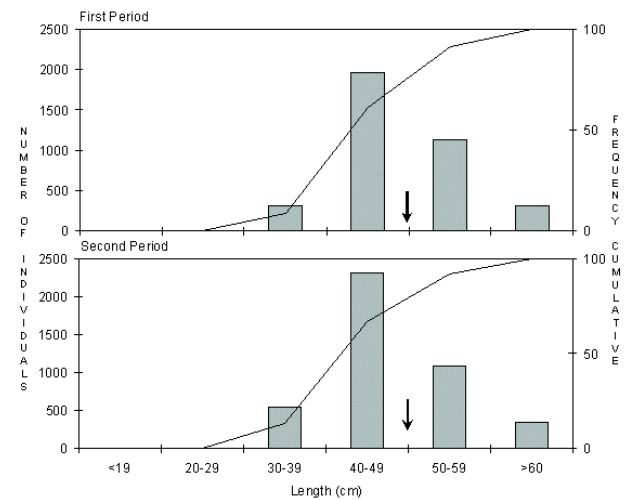


Figure 2 - Numeric and cumulative frequencies (%) of *Lophius gastrophysus*, in the large category, per size class, from March 2004 to February 2006. Arrow indicates mean size at first sexual maturation for females.

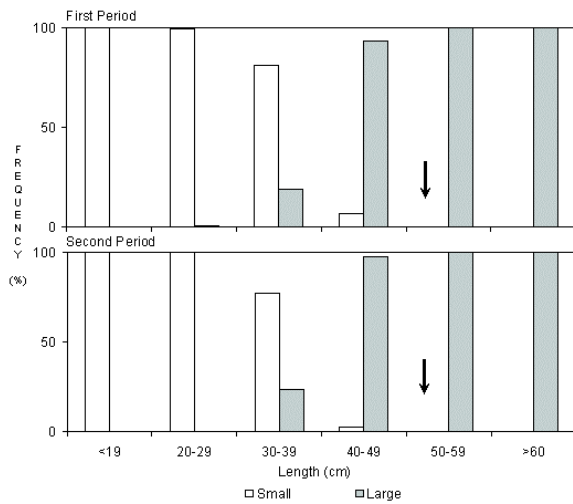


Figure 3– Percentage frequency (%) of *Lophius gastrophysus* landed in the small and large categories, per size class during the first period (March 2004 to February 2005) and the second period (March 2005 to February 2006). Arrow indicates mean size at first sexual maturation for females.

fleet that lands in the State of Rio de Janeiro, or may simply result from its fishing grounds being dominated by small (juvenile) fish. Ungaro *et al.* (2002), analyzing *Lophius budegassa* and *L. piscatorius* on the Mediterranean continental shelf, observed that the catch was composed of individuals smaller than 30-40 cm, whereas the fish caught on the slope were larger than 50 cm.

Stratification of fish length with ocean depth was observed by Laurenson *et al.* (2004) for *L. piscatorius* in the northwest Atlantic: juveniles occurred in more coastal areas, and moved to deeper waters as they grew. In Brazil, Perez *et al.* (2002c) provided evidence for depth stratification of *L. gastrophysus*, with smaller and immature individuals in the shallower areas, and larger and adult individuals in the deeper zones. The authors also observed that mature females over 50 cm were caught by the gillnet fishery, and that the trawler fishery caught mostly juvenile individuals, smaller than 50 cm. Also in Brazil, the same pattern was found by Schwingel & Andrade (2002), who reported that the gill net took mainly females of *L. gastrophysus* because they are larger.

The mean size of the individuals sampled in this investigation was larger than that of fish caught by trawling on the inner continental shelf by Vianna & Almeida (2005), but similar to that of fish collected by trawling on the outer shelf and slope by Haimovici (1997), and to that of fish collected from gill nets by Lopes (2005), also on the outer shelf and slope. In making these comparisons, we must consider that in this study we measured only those fish that were landed, in contrast to Vianna & Almeida (2005), who analyzed unsorted catches. Thus, the length classes measured and the

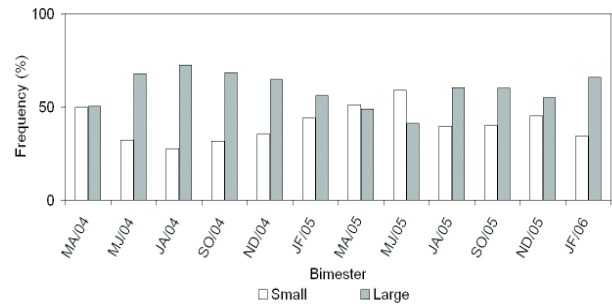


Figure 4 – Percentage frequency (%) of *Lophius gastrophysus* landed in the small and large categories, per sampling bimester during two study periods (March 2004 to February 2006). MA, March-April; MJ, May-June; JA, July-August; SO, September-October; ND, November-December; JF, January-February

landing data apply to the outer shelf the fishing ground exploited by the fleet from which our data were obtained. We believe that the shrimp trawlers impact the population of juveniles of *L. gastrophysus* because of the combined factors of the low selectivity of the gear used and the depths that the vessels work.

The highest catches per unit effort can be related to different factors. Vianna *et al.* (2005), analyzing the official landing data for Rio de Janeiro (IBAMA-RJ), observed that the largest catches of *L. gastrophysus* occur in spring. In the present study, the highest CPUEs were recorded in late spring and early summer. The largest catches were also observed by Vianna & Almeida (2005) in this period, and the peak of the catch was associated with the incursion of the South Atlantic Central Water, as they reported that *L. gastrophysus* showed a restricted distribution related to this cold water mass. Probably the largest catches of *L. gastrophysus* by trawler in shallower waters of southeastern Brazil are related to the cold water mass, which makes it more feasible for the less-specialized fleet to catch this species.

This conjunction of factors raises concern regarding the sustainability of this fishery, not only because of the catch of *L. gastrophysus* as a target species, but also because of the bycatch. The species of *Lophius* compose part of the bycatch of trawler fisheries in many parts of the world, although they are one of the main demersal resources exploited in the Atlantic Ocean (Leslie & Grant, 1990) and have become very popular in recent decades in the international market (Steimle *et al.*, 1999). In Brazil, *L. gastrophysus* has been part of the commercial bycatch of the shrimp fishing fleet in the southeast since the 1990s, and in 2000 it began to be targeted by double-rig vessels and gillnet fishing boats in the southeast and south regions (Perez *et al.*, 2001; 2002a).

At present in Brazil, efforts are being made to restrict the catch of *L. gastrophysus* to the gill net. Gillnet fishing for demersal species in areas of the

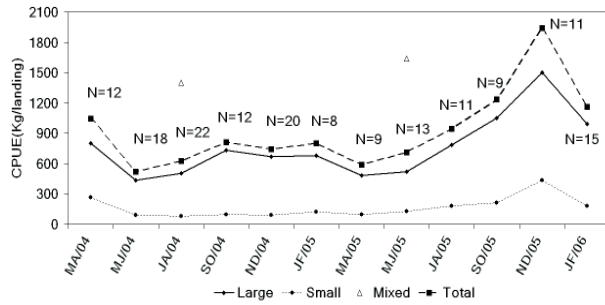


Figure 5 - Values of CPUE (kg/landing) of *Lophius gastrophysus* landed at the fishing port of Niterói, Rio de Janeiro, per sampling bimester during the two study periods (March 2004 to February 2006. (N = number of landings)

Brazilian outer shelf and slope has been carried out since the beginning of the 1990s (Haimovici, 1997). However, the foreign vessels chartered to operate in depths greater than 200 m introduced cheaper and more-selective types of gill nets, which preserve the juveniles of *L. gastrophysus* (Wahrlich *et al.*, 2004). These efforts are important, because although this is a relatively new fishery, there are already indications that *L. gastrophysus* is being overfished (Perez *et al.*, 2005). The situation is similar to those of other species of *Lophius*, and has raised concern in different countries regarding its sustainability, such as the targeted fisheries for *L. americanus* in the western North Atlantic (Kulka & Miri, 2001); *L. piscatorius* and *L. budegassa* in the North Sea, the British Isles, and the Iberian Peninsula (Bruno *et al.*, 2001); *L. vomerinus* in South Africa (Leslie & Grant, 1990); and *L. piscatorius* in the eastern North Atlantic (Piñeiro *et al.*, 2001). In Brazil, the intensification of the fishing effort on *L. gastrophysus*, through the concomitant activity of the licensed fleet and the bycatch, explains the concern of those involved in this fishery.

In spite of the scarcity of information on *L. gastrophysus*, a management plan of the its fishery off Brazilian waters was developed taking into account biomass estimates obtained by fishing and effort data as well as preliminary biological data (Perez *et al.*, 2002b). Based on this plan, Normative Ruling No. 23, promulgated on 4 July 2005, established criteria and procedures for regularizing the monkfish fishery. However, according to Perez *et al.* (2002a), certain factors must be considered to maintain the sustainability of the stocks of *L. gastrophysus*, such as the prioritization of gill nets and specialized vessels. Normative Ruling No. 23 is quite restrictive, limiting the licensed fleet to nine vessels which can operate only with a bottom gill net with a 280-mm mesh and at minimum depths of 250 m. Article 11 of this ruling mandates that for the fishing fleet not licensed for *L. gastrophysus*, production of this species may not exceed

5% of the total weight of gutted fish landed per voyage. However, Vianna *et al.* (2005) showed that monkfish landings by the industrial shrimp fleet in Rio de Janeiro exceeded 10% of total weight. If we consider a number close to that calculated by Perez *et al.* (2001), of 511 double-rig trawlers of industrial size operating on the southeast-southern Brazilian coast, the damage caused by the catch of young fish by the shrimp fishery is great enough to compromise the sustainability of the resource.

We urgently recommend that effective measures be implemented and enforced to reduce the bycatch of *L. gastrophysus* by the shrimp fishing fleet in order not to compromise the development of a sustainable fishery for this species in Brazilian waters.

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