

# Three small-scale fisheries based on the island of Majorca (NW Mediterranean)

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Around 45 % of the fishing fleet based on the island of Majorca (northwestern Mediterranean) engages in three seasonal fisheries directed at the transparent goby, *Aphia minuta* (from December to March), lobster, *Palinurus elephas* (from March to August), and dolphinfish, *Coryphaena hippurus* (from August to December). In 1991-92, the boats engaging in the lobster fishery amounted to 32 % of the total number of boats and were based around the entire island; 13 % of the total number of boats engaged in the transparent goby fishery and were based mainly in the vicinity of the bays; and 12 % of the total number of boats engaged in the fishery for dolphinfish and pilotfish (*Naucrates ductor*), the main by-catch species in that fishery. The number of units allocated to each of these fisheries remained relatively constant over the period 1982-1992, although the number of units operating in the lobster fishery exhibited a certain tendency to increase. The gears used are boat seines in the transparent goby fishery, trammel nets in the lobster fishery, and purse seines in the dolphinfish fishery. Yields in the transparent goby fishery declined from 1983 to 1987, remained stable from 1987 to 1990, and recovered in 1991. Yields in the dolphinfish and pilotfish fishery have remained stable at around 2.2 tonnes/boat since 1988. Catch data on lobsters are scarce, the only estimate being 77.7 t in 1986. The size distributions for lobster were highly variable in 1986 and 1988, with males tending to have larger sizes. The size distributions in the transparent goby catches ranged from 14 to 45 mm in the 1990-91 and 1991-92 fishing seasons and exhibited progressive increases in the minimum, maximum, and mean sizes during the fishing season. Monthly size distributions and mean size values for dolphinfish and pilotfish in 1990 and 1991 are indicative of rapid growth of these species during the fishing season.

**Key words:** small-scale fisheries, Majorca, NW Mediterranean, *Aphia minuta*, *Palinurus elephas*, *Coryphaena hippurus*, *Naucrates ductor*.

TRES PESQUERIAS DE ARTES MENORES DE LA ISLA DE MALLORCA (MEDITERRANEO NOROCCIDENTAL). El 45% de la flota pesquera de la isla de Mallorca (Mediterráneo Noroccidental) se dedica a tres pesquerías estacionales

dirigidas a la captura de *jonquillo* (*Aphia minuta*) de diciembre a marzo, langosta (*Palinurus elephas*) de marzo a agosto y llampuga (*Coryphaena hippurus*) de agosto a diciembre. En 1991-1992, el número de barcos dedicados a la pesca de langosta fue el 32% del total, distribuidos alrededor de toda la Isla, el 13% se dedicó a la pesca de *jonquillo* principalmente en la zona de bahías y el 12% a la pesca de llampuga y pez piloto (*Naucrates ductor*), principal especie acompañante de esta pesquería. El número de unidades dedicados a cada pesquería durante el periodo 1982-1992 ha permanecido bastante estable, con cierta tendencia a aumentar en la pesquería de langosta. Los artes utilizados en cada pesquería son la jábega para el *jonquillo*, trasmallos para la langosta y red de cerco para la *llampuga*. La CPUE de *jonquillo* descendió desde 1983 hasta 1987, manteniéndose estable desde 1987 hasta 1990 y recuperándose en 1991. Desde 1988, la CPUE de *llampuga* y pez piloto se ha mantenido estable, alrededor de las 2.2 Tm/barco. Los datos de captura de langosta son escasos, sólo se poseen estimaciones que en 1986 las situaban en 77.7 Tm. En 1986 y 1988, las distribuciones de tallas de langosta muestran gran variabilidad, con tallas superiores para los machos, mientras que el rango de distribución de tallas de la captura de *jonquillo* en las temporadas 1990-91 y 1991-92 fue de 14-45 mm, con un aumento progresivo de las tallas mínima, máxima y media a lo largo del periodo de explotación. Las distribuciones mensuales y la talla media de captura de *llampuga* y pez piloto en 1990 y 1991 muestran un rápido crecimiento de estas dos especies durante su explotación.

**Palabras clave:** pesquerías de artes menores, Mallorca, Mediterráneo Noroccidental, *Aphia minuta*, *Palinurus elephas*, *Coryphaena hippurus*, *Naucrates ductor*.

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## Introduction

The small-scale fisheries based on the Island of Majorca (northwestern Mediterranean) between 38°35'-40°05' N and 04°20'-01°15' E) (Fig. 1) have from antiquity been a major human activity. There is a record of regulations for the beach-seine fishery dating from the beginning of the sixteenth century. At the end of the last century, of the 273 boats based on the island, 241 were engaged in the small-scale fisheries (Archiduque Luis Salvador, 1957).

Large numbers of boats have been and are engaged in this traditional

activity commensurate with its importance. A census carried out in 1988 (Govern Balear, 1989) recorded a total of 401 boats in small-scale fisheries, representing 83.2 % of the units in the island's fishing fleet, with a total of 1 398 GRT and 15 282 HP. The boats are typical Mediterranean wooden boats, on average 8 m in length, 6 GRT, with 70-HP engines.

Around 45 % of this fleet is engaged in the three main seasonal fisheries directed at: (i) transparent goby

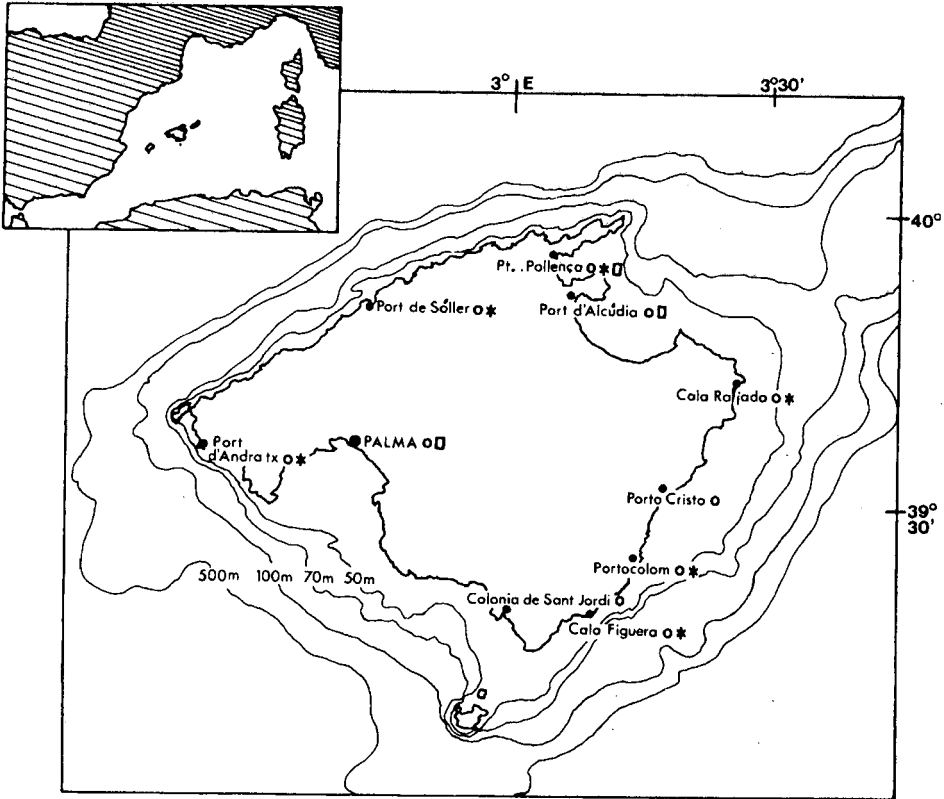


Fig. 1. Map of the island of Mallorca showing the main harbours where the fleets engaged in the □ transparent goby, ○ lobster, and \* dolphinfish fisheries are based.

Fig. 1. Mapa de la isla de Mallorca mostrando las principales bahías donde actúan las flotas pesqueras relacionadas con el □ jonquillo, la ○ langosta y la \* llampuga.

(*Aphia minuta*, Risso 1810) from December to March, using a boat seine over bottoms of hard sand, pebbles, or flat rock between 5 and 60 m depth (Iglesias & Martorell, 1988); (ii) common spiny lobster (*Palinurus elephas*, Fabricius 1787) from March to August, with trammel nets deployed on rocky bottoms at depths between 50 and 150 m (Iglesias & Martorell, 1988); and (iii)

dolphinfish (*Coryphaena hippurus*, Linnaeus 1758) from August to December, based in the use of surrounding nets without purse line around fish aggregation devices outside the 70 m. isobath (Massutí & Morales-Nin, 1991). Catches of these species earn high economic value and are caught mainly for consumption in the local market.

Other small-scale fisheries developed in the Island are directed to cuttlefish (*Sepia officinalis*), red mullet (*Mullus surmuletus*), common seabream (*Pagrus pagrus*), common dentex (*Dentex dentex*), greater amberjack (*Seriola dumerilii*), and squid (*Loligo vulgaris*), taken with trammel nets, gillnets, longlines, pound nets, and rippers.

Despite the importance of these small-scale fisheries on the island, data are scanty. The only existing studies are descriptive studies dealing with the fleet, gear, fishing methods, and target species (Lozano-Cabo, 1961; Llabrés & Martorell, 1984; Iglesias & Martorell 1986).

The seasonal nature of these fisheries and the biological characteristics of the target species make application of classic population dynamics models difficult. Furthermore, determination of fishing effort and monitoring of the catches is complicated, and hence there is no adequate historical data series for use in such models.

The present paper examines the fishing effort, historical catch series for the last ten years and the size composition of the catches in the three main small-scale fisheries in Majorca: the transparent goby, lobster, and dolphinfish fisheries. Pilotfish, the main by-catch in the dolphinfish fishery, has also been considered.

## Materials and Methods

The fleet data were collected by census taken by the local fisheries department from the licenses issued yearly for each of the fisheries to the boats at the request of the masters and

from information provided by fishermen's associations at different harbours on the Island.

Detailed data on monthly catches and on the value of the catches were obtained from the central fish auction wharf in Palma, where catches offloaded at all the ports on the island are sold fresh. However, some fish is sold directly by fishermen to private parties and restaurants. This is generally the rule for lobsters, which are kept alive and sold directly to restaurants and fishponds for subsequent sale, in which case detailed data on monthly catches and their value were obtained directly from some fishermen's detailed records.

Data on total seasonal catches in tonnes were converted to catch per unit effort (cpue) expressed as the number of boats for each season, since other effort measures such as number of sets, number of trammel nets hauled, etc. are unavailable. Because dolphinfish and pilotfish are captured together, the cpue (catch/boat) was calculated for both species combined.

Detailed length composition data were obtained whenever possible from the central fish auction wharf and from samples taken in port or on board boats. Table 1 summarizes the available data for each species.

## Results

### *Fleet and fishing effort*

Palma, Alcúdia, and Pollença are the main harbours where the fleet directed at transparent goby is based, while Sóller, Pollença, Cala Rajada, Portocolom, Cala Figuera, and Andratx

SPECIES	DATA	SOURCE	PERIOD	
<u>Aphia minuta</u>	Catches	Central Fish Auction Wharf	1981-1992	
	Length frequency	Central Fish Auction Wharf	1990-1991 1991-1992	N=2411 N=2718
<u>Palinurus elephas</u>	Catches	Sampling on harbours	1986	
	Length frequency by sexes	Sampling on fishponds	1986 1988	N=762 N=176
<u>Coryphaena hippurus</u>	Catches	Central Fish Auction Wharf	1981-1991	
	Length frequency	Sampling on boats	1990 1991	N=2635 N=1449
<u>Naucrates ductor</u>	Catches	Central Fish Auction Wharf	1981-1991	
	Length frequency	Sampling on boats	1990 1991	N=738 N=1548

**Table 1.** Catches, length composition and data sources used in the study.  
*Tabla 1. Capturas, composición longitudinal y fuentes de los datos empleados en este estudio.*

are the main harbours for the dolphinfish fleet. Boats engaged in the lobster fishery are deployed at all the harbours on the island (Fig. 1).

The official proportions of the fleet engaged in each fishery in the 1991-92 fishing season were 32 % in the lobster fishery, 13 % in the transparent goby fishery, and 12 % in the dolphinfish fishery. According to estimates made through trips to the harbours, by the fishermen's associations, and by interviews with sector representatives, only 40-50 % of the boats in the census are full-time professional fishing boats operating all year round. Therefore, official figures do not reflect the true situation,

in that many boats do not fish continuously throughout the year but only in the summer, when the weather is good and demand for catches is high.

Fig. 2 graphically represents the available data on the number of boats over the past 10 years. The number of boats has remained relatively stable, with slight fluctuations depending on the year. On the whole, more boats are engaged in the dolphinfish fishery than in the transparent goby fishery. The scant data available on the lobster fleet indicate that there are approximately 100 units in operation and that there has been a certain tendency to increase over the period considered.

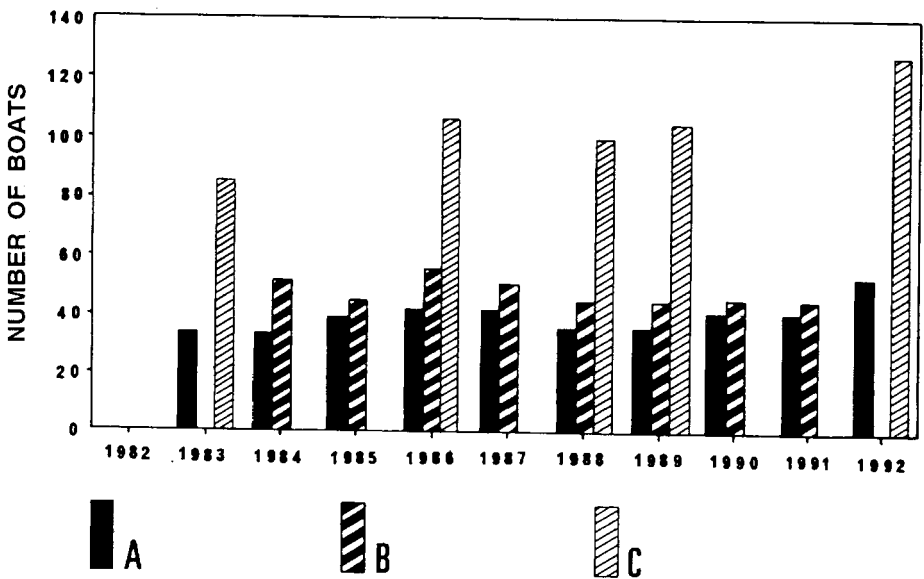


Fig. 2. Number of units in the fleets engaged in the transparent goby (A), dolphinfish (B), and lobster (C) fisheries.

Fig. 2. Número de unidades capturadas por las pesquerías de jonquillo (A), llampuga (B) y langosta (C)

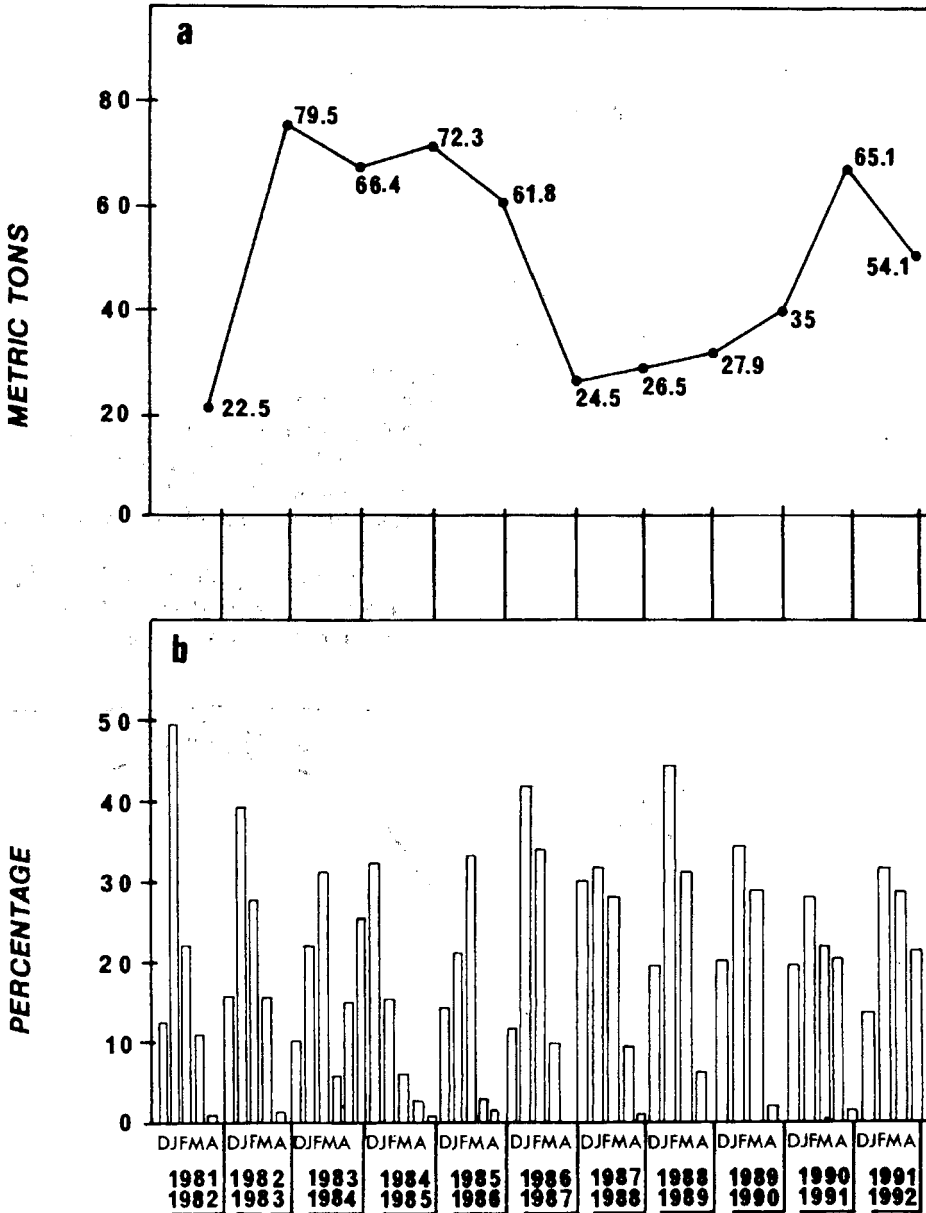


Fig. 3. Historical catch series (a) and monthly catch trends (b) for transparent goby.  
 Fig. 3. Series histórica (a) y tendencias mensuales de captura (b) del jonquillo

**Commercial catches, cpue, and economic value of the catch**

Total annual lobster catches are not available because of direct marketing of the catches by fishermen and fishermen's reluctance to keep records. The only information available is an estimated catch of 77.7 t in 1986.

The situation for the transparent goby is the converse, since all catches are sold through the central fish auction wharf. The historical data series on catches (Fig. 3a) displays two clearly distinct periods corresponding to the period before fishery regulations and after the introduction of regulatory measures in 1987-88. In the earlier period, when fishermen operated freely, catches ranged around 70 t. Following the introduction of catch limitations in

the form of a pre-established maximum daily catch per boat, catches declined to 24.5 t in 1986-87 and then increased gradually until by 1990-91 they had climbed back to a figure similar to the former level.

The main part of transparent goby catches are taken in the first three months of the fishing season, with the highest catches being made in January in most years (Fig. 3b), except during the period from 1983 to 1986, when the highest catches were taken at the beginning of the season (1984-85) or in February (1983-84 and 1985-86). In addition, substantial catches were also recorded at the end of the season in 1983-84.

Catch rates (catch/boats) in the transparent goby fishery (Fig. 4) decreased from 1983 to 1987. Cpue

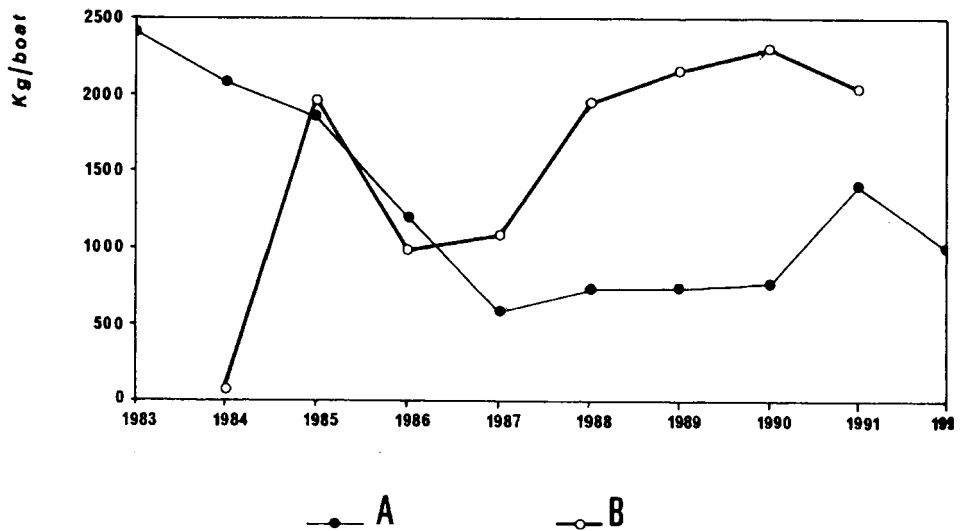


Fig. 4. Catch rates (kg/boat) in the transparent goby (A) and dolphinfish (B) fisheries.  
Fig. 4. Tasas de captura (Kg/barco) del jonquillo (A) y la llampuga (B).



values for the period 1987-1990 were rather similar, with the exception of 1990-91, when cpue values were higher, similar to the levels in the period before regulation of this fishery. In the most recent fishing season

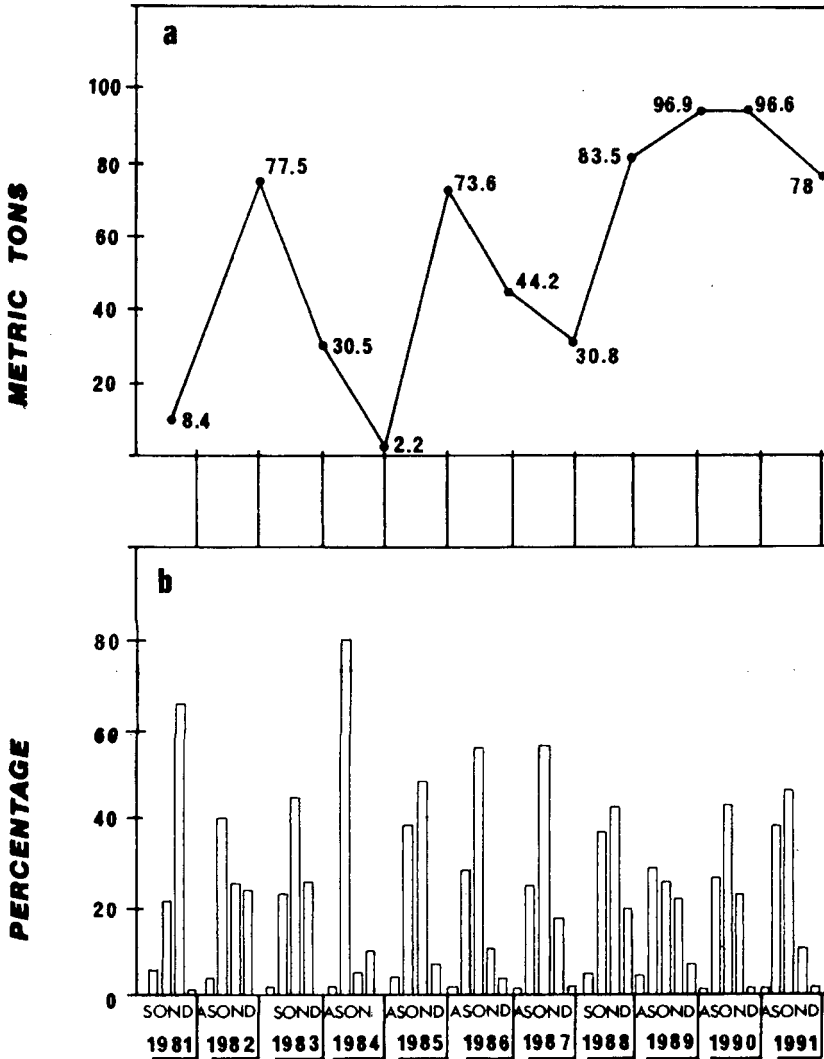


Fig. 5. Historical catch series (a) and monthly catch trends (b) for dolphinfish.  
 Fig. 5. Serie histórica (a) y tendencias mensuales de captura (b) de la llampuga.

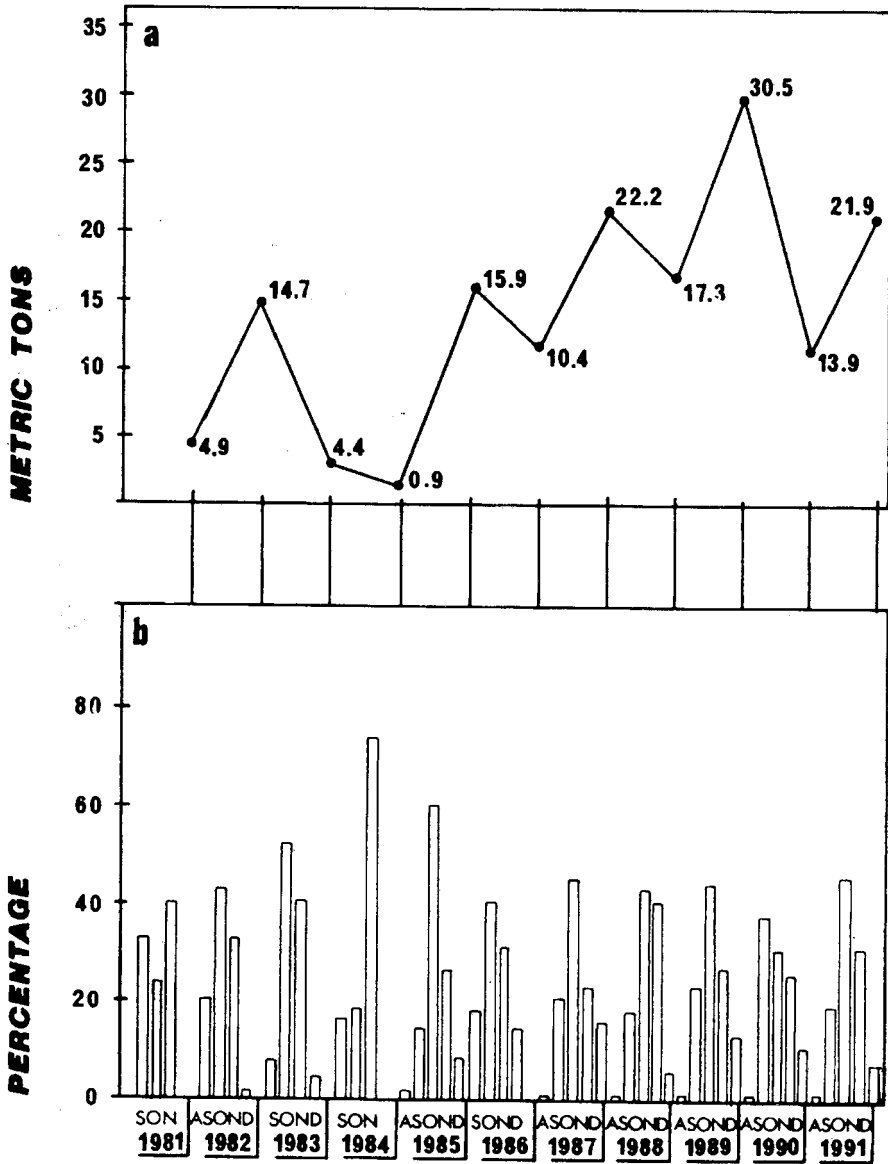


Fig. 6. Historical catch series (a) and monthly catch trends (b) for pilotfish.  
 Fig. 6. Serie histórica (a) y tendencias mensuales de captura (b) del pez piloto.

(1991-92), catches decreased significantly, because of lower catches in Palma Bay, where another goby, *Pseudaphia ferreri*, was very abundant.

Annual catches of dolphinfish (Fig. 5a) display marked fluctuations until 1987, after which they were more stable at more than 70 t until 1991. Catches of pilotfish, though smaller than those of dolphinfish, followed the same pattern of fluctuations (Fig. 6a); however, after 1987 they have continued to fluctuate, with a certain tendency to increase. Again, the catch data for this fishery are underestimated because of direct marketing of around 30% of catches by fishermen, principally in the case of dolphinfish.

The monthly catch distributions (Fig. 5b and 6b) reflect the short duration of the fishery. Landings of these two species took place mainly from September to November. Catches were lower at the beginning of the fishing season in August and at the end of the season in December and in some years were nil or negligible, especially in the case of pilotfish in August and dolphinfish in December.

The cpue data series for the dolphinfish fishery (calculated for dolphinfish and pilotfish together) displayed the same fluctuating trend as the catches, but the fluctuations were slightly less pronounced.

The data on the economic value of the catches (Table 2) over the study period showed that the higher price for transparent goby, more highly regarded than dolphinfish, was offset by the greater abundance of this latter species, such that the economic importance of dolphinfish was very similar to that of transparent goby. Pilotfish is not overly

popular and represents only a small proportion of the value of the total commercial catch.

The mean price for lobster in recent years has ranged from 4 000 and 6 000 pts/kg, and hence in line with the estimated 1986 catch represented a value of 388.5 millions pts. Accordingly, this species is not only one of the main contributors to the catches during the summer months but is the most profitable for the small-scale fleet.

### **Population structure**

The size range for transparent goby in 1990-91 and 1991-92 was 14 to 45 mm and tended towards somewhat larger sizes in 1990-91. The monthly catch distributions (Fig. 7 and 8) indicate that the minimum, maximum, and mean sizes increased over the fishing season and also that at least two modal size groups were present throughout the season. These two size groups may reflect two different spawning seasons.

The size distributions for lobster by sex are depicted in Figures 9 and 10. For males the monthly mean size ranged from 87 to 107 mm in 1986; the minimum size recorded was 70 mm and the maximum size recorded was 160 mm. In 1988 the monthly mean size ranged between 93 and 113 mm, the minimum size being 80 mm, and the maximum size 120 mm.

For females, the mean monthly size ranged from 82 to 97 mm in 1986, with a minimum size of 60 mm and a maximum size of 140 mm. In 1988 the monthly mean size ranged between 89 and 95 mm, with a minimum size of 80 mm and a maximum size of 120 mm.

YEAR	TRANSPARENT GOBY			DOLPHINFISH			PILOTFISH		
	Pts/Kg	Pts* Total	Percentage	Pts/Kg	Pts* Total	Percentage	Pts/Kg	Pts* Total	Percentage
1981				461.9	3.9	1.50	252.3	1.3	0.57
1982	510.3	11.5	3.59	292.2	22.6	5.61	172.2	2.5	0.63
1983	356.1	28.2	5.69	473.4	14.4	4.77	305.0	1.4	0.35
1984	565.0	37.5	6.34	992.1	2.2	0.46	509.3	0.5	0.15
1985	561.2	40.6	6.16	400.0	29.4	4.64	190.3	3.0	0.47
1986	689.9	35.7	5.53	491.5	21.7	3.73	173.5	2.8	0.62
1987	956.3	23.4	6.06	651.0	20.1	3.18	219.4	4.9	0.77
1988	1002.4	26.6	5.00	424.3	35.4	6.00	242.9	4.2	0.71
1989	838.2	23.4	5.04	413.2	40.1	7.16	205.3	6.3	1.20
1990	813.3	28.4	6.14	380.9	36.8	6.00	284.4	4.0	0.64
1991	959.3	62.5	9.99	480.8	37.5	5.01	249.0	5.4	0.72
1992	859.6	46.2	8.26						

\* Millions

**Table 2.** Economic value of catches of the species considered from the records of the Central Fish Auction Wharf in Majorca (sales of each species expressed as a percentage of the total catch of each species during the fishing season).

*Tabla 2. Valor económico de las capturas extraído de los datos de la Lonja de Mallorca (las ventas de cada especie están expresadas como el porcentaje del total de las capturas de cada especie durante la temporada de pesca).*

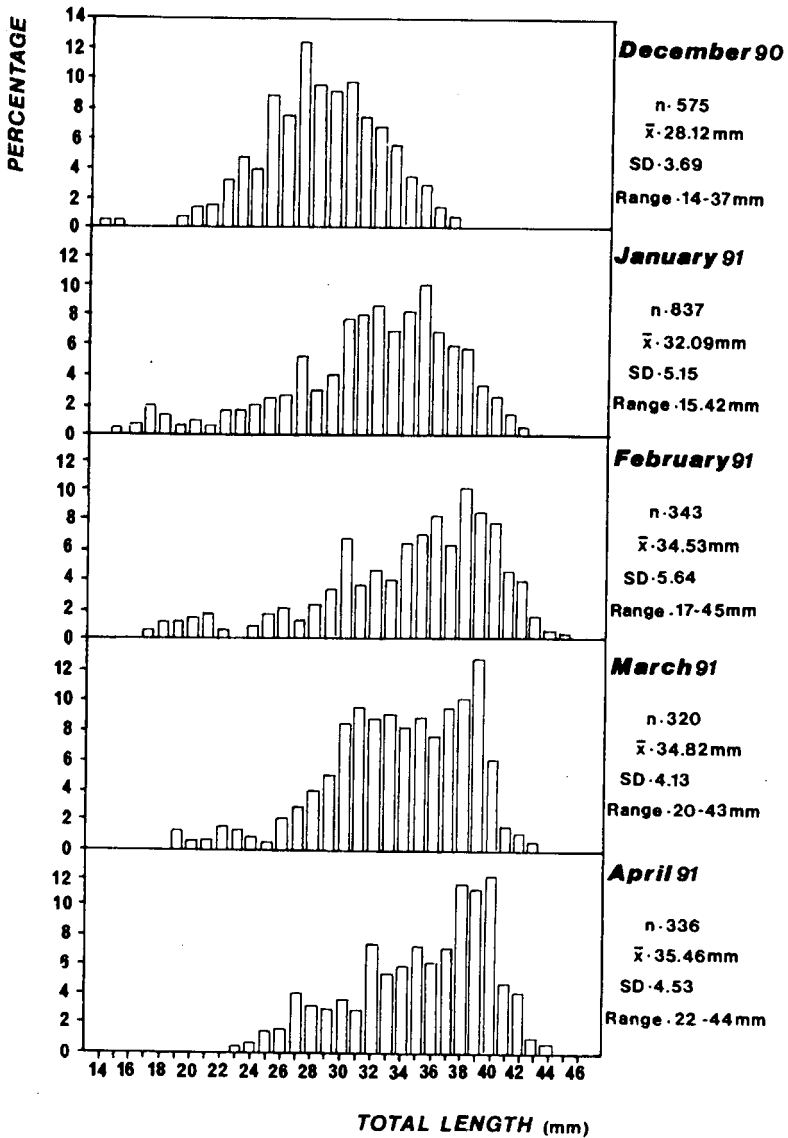
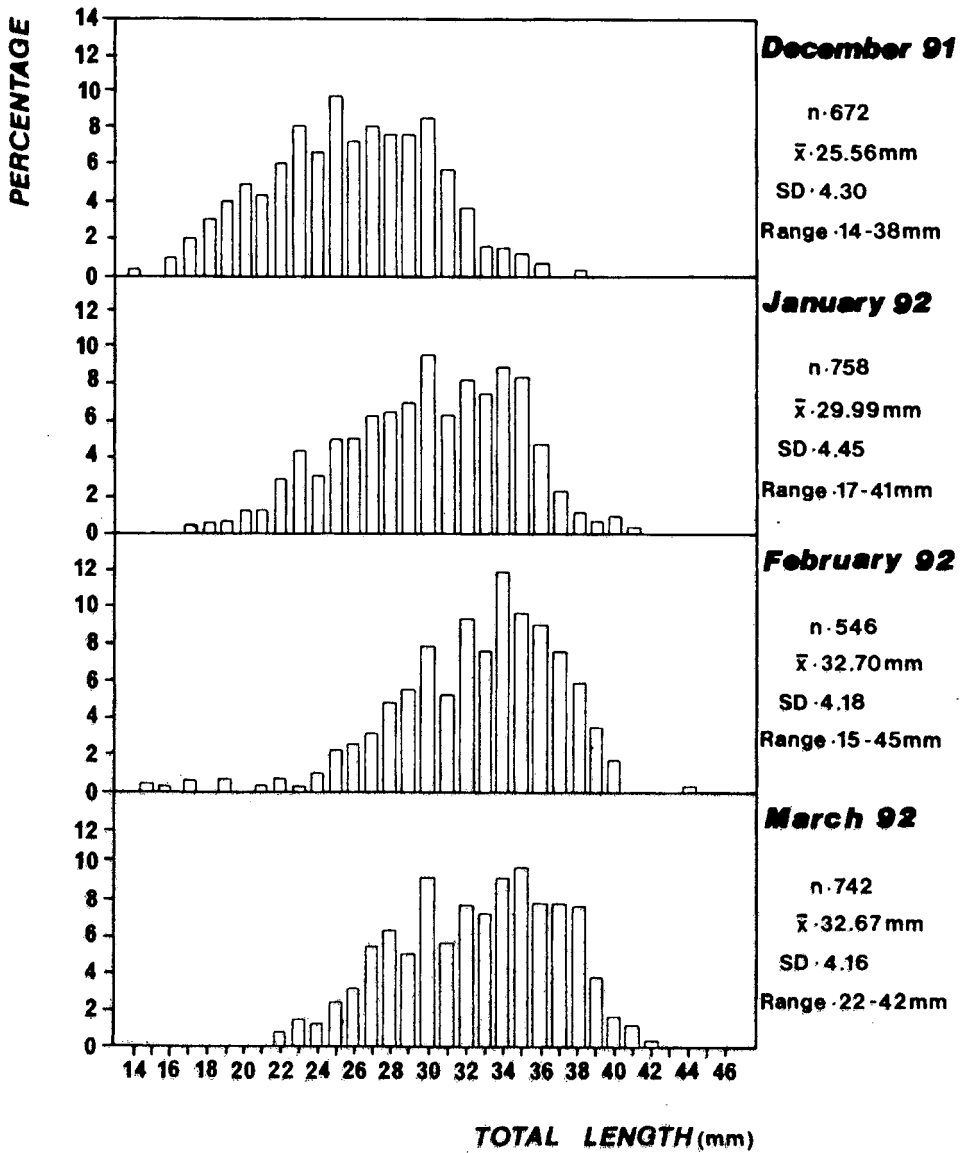


Fig. 7. Monthly size distributions for the transparent goby fishery in the 1990-91 fishing season.

Fig. 7. Distribución mensual del tamaño del jonquillo capturado durante la temporada pesquera 1990-91.



**Figure 8.** Monthly size distributions for the transparent goby fishery in the 1991-92 fishing season.  
*Fig. 8. Distribución mensual del tamaño del jonquillo capturado durante la temporada pesquera 1991-92.*

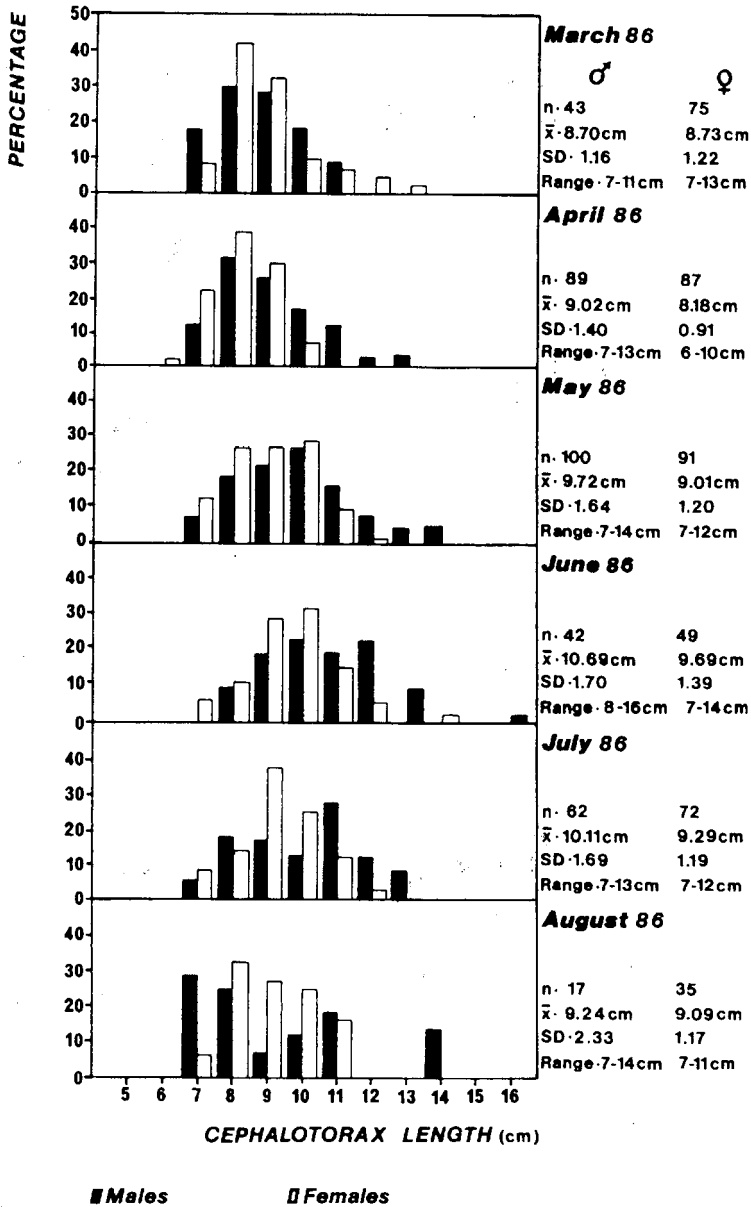


Fig. 9. Monthly size distributions by sex for lobster catches in the 1986 fishing season.  
 Fig. 9. Distribución mensual del tamaño según el sexo de las langostas capturadas durante la temporada pesquera de 1986.

The size distributions for lobster were variable for each month and year by sex. It was not possible to discern any definite pattern or trend in size over the period considered. The difficulty in identifying modes in the size distributions is probably a result of the combined effect of an overlap in size between several age groups and to variations in the relative abundance of

the said age groups in the catches. However, both the mean size and the size spread were larger for males than for females.

The length distributions for dolphinfish (Fig. 11 and 12) indicate that the fishery is based on quite a broad range of lengths (21-70 cm in 1990 and 18-65 cm in 1991), that is, fast-growing juveniles in age group 0 (Uchiyama *et*

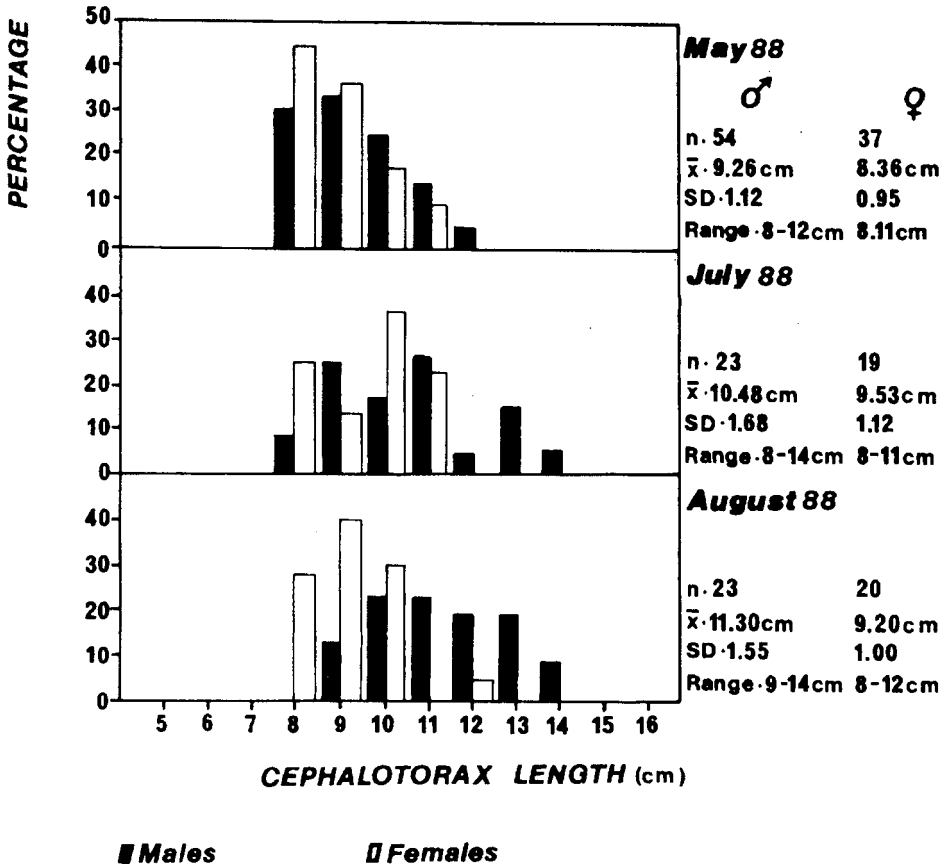


Fig. 10. Monthly size distributions by sex for lobster catches in the 1988 fishing season.  
 Fig. 10. Distribución mensual del tamaño según el sexo de las langostas capturadas durante la temporada pesquera de 1988.



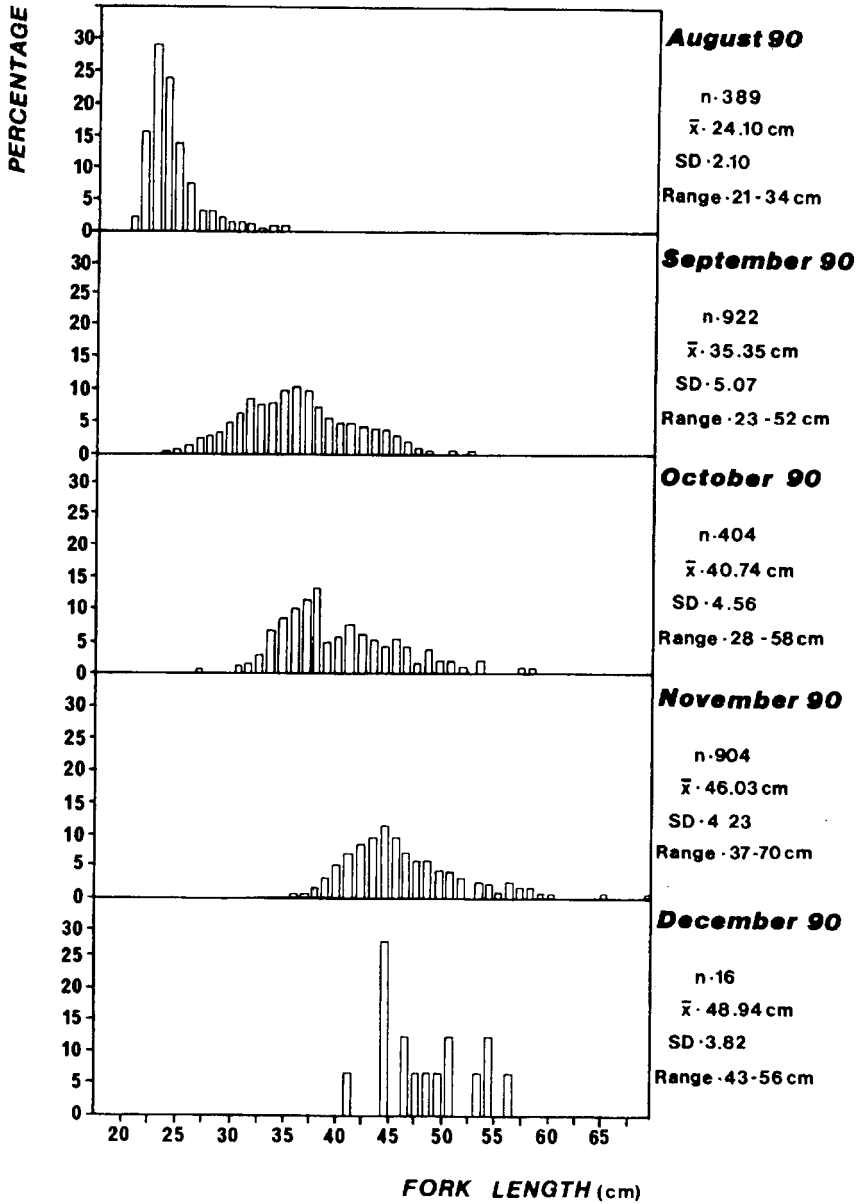


Fig. 11. Monthly size distributions for dolphinfishery in the 1990 fishing season.  
 Fig. 11. Distribución mensual del tamaño de la llampuga capturada durante la temporada pesquera de 1990.

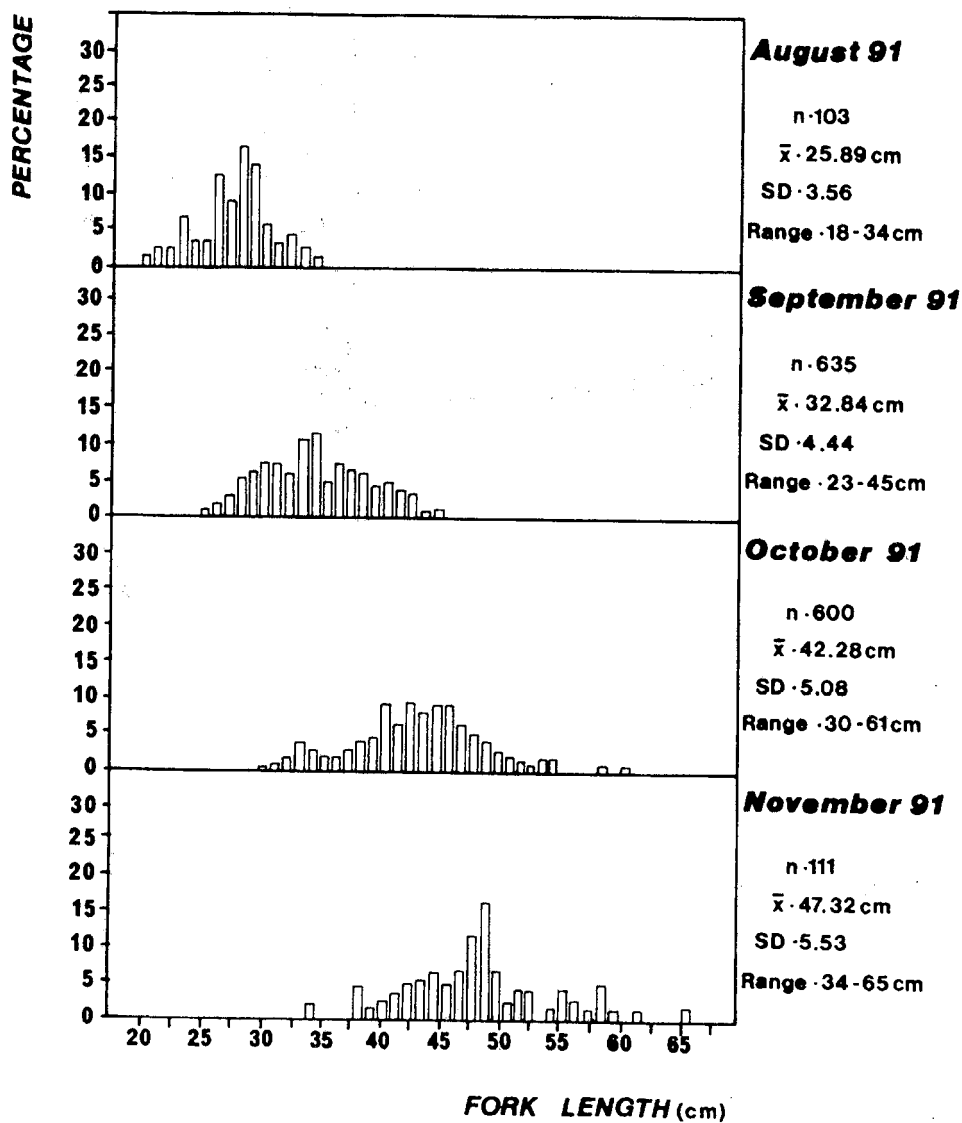


Fig. 12. Monthly size distributions for dolphin fishery in the 1991 fishing season.  
 Fig. 12. Distribución mensual del tamaño del jonquillo capturado durante la temporada pesquera de 1991.

al., 1986). This fast rate of growth is reflected by the increase in the monthly mean length over the fishing season, during which it nearly doubles. The length distribution for December 1990 would appear to suggest that the largest individuals are the first to leave the shoaling and fishing grounds. This

type of behaviour has been reported in other regions (Rose & Hassler, 1974).

The length range for pilotfish catches was from 13 to 29 cm (Fig. 13 and 14). The mean, maximum, and minimum lengths all increased progressively, which is indicative of rapid growth by this species over the

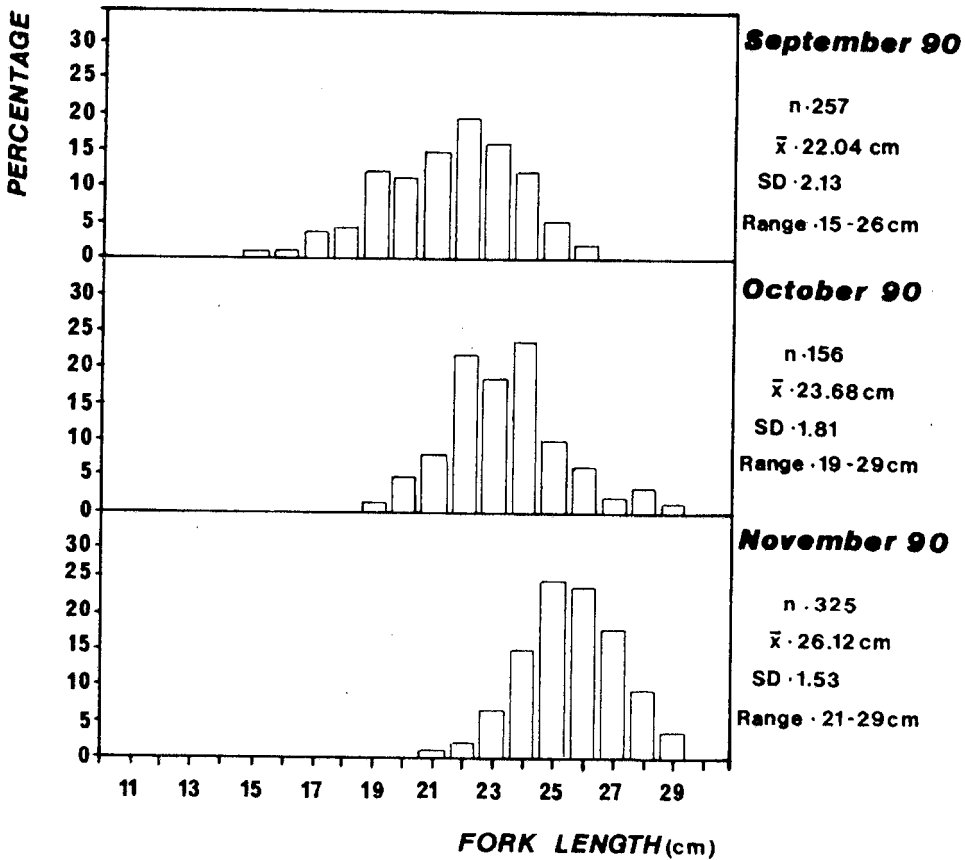


Fig. 13. Monthly size distributions for pilotfishery in the 1990 fishing season.  
 Fig. 13. Distribución mensual del tamaño del pez piloto capturado durante la temporada pesquera de 1990.

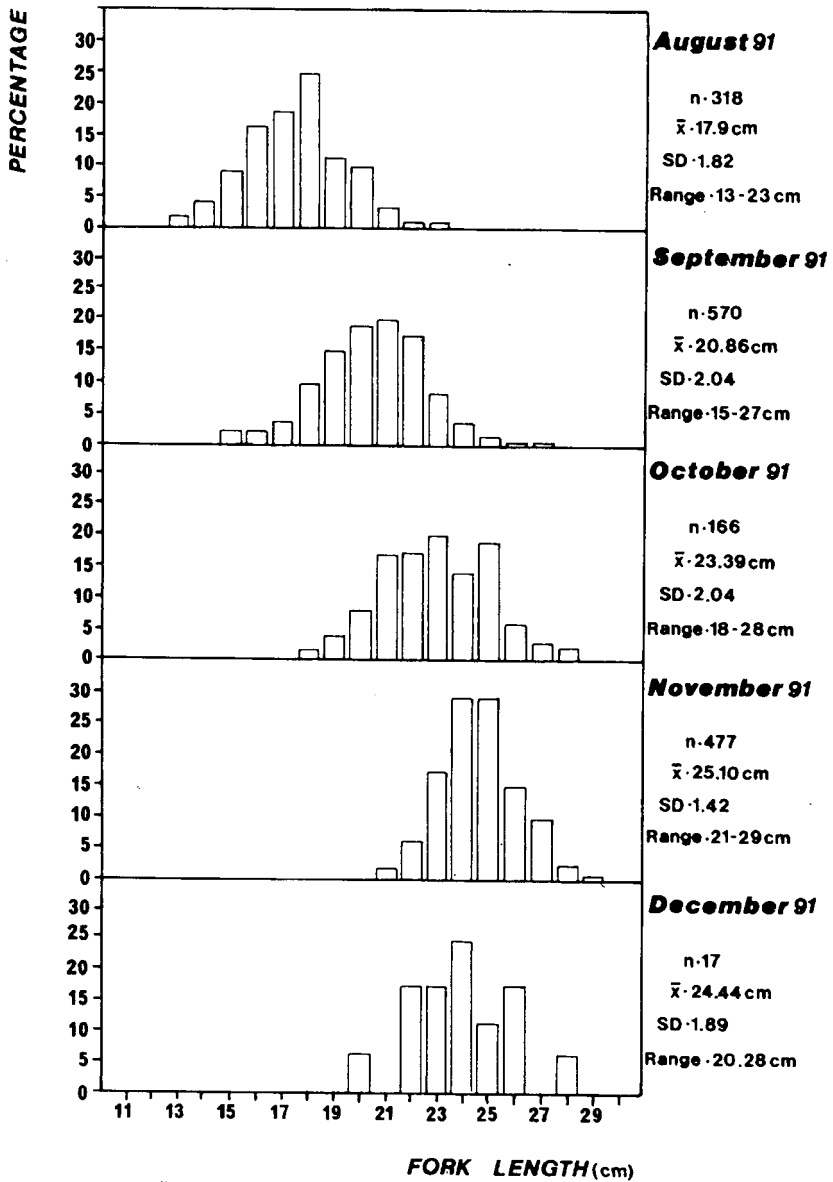


Fig. 14. Monthly size distributions for pilotfishery in the 1991 fishing season.  
 Fig. 14. Distribución mensual del tamaño del pez piloto durante la temporada pesquera de 1991.

fishing season, and this has been corroborated by mariculture experiments (F. Riera, personal communication). Small fish were present in November, which suggests that a second recruitment may take place. These fishes have not been included in the calculations of mean length because they were few in number and were discarded on account of their small size.

## DISCUSSION

The fleet of the small-scale fisheries based on Majorca Island is composed of larger, more powerful boats than in the rest of the Spanish Mediterranean, on average 6 GRT and 70 HP, as opposed to 5 GRT and 35 HP in Catalonia and 3 GRT and 40 HP in Valencia (Martín, 1991). The boats in the small-scale fleet in southern Spain are on average smaller and less powerful as well (Camiñas *et al.*, 1987).

Most of the boats operating continuously all year long engage in the transparent goby, lobster, and dolphinfish fisheries. The lobster fishery is the major fishery both in terms of economic value and number of units operating. The transparent goby and dolphinfish fisheries are similar in terms of number of boats, catches, and economic yield.

Lobster are an extremely valuable commercial species fished throughout the Balearic Islands, particularly in the channel between the islands of Majorca and Menorca, where the shelf is quite broad. The transparent goby and dolphinfish fisheries are conducted solely by boats based on the island of Majorca, where these fisheries enjoy a

long-standing tradition and the species are highly regarded, as opposed to the situation on the other islands.

These three fisheries follow one after another during the year, and exploitation is based on the behaviour and availability of the species. Accordingly, the transparent goby fishery takes place during the winter months, when the species forms spawning aggregations inshore and is vulnerable to the fishery. Lobster can be taken from March to August, and exploitation is most intense in summer, when they are more active predators and catchability increases. The market price and demand for this species also reach their peaks in the summer. The dolphinfish fishery takes place in autumn, when juveniles make their appearance in the area in response to oceanographic conditions and the species' migratory behaviour.

Study of the small-scale fisheries in Majorca is hindered by the lack of reliable data over a sufficiently long period of time. A considerable proportion of the registered fishing units in the fleet (around 50-60 %) is known to be operative only sporadically (mainly in summer), and hence fishing effort is overestimated. The reasons for this underutilization of the fleet are socio-economic, in that tourism and commerce are the primary sources of income in the islands. Because of the importance of these sectors, fishing is sometimes carried out as a complementary activity.

Based on available data, fishing effort (number of boats) has remained rather stable over the past ten years, subject to slight fluctuations and a certain tendency to increase in the

lobster fishery, which may in fact be due to tighter control of the fleet and consequently to more accurate records.

The lack of specific data in the lobster and dolphinfish fisheries is another major difficulty. Thus, there are no data on real effort (number of trammel nets hauled by season in the lobster fishery and number of fish aggregation devices emplaced and sorties effected in the dolphinfish fishery), while recorded catches of dolphinfish and pilotfish are underestimated because of direct sales in local markets, and there is no record of lobster catches at all. The transparent goby fishery is the most documented, since all the catches taken in this fishery are sold at the central fish auction wharf in Palma and the fleet is regulated by the local fisheries department through a licensing system.

The transparent goby fishery concentrates on fast-growing individuals with a life-span of only one year and hence is to a great extent dependent upon recruitment success. Both catches and catch rates have undergone a considerable decline from 1982-83 to 1986-87, when regulation of this fishery set a catch quota per boat per day and limited fishing to weekdays. Though the basis for these measures was solely economic (seeking to raise the market price for this species), the effect on the state of this stock has been positive in that, in combination with the poor weather conditions often encountered during the fishing season, which prevent boats from putting out to sea, total catches decreased. The catch rate has gradually recovered since the 1986-87 season.

Though subject to fluctuations, landings in Majorca tend to be higher

than those in similar fisheries elsewhere in the Mediterranean, such as Murcia (from 7 to 23 t/year) (Martínez-Baño *et al.*, 1991), the northern Tyrrhenian Sea (from 4 to 22 t/year) (Serena *et al.*, 1990), and the central Adriatic (5 t/year) (Mancini & Cavinato, 1969).

The dolphinfish fishery exploits the juvenile stages of the target species, and therefore the large fluctuations in the catches and catch rate in this fishery may be the result of variations in annual recruitment due to changes in environmental conditions, spawning, and the migratory behaviour of the species. Dolphinfish and pilotfish undergo rapid growth during the fishing season, reflected in the monthly length distributions in the catches and in the mean monthly length values.

Dolphinfish is the target species in this fishery because of both its higher market value and its higher volume of catches. Though in recent years landings of this species have held steady at above 70 t, catches are low in comparison with those in the other two fisheries conducted elsewhere in the Mediterranean. Since 1981 catches in Malta have ranged from 170 to 570 t, whereas in Tunisia catches have been more constant at around 300 t (J. Caddy, personal communication).

The seasonality of this fishery is not exclusive to the Balearic Islands; rather, it is a characteristic of all the fisheries for this species, both in tropical and in subtropical regions (Kojima, 1955; Williams & Newell, 1957; Oxenford & Hunte, 1986; Mahon, 1987; Patterson & Martínez, 1991). The fishing season for this species in the rest of the Mediterranean (in both Malta and Tunisia) is the same as in Majorca.

Unlike the other two fisheries, the lobster fishery is directed at a slow-growing, species with a long life-span (of from 10 to 15 years) which is reflected in the absence of clearly defined modal size classes in the size frequencies. The only catch data for this fishery is an estimate of 77.7 t in 1986. This figure is at the lower end of the range of estimates calculated by Campillo (1982) and Marín (1987) on the island of Corsica, which ranged from 70 to 200 t, depending upon the year.

Despite the lack of reliable catch and effort data, the lobster fishery can be considered the most stable on the basis of the information provided by fishermen and fishermen's associations and compiled by monitoring the annual catches taken by selected units of the fleet, all of which concur in that catches have held steady in recent years. Moreover, during the years in which boats have been monitored (1983-1988), no changes have been observed in the size distributions in the catches, nor has there been a decrease in the mean size. Such stability is probably indicative that the species has benefitted from protection during its spawning season and from other regulatory measures.

In addition to the lack of adequate data on which to base analyses of the fisheries considered herein, there are also methodological difficulties attaching to the short life spans of transparent goby, dolphinfish, and pilotfish, which prevent application of presently used models of population dynamics based on a time scale of one year. Other models, like the model of Leslie (Leslie & Davis, 1939), are not applicable because of the marked migratory nature of the species (dolphinfish) or the

existence of a catch quota per boat per day (transparent goby). In the case of the lobster fishery, in which such methods could be applied, adequate data series are not available.

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