Occurrence of decapods larvae, specially *Xiphopenaeus kroyeri* (Penaeidea) in the shallow shelf of Paraná.

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Abstract

Larval ecology is now being incorporated to fisheries biology, together with catch data and adult biology. The sea bob shrimp *Xiphopenaeus kroyeri* is one of the main catches of the artisanal fisheries in Paraná coast, in southern Brazilian shelf waters. This work aims to describe the occurrence and temporal variation of the sea bob shrimp and other decapods larvae in a fixed site during two years. Plankton samples were obtained monthly, from January 1998 to December 1999, at 10m local depth, in Paraná shallow shelf (25° 37'S, 48° 25'W). Plankton samples were obtained in vertical and oblique tows, using a conical cylindrical plankton net with 200 µm mesh size. We identified 31 morphotypes of decapod larvae. The larvae occurred during the whole year, but the highest abundance was registered in February 1998 and March 1999, when water temperature was higher than 26 °C. Sergestoidea protozoea and *Lucifer* and *Acetes* mysis were the most abundant larvae, specially in summer and autumn. In the rest of the year there was not a dominant group, although Thalassinidae and Caridea were abundant. The *X. kroyeri* larvae were not present during the whole year although mature females were caught in the same site in all months long. The highest abundance of *X. kroyeri* larvae was coincident to the decapod larvae peak. At that time the shrimp trawling was forbidden in the area. We believe that during the closure of shrimp fisheries, the increasing number of adults improves the breeding success and therefore the larvae production.

Key words: Larvae, *Xiphopenaeus kroyeri,* sea bob shrimp, decapods, shallow shelf.

Introduction

The life cycle of shrimps includes many different stages that grow in different coastal habitats. In most of the species, the adults are found in shelf waters and juveniles in estuarine waters. Among the three shrimp species that are explored in the southeastern/ south coast of Brazil, we believe that the seabob shrimp *Xiphopenaeus kroyeri* (Heller, 1862) is the one without an estuarine stage. Its abundance is however linked to the enrichment of the coastal zone by the adjacent mangroves. In French Guiana, Lhomme (1997) suggested that the nursery area of *X. kroyeri* occurred in a littoral fringe which presents some characteristics of an estuarine ecosystem.

Shrimp fisheries in the shallow waters of Paraná coast is mainly artisanal and trading activity is concentrated in summer months. The seabob shrimp *X. kroyeri* represented 48 % to 64 % of the total fisheries in Cananéia, during 1995 and 1996 (Mendonça, 1997) and part of this amount was for sure fished in Paraná coast. There are only partial records of the seabob shrimp landings in Paraná markets. Valentini *et al.* (1991) reviewed commercial aspects and management of shrimp fisheries and included some information about *X. kroyeri.* Older fisheries records about artisanal fisheries included also the species (Loyola and Nakamura,1982).

There are few studies about this species ecology. The growth curve was proposed for the Matinhos beach population, in Paraná coast (Branco *et al.*,1994) and some biology aspects were studied by Amado (1978) in the same area. The population structure was described at Ubatuba area (São Paulo) (Nakagaki and Negreiros-Fransozo, 1998), at the mouth of the Itajaí-Açú River (Santa Catarina) (Branco *et al.*, 1999) and in Paraná coast (Ennes, 2000).

It is now currently accepted that the management of benthic resources must include fisheries records, adult biology, larval transport and recruitment studies. The temporal analysis of commercial benthic species showed that in the most studied species, there are fisheries and adults population data since 1850, while larval records were obtained during only 15 years. The Botsford *et al.* (1994) review showed the dependence of many different benthic populations to the larval dispersal strategy.

There is no record about the occurrence, abundance or distribution of *X. kroyeri* larvae in the southeastern/ south coast. The larval development is composed by 5 nauplius (Renfro and Cook, 1963), 3 protozoea, 3 mysis (Cook, 1966) and post-larvae.

This work aims to describe the occurrence and temporal variation of larvae in a fixed site in Paraná coast during two years. Occurrence and temporal variation of other decapods larvae, excepting brachyurans were also analyzed.

Material and Methods

The sampling site was established in Shangri- lá beach, at Praia de Leste coastal plain, in Paraná coast (25° 37'S, 48° 25"W) (Fig. 1), at 10m local depth. Plankton samples were obtained monthly, from January 1998 to December 1999, with exception of July and September 1998 and July 1999, due to bad weather conditions. Vertical tows in the whole water column were conducted only during the first year. Oblique tows from the bottom to surface were conducted during 3 minutes from January 1998 to January 1999 and during 6 minutes from February to December 1999. We used a conical cylindrical plankton net with 200 μm mesh size, 1.50 m length and 0.50 m mouth diameter. Plankton samples were fixed with 4 % buffered formaldehyde. Water was collected at surface and bottom with a Van Dorn bottle to measure temperature and salinity, using thermometer and refractometer. Decapods larvae were sorted in the whole sample, with the exception of February 22th 1998 vertical, February 19th 1998 oblique, March and April 1999 oblique. In these samples, we used a Folson splitter and sorted *X. kroyeri* protozoea in 1/ 8 of the sample. Larvae were identified under microscope according to Calazans (1993). Occurrence graphs of *X. kroeyri* and decapods larvae morphotypes were obtained.

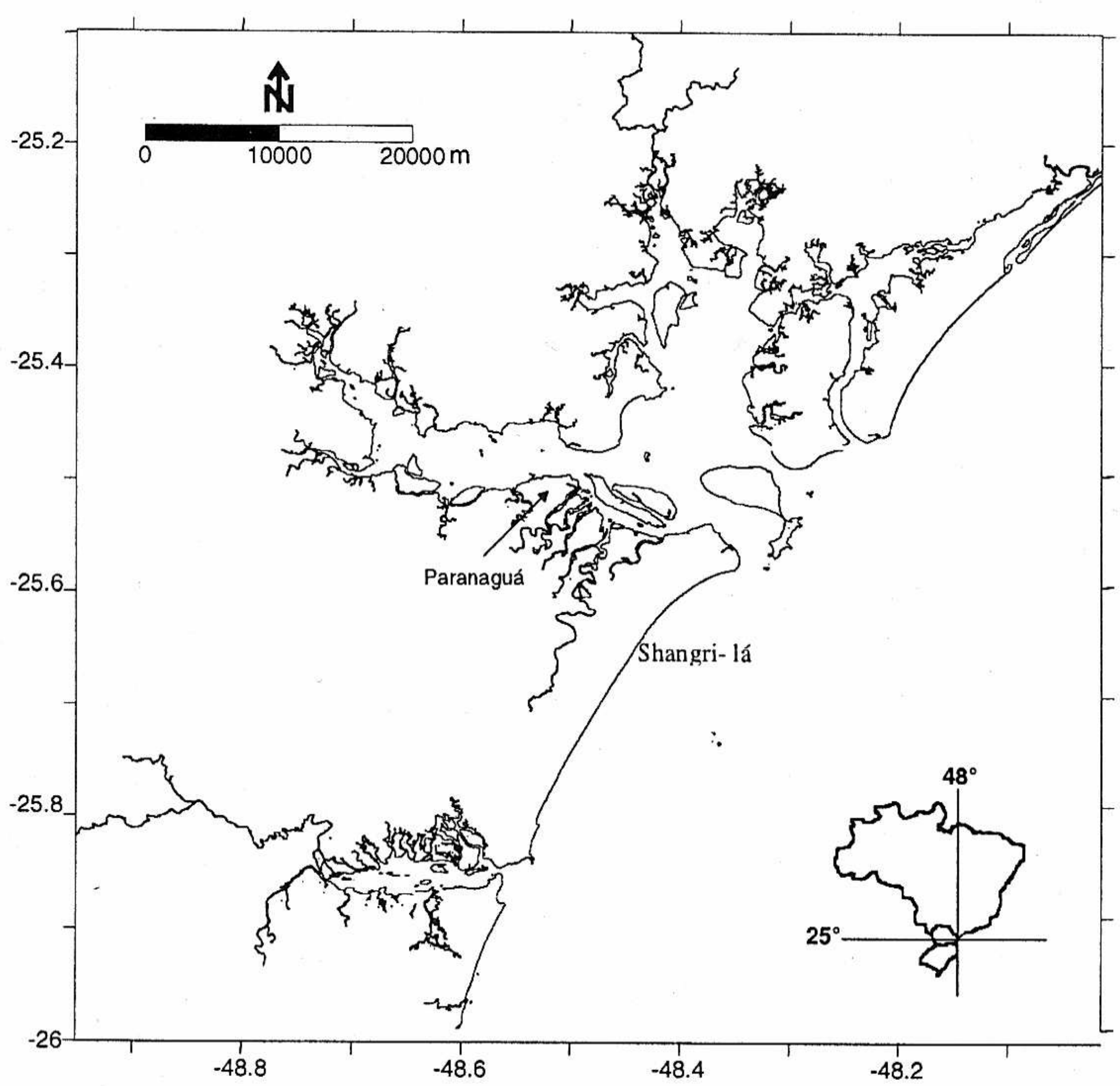

Figure 1: Sampling site in Shangri- lá beach, Paraná coast (25° 37'S, 48° 25'W).

Results

Temperature variation was typically seasonal, over 26 °C from January to March, descending until 22 °C, from June to October (Fig. 2). During 1998, salinity oscillated from low values (28 at the surface and 30 psu in the bottom) in February to values higher than 32 psu in March and April, but in 1999 salinity had low variation and was always higher than 33 psu (Fig.3).

We identified 31 morphotypes of decapod larvae (Table I). Decapod larvae occurred during the whole year, but the highest abundance was registered February 1998 and March 1999, when water temperature was very warm (Fig. 2 and 4). Correlation was positive between temperature and decapod larvae in vertical (r = 0.69) and oblique tows (r= 0.40) and between temperature and *X. kroyeri* larvae in vertical (r = 0.58) and oblique tows (r= 0.40). Maximum concentration of decapod larvae was 3574 ind./ m^3.

Xiphopenaeus kroyeri larvae was not present during the whole year and their highest abundance occurred also in February 1998 and March 1999 (Fig.4).

Sergestoidea protozoea and *Lucifer* and *Acetes* mysis were the most abundant larvae, especially in summer and autumn (Fig. 5 to 7).

In the vertical tows, Sergestoidea protozoea were dominant in February and May (> 80 %) and *Lucifer* larvae were dominant in January, March and August (> 80 %). *Acetes* and *X. kroeyri* larvae were about 10 % of the total. Excepting August, Thalassinidea was the dominant larvae from June 1998 until January 1999 (Table II).

In the 1998 oblique tows, the dominance of one group was not evident. Sergestoidea protozoea, *Acetes* and *Lucifer* larvae were dominant in each summer/ autumn month, followed closely by Thalassinidae larvae. During early winter, Caridea larvae were dominant and Thalassinidae dominated from late winter to early summer, like in the vertical hauls (Table II).

In the 1999 oblique tows, *Lucifer* larvae were dominant during the whole year, except for April and November. In April, *Acetes* and *X.kroyeri* showed peaks of abundance (25 and 45 % of the decapod larvae) and in the winter there was a Caridea peak, like in the previous year. Thalassinidae progressively enhanced its dominance from winter to early summer, like in 1998 (Table II).

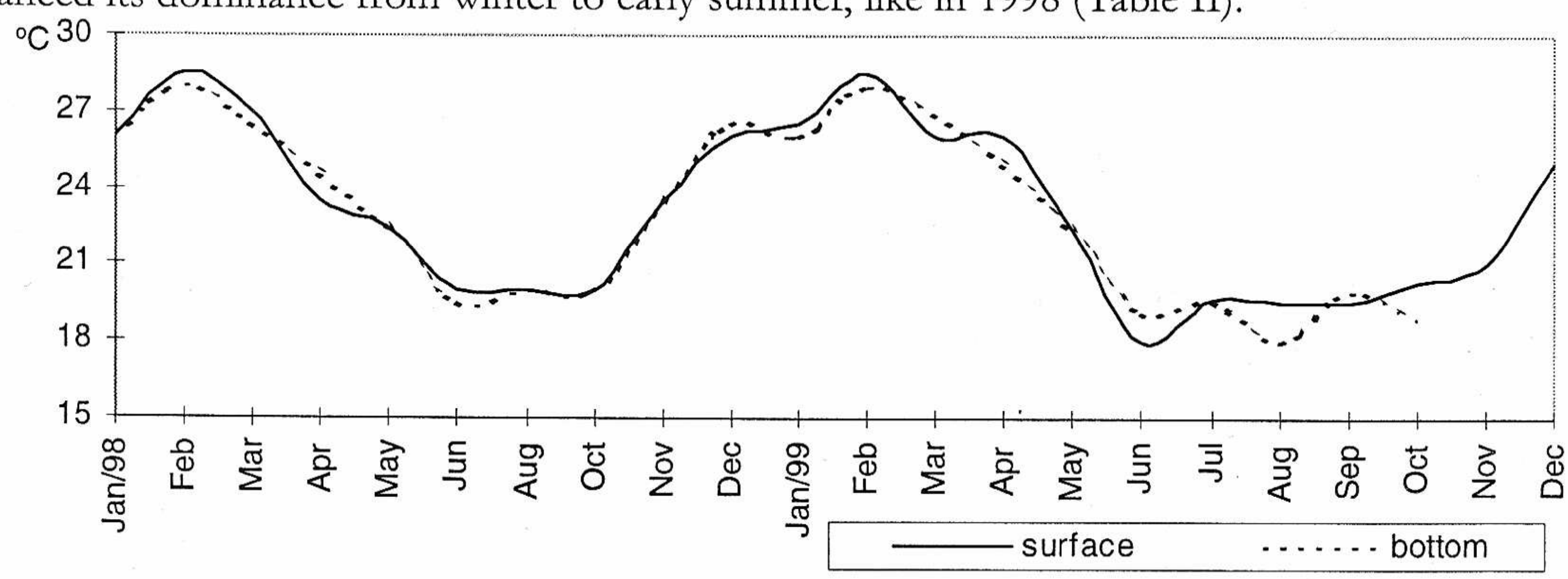

Figure 2: Water temperature (°C) at surface and bottom, from January 1998 to December 1999.

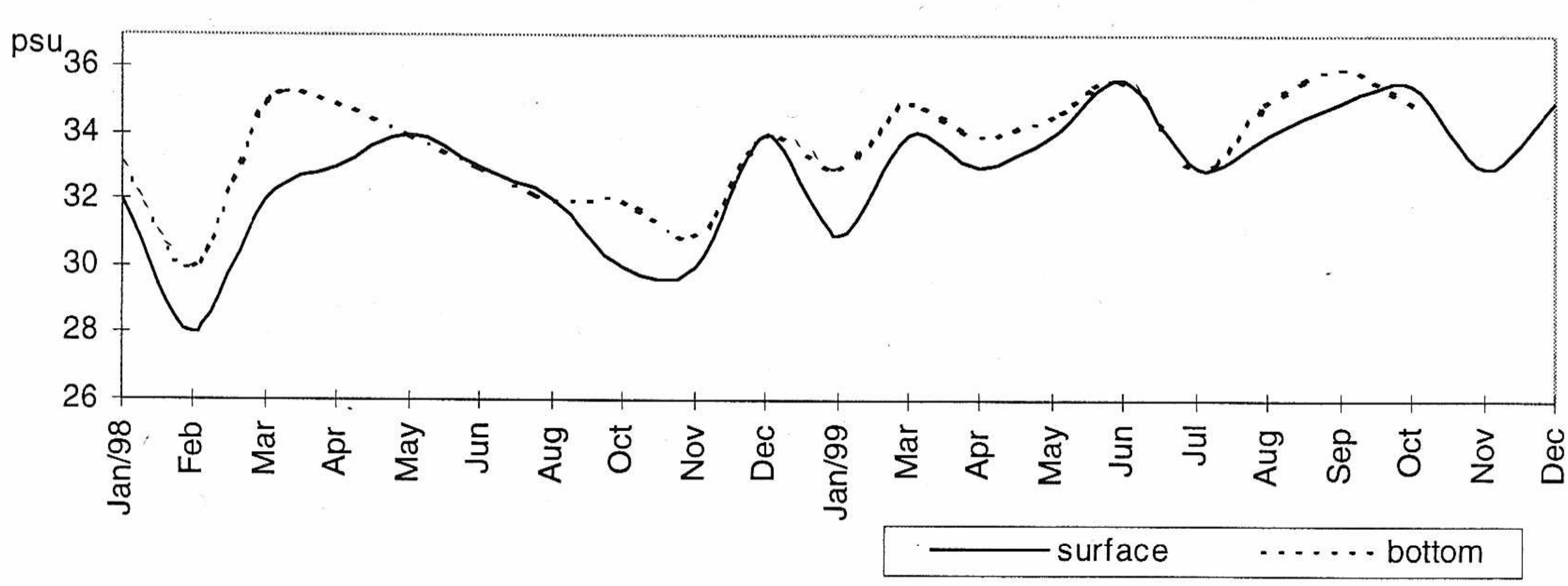

Figura 3: Water salinity at surface and bottom from January 1998 to December 1999.

Table I: Decapods larvae identified in plankton samples of Shangri-lá beach during 1998-1999.

Superfamily Penaeoidea		nauplius
Fam. Penaeidea	*Pennaeus*	protozoea I
	Trachypenaeus	mysis I
		mysis II
		mysis III
	Xiphopenaeus kroyeri	protozoea I
		protozoea II
		protozoea III
		mysis I
		mysis II
		mysis III
Fam. Solenoceridae		mysis
Fam. Sicyonidae		mysis
Superfamily Sergestoidea		protozoea I
		protozoea II
		protozoea III
Fam. Sergestidae	*Acetes*	mysis I
		mysis II
		mysis III
		decapodids
		juvenile
	Peisos	juvenile
Fam. Luciferidae	*Lucifer*	mysis I
		mysis II
		mysis III
		decapodids
Infraorder Thalassinidea (Grupo1: Fam. Axiidae e Callianasidae)		
Infraorder Thalassinidea (Grupo2: Fam.Laomediidae, Thalassinidae e Upogebidae)		
Infraorder Caridea		
Infraorder Anomura		
Infraorder Anomura (Fam. Hippidae)		

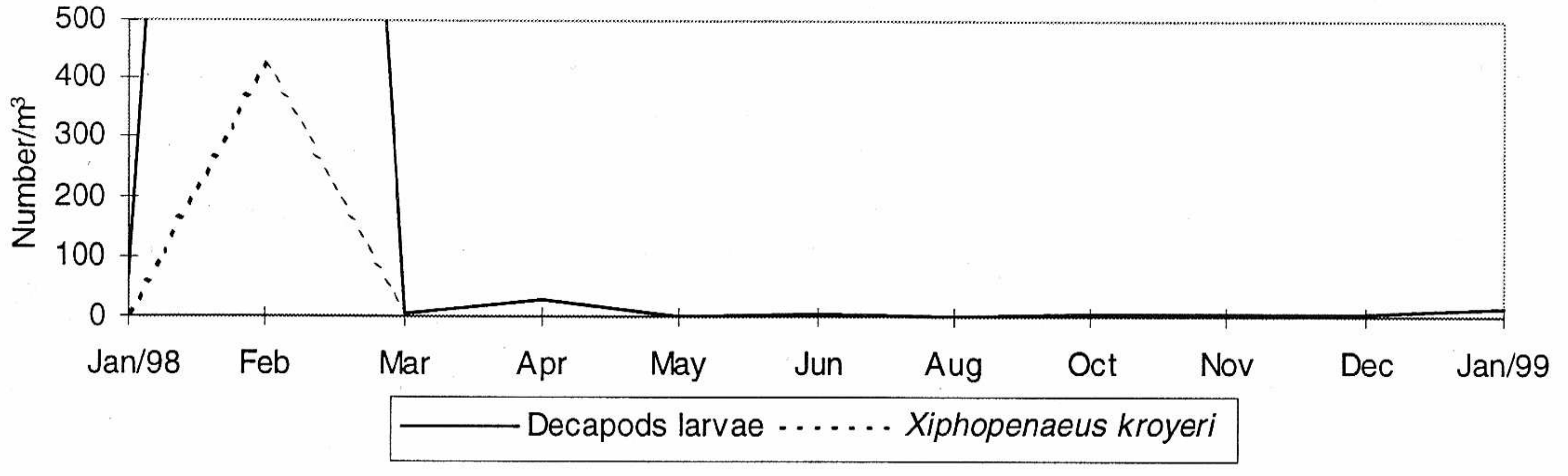

Figure 4 A: Decapods and *Xiphopenaues kroyeri* larvae occurrence in vertical tows (no./m^3) from January 1998 to January 1999. Decapods larvae in February = 3574 ind./m3

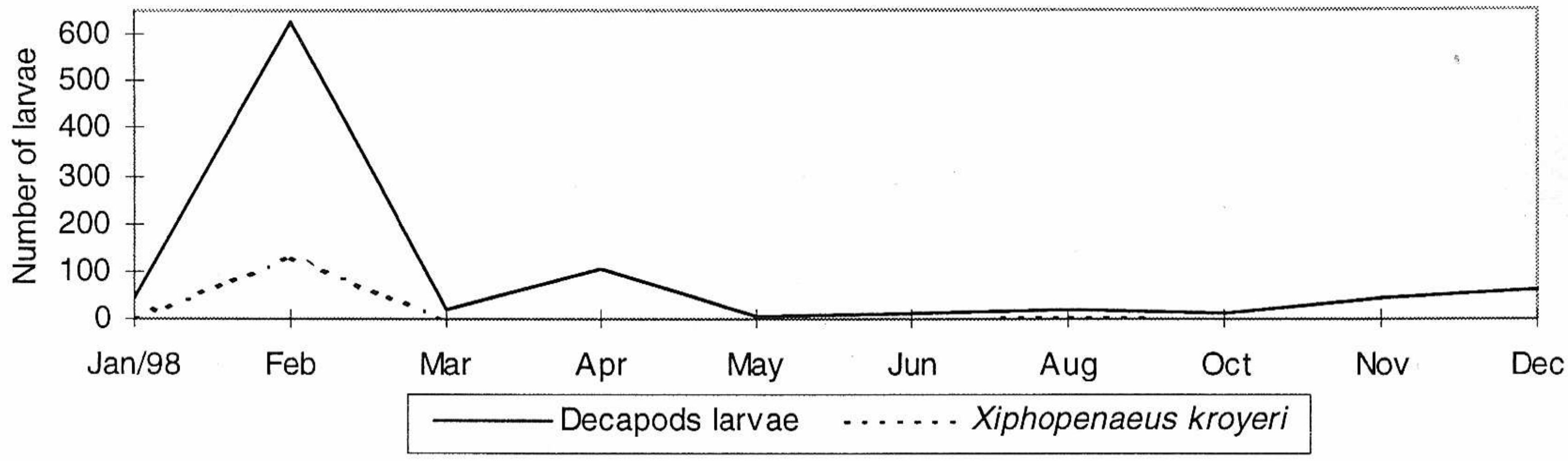

Figure 4 B: Decapods and *Xiphopenaues kroyeri* larvae occurrence in oblique tows from January to December 1998.

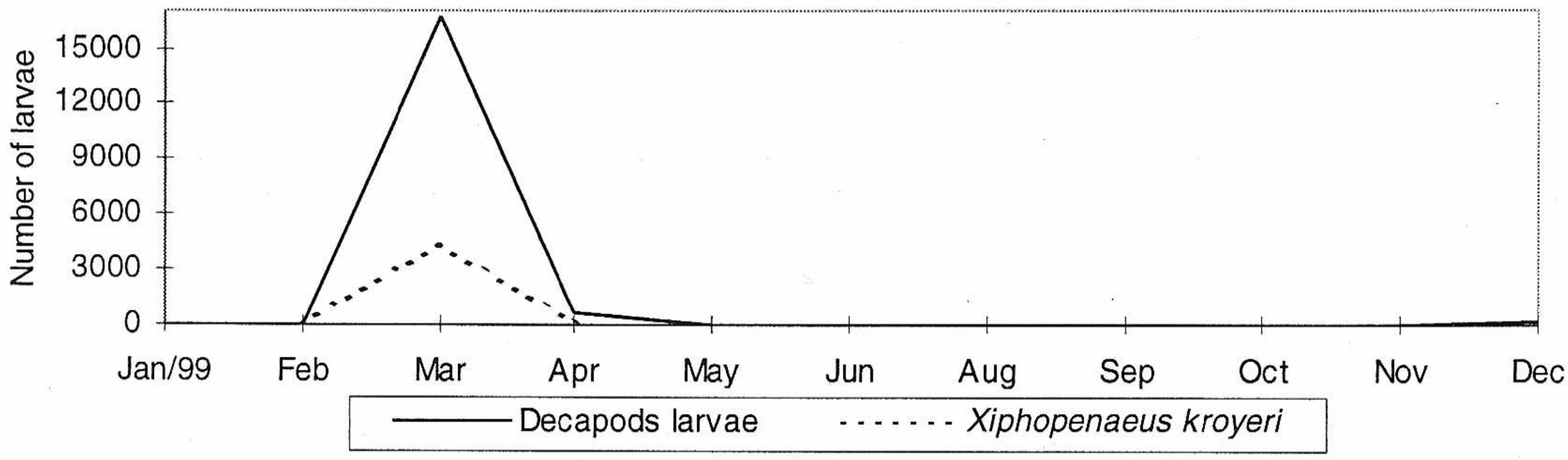

Figure 4 C: Decapods and *Xiphopenaues kroyeri* larvae occurrence in oblique tows from January to December 1999.

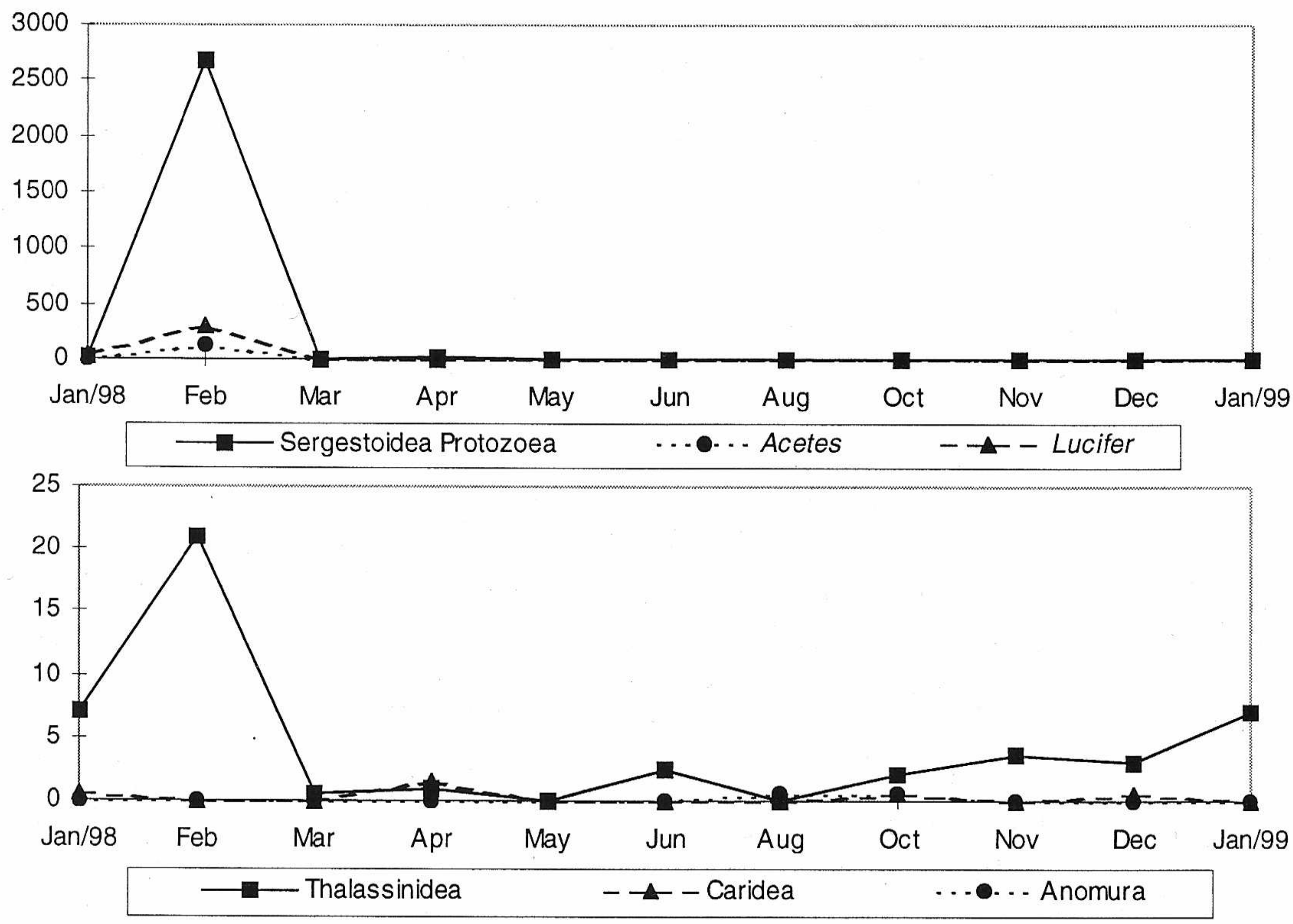

Figure 5: Decapods larvae taxa occurrence in vertical tows (number/m^3) from January 1998 to January 1999.

Discussion

Planktonic larvae in the water is commonly associated to the reproductive period and adults spawning ocurrence. Our results showed the alternation of decapod larvae peaks during the year and even in short periods during the summer. These peaks could be related to the breeding/ spawning season of planktonic and benthic decapods in the sandy beach and in the shallow shelf waters. Besides, the alternation of crustacean larvae in the water had already been registered for estuarine species and is supposed to be related to the partition of resources (Dittel *et al.*, 1991). In the coastal waters of northeastern Brazil, in Pernambuco, the same decapods groups were found to be dominant (Schwanbord *et al.*,1999).

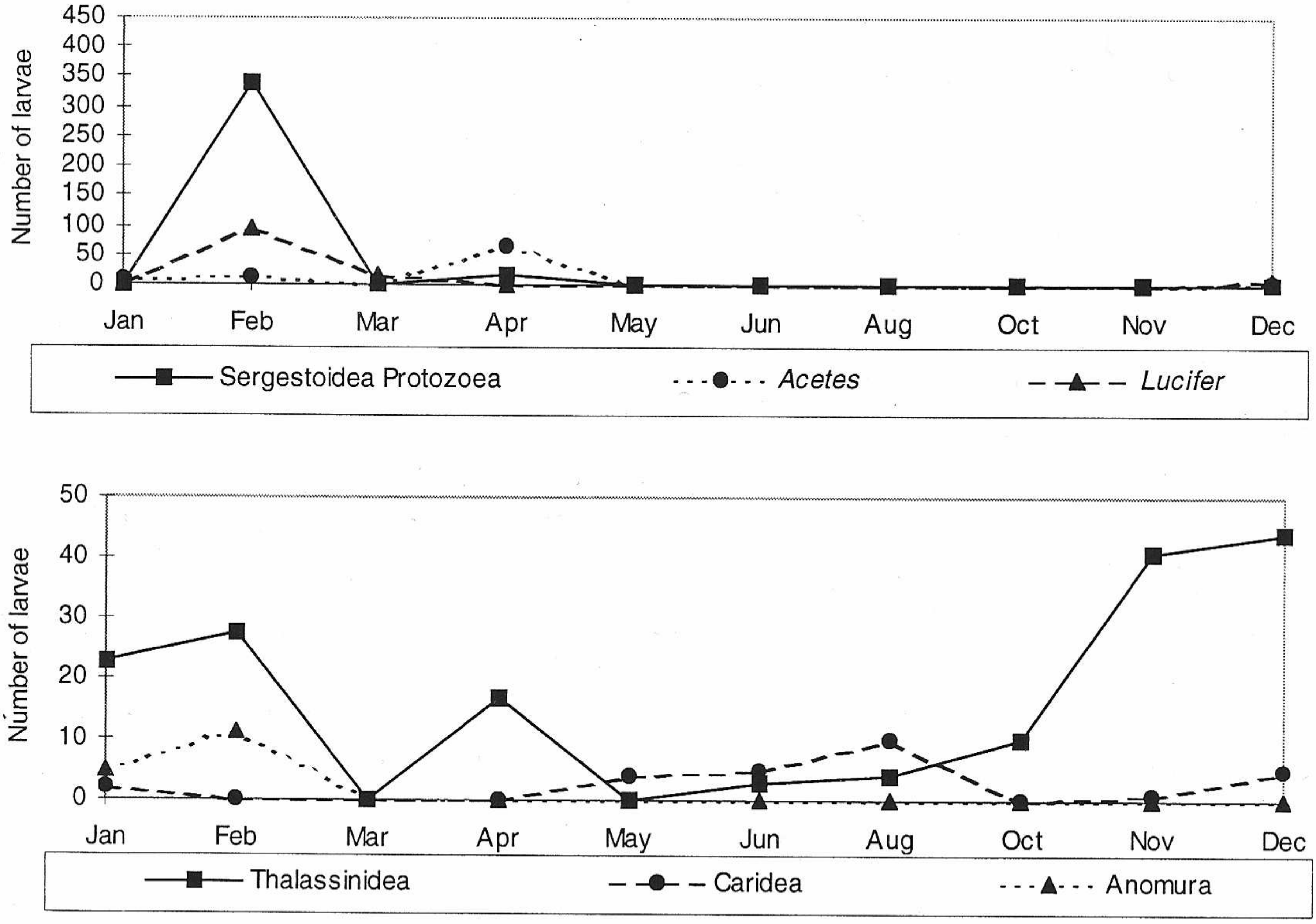

Figure 6: Decapods larvae taxa occurrence in oblique tows from January to December 1998.

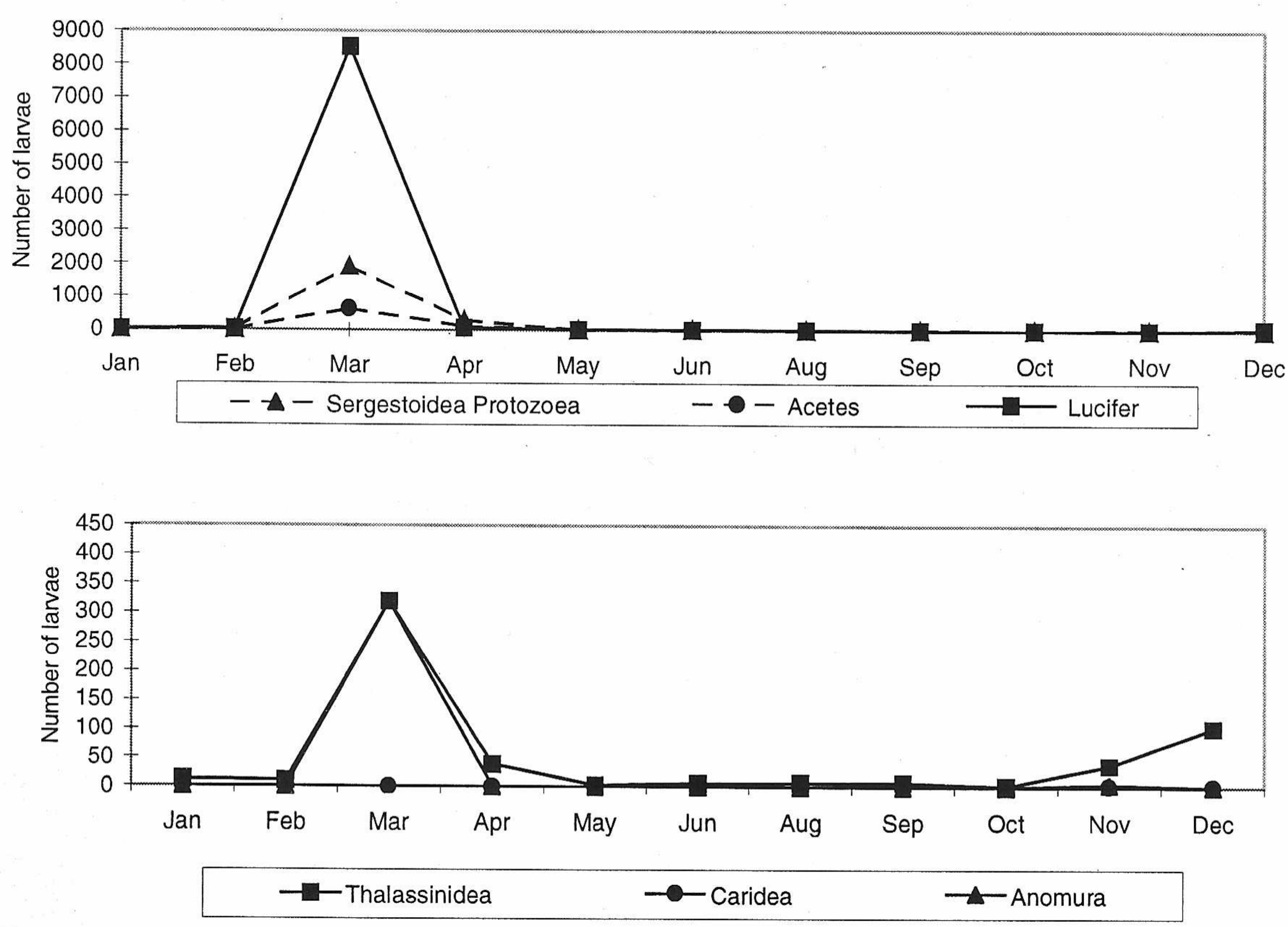

Figura 7: Decapods larvae taxa occurrence in oblique tows from January to December 1999.

Table II: Decapods larvae percentage in 1998 vertical and oblique hauls and 1999 oblique hauls.

1998 vertical haul	JAN	FEB 19	FEB 22	MAR	APR	MAY	JUN	AUG	OCT	NOV	DEC	JAN 99
Sergestoidea Protozoea	16	72	75	36	74	100	0	0	13	0	9	4
Acetes	10	3	4	0	12	0	0	0	0	0	9	
Lucifer	54	11	8	45	0	0	0	67	0	0	18	36
Xiphopenaeus kroyeri	9	9	12	9	4	0	0	0	13	0	0	0
Thalassinidea	10	5	1	9	4	0	100	0	50	88	55	50
Caridea	1	0	0	0	5	0	0	0	13	0	9	0
Anomura	0	0	0	0	0	0	0	33	13	13	0	0

1998 oblique hauls	JAN	FEB 19	FEB 22	MAR	APR	MAY	JUN	AUG	OCT	NOV	DEC
Sergestoidea Protozoea	0	54	8	0	15	0	0	0	8	0	0
Acetes	21	0	17	10	63	17	18	0	8	2	9
Lucifer	5	15	8	80	0	0	0	0	0	0	15
Xiphopenaeus kroyeri	0	21	0	10	3	17	0	22	0	0	0
Thalassinidea	55	4	58	0	16	0	27	22	77	93	68
Caridea	5	0	0	0	0	67	45	56	0	2	8
Anomura	12	2	8	0	0	0	0	0	8	0	0

1999 Oblique hauls	JAN	FEB	MAR	APR	MAY	JUN	AUG	SEP	OCT	NOV	DEC
Sergestoidea Protozoea	0	11	12	30	10	0	0	0	0	13	2
Acetes	8	2	4	12	0	0	4	18	25	0	6
Lucifer	42	62	53	7	50	44	24	12	25	4	25
Xiphopenaeus kroyeri	16	2	27	45	20	0	0	0	0	2	0
Thalassinidea	32	19	2	4	15	38	28	47	50	69	64
Caridea	3	2	0	0	0	0	32	24	0	4	1
Anomura	0	0	2	0	0	0	0	0	0	9	1

Among the holoplanktonic decapods, *Lucifer faxoni* (Borradaile, 1915) highest larvae production was registered in July in São Paulo coast (Alvarez, 1985) and in September in Guanabara Bay (Cardoso, pers. comm.), both results being different from our summer production. *Acetes* protozoe abundance peaks were registered in summer in southern waters in Rio Grande do Sul, indicating the influence of temperature in the species spawning (Calazans, 1994). There were no data available about the spawning season of the Thalassinidea, Caridea or Anomura in the adjacent environments. Our results showed that they have a large reproductive season but their input of larvae in the planktonic community is specially important during winter and spring.

Regarding the *X. kroyeri* larvae, we must consider that the center of the spawning area can change in space and time; in general it occurs at the same time of the area of commercial fisheries (Jones *et al.*, 1970). The ideal sampling strategy should cover the fisheries ground and should be done with at least one week interval, once that the larvae can take only one month from protozoe to post larvae. As the results were very similar in both years, we could suggest some hypotheses.

Adult females of *X. kroyeri*, with developed gonads, were found during the whole year (Ennes, 2000) but the occurrence of larvae in plankton samples indicated that the middle summer is the period of highest production and larvae survival. In Florida the highest larvae concentration were also associated to warm temperature (Jones *et al.*, 1970).

During early summer and autumn the temperature of the water allowed the reproduction of many Sergestoidea, so it is amazing that even having mature females of *X. kroyeri* in the sea, we didn't capture their larvae. Besides, during February and March, when we found their larvae, the shrimp trawling of *Pennaues* is forbidden in the area. Therefore *X.kroyeri* is not capture too. We believe that during the rest of the year the intensive capture of shrimps decreases the probability of successful breeding and production of larvae. When the shrimp fisheries is closed the abundance of adults increases and therefore the breeding success and the production of larvae. At that time, the contribution of *X. kroyeri* larvae in the plankton community also increases, indicating that the plankton community is also impacted by the fisheries/ no fisheries cycle.

We believe that the fisheries closure to other peneids species is favoring the *X. kroyeri* population and is important to improve their reproduction and the input of *X. kroyeri* larvae in the sea water.

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References

Amado, M. D. 1978. Estudo biológico do *Xiphopenaeus kroyeri* (Heller, 1862) camarão sete barbas (Crustacea-Penaeidea) de Matinhos- Paraná, 94 pp. MSc. Dissertation Zoology. Universidade Federal do Paraná, PR.

Alvarez, M. P. J. 1985. Migração vertical e *Lucifer Faxoni* Borradaile, 1915 (Crustacea, Decapoda) nas águas ao largo de Santos, Brasil. Boletim de Zoologia da Universidade de São Paulo, 9: 177-193.

Botsford, L. W.; Moloney, C. L.; Hastings, A.; Largier, J. L.; Powell, T. M.; Higgins, K. and Quinn, J. F. (1994) The influence of spatially and temporally varying oceanographic conditions on meroplanktonic metapopulations. Deep-Sea Research II 41(1): 107-145.

Branco, J. O.; Lunardon-Branco, M. J., and Definis, A. 1994 The growth of *Xiphopenaeus kroyeri* (Heller, 1862) (Crustacea, Natantia, Penaeidae) from the Matinhos region, Paraná state, Brazil. Arquivos de Biologia e Tecnologia 37:(1) 1-8 1994.

Branco, J. O.; Lunardon-Branco, M.; Souto, F. X. and Guerra, C. R. 1999. Population structure of sea bob shrimp, *Xiphopenaeus kroyeri* (Heller, 1862), at the mouth of the Itajai-Açu river (Santa Catarina, Brazil). Brazilian Archives of Biology and Technology , 42:(1) 115-125 1999.

Calazans, D. 1993. Key to the larvae and decapods of genera of the Infraorder Penaeidea from the southern Brazilian coast. Nauplius. 1: 45-62.

Calazans, D. 1994. Morphology, abundance and distribution of larval phases of two sergestides in the southern Brazilian coast. Nauplius. 2: 75-86.

Cook, H. L. 1966. A generic key to the protozoean, mysis, and post larval stages of the littoral Penaeidae of the Northwestern Gulf of Mexico. Fishery Bulletin, 66 (2): 437- 447.

Dittel, A. I.; Epifanio, C. E. and Lizano, O. 1991. Flux of crab larvae in a mangrove creek in the Gulf of Nicoya, Costa Rica. Estuarine Coastal anda Shelf Sciences, 32: 129-140.

Ennes, R. A. L. 2000. Aspectos populacionais e da pesca do camarão sete barbas *Xiphopenaeus kroyeri* (Helle, 1862) (Crustacea: Decapoda: Penaeidae) obtidos na pesca artesanal do Balneário Shangri-lá, Paraná, 55 p. MSc. Dissertation Zoology, Universidade Federal do Paraná.

Jones, A. C.; Dimitriou, D. E.; Ewald, J. J. and Tweedy, J. H. 1970 Distribution of early developmental stages of pink shrimp, *Penaeus duorarum*, in Florida waters. Bulletin of Marine Sciences, 26(2): 634-661.

Lhomme, F. 1997 Recruitment of postlarvae of the shrimp *Penaeus subtilis* (Perez Farfante, 1967) in 2 estuaries of French Guiana. Annales de l' Institut Oceanographique 68:(1-2) 169-178.

Loyola, E.; Silva, J. and Nakamura, I. T. 1982. Espécies de *Penaeus* Fabricius, 1798 (Crustacea, Penaeidae) do litoral do Estado do Paraná. Acta Biologia Paranaense, 10/11: 199-214.

Mendonça, J. T. 1997. Projeto Pesca sul paulista- estatística pesqueira no litroal sul paulista. Anais do VII Congresso LatinoAmericano sobre Ciências do Mar. Resumo expandido, vol.II p.160-161

Nakagaki, J. M. and Negreiros-Fransozo, M. L. 1998. Population biology of *Xiphopenaeus kroyeri* (Heller, 1862) (Decapoda : Penaeidae) from Ubatuba Bay, Sao Paulo, Brazil. Journal of Shellfish Research 17:(4) 931-935.

Renfro, W. C. and Cook, H. L. 1963. Early larval stages of the Sea bob *Xiphopenaeus kroyeri* (Heller). Fishery Bulletin, 63(1): 165-177.

Schwamborn, R.; Ekau, W.; Silva, A. P.; Silva, T. A. and Saint-Paul, U. 1999.The contribution of estuarine decapod larvae to marine zooplankton communities in North-East Brazil Archive of Fishery and Marine Research 47: (2-3) 167-182.

Valentini, H.; D'Incao, F.; Rodriguez, L. F.; Neto, J. and Domit, L. G. 1991. Análise da pesca do camarão sete barbas (*Xiphopenaeus kroyeri*) nas regiões sudeste e sul do Brasil. Atlântica, 13(1): 172-177.

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