Illex argentinus: life cycle, population structure, and fishery

P. G. Rodhouse, J. Barton, E. M. C. Hatfield, and C. Symon


Since the establishment of the Falkland Islands Conservation and Management Zone (FICZ) in 1986, catch and effort data for Illex argentinus have been reported to the Fisheries Department of the Falkland Islands Government, and observers have collected biological data aboard commercial vessels fishing within the zone. I. argentinus are caught in the FICZ between March and June. Early in the season the fishery is concentrated to the north of the FICZ and later spreads to approximately 52-53°S. By June the fleet has shifted to the northwest of the zone. Catches and catch rates peak early in the season and decline thereafter. Male squid recruit into the fishery at a modal mantle length of about 200 mm and grow to about 300 mm by the end of the season, and females recruit at approximately the same size and grow to some 350 mm. For both sexes this is generally in agreement with data derived from growth increments in the statolith. At the time of recruitment, males are more sexually mature than females. Maturation in both sexes proceeds with growth and most squid migrate out of the fishery about one month before the estimated peak time of hatching of the next generation. Squid maturing early in the season are smaller than those maturing later. Data from the fishery are consistent with the hypothesis that the spawning grounds of I. argentinus are towards the north of the Patagonian Shelf, that eggs and larvae develop in the Brazil Current, and the squid then spread over the shelf to feed, grow, and mature. There is evidence that squid on the spawning migration follow the northerly flow of the Patagonian Current to the west of the Falkland Islands.

Introduction

The ommastrephid squid, Illex argentinus de Castellanos 1960 (Cephalopoda: Ommastrephidae), occurs over the Patagonian Shelf and slope from about 30°S to 54°S at depths from 50 to 1000 m (de Castellanos and Menni, 1969; Roper et al., 1984). It has also been recorded as occasional specimens in association with Martialia hyadesi at the Antarctic Polar Front to the west of South Georgia (Rodhouse, 1991). On the Patagonian Shelf it is a short-lived, fast-growing species which attains full sexual maturity and spawns within one year (Csirke, 1987). The fishery for I. argentinus is pursued mainly by jigging vessels (see Hamabe et al., 1983), but squid are also taken by trawlers.

Knowledge of the life cycle of I. argentinus is based largely on fisheries data and material collected from commercial catches and some limited information from research cruises (Hatanaka et al., 1985; Hatanaka, 1986; Koronkiewicz, 1986; Hatanaka, 1988; Brunetti and Pérez Comas, 1989a, b; Nigmatullin, 1989; Brunetti, 1990a, b; Haimovic and Alvarez-Pérez, 1990). From these data the following outline life history can be deduced. Most of the stock on the Patagonian Shelf spawns during the winter months, but there is also a smaller, summer spawning subpopulation (Brunetti et al., 1991). The spawning grounds have not been identified but winter spawners are thought to lay their eggs to the north of the Patagonian Shelf in the northern part of the Falkland Current or in the Brazil Current (see Peterson and Whitworth (1989) for a review of the regional oceanography). Summer spawners are thought to spawn in coastal waters. Young squid, derived from the main winter spawning, arrive in the northern section of the shelf in the austral spring. They spread southwards and offshore and then during the summer they move in over the shelf where the main feeding grounds are located and where they are exploited by the commercial fishery. Subsequently, in the autumn, they move northwards towards the presumed spawning grounds. Death follows
soon after spawning, so the population is mostly comprised of a single cohort derived from the winter spawners. There is no evidence that any squid survive into a second year.

Growth of post-recruit *I. argentinus* has been analysed from data relating mantle length to age, determined by counting daily growth increments in the statolith (Rodhouse and Hatfield, 1990). As deduced from fishery data both sexes were confirmed to live for approximately one year. Females grow faster than males but males mature earlier than females. Hatching dates, back-calculated from age and date of capture, peak in July. Growth in mantle length is best approximated by a linear model during the period the squid are exploited by the fishery and there is a consistent trend of increasing growth rate with date of hatching.

The development of the Patagonian Shelf fishery for *I. argentinus*, since the early 1970s, has been documented by Csirke (1987) and Brunetti (1990c). In 1986 the Falkland Islands Government established the Falklands Interim Conservation and Management Zone (FICZ), which covers an area of 150 miles radius from a point in the centre of the Islands, but not including an area in the southwest (Fig. 1) (Anon., 1989). The establishment of an observer programme and reports from vessels licensed to fish in the Zone have subsequently produced data on the fishery within the FICZ for the years 1987–1989.

In this article we review the life cycle and population structure of *I. argentinus* in the light of these new data from the FICZ.

**Materials and methods**

Catch and effort data for *I. argentinus* are taken largely from jigging vessels reporting to the Fisheries Department, Port Stanley, between 1987 and 1989. Biological data were collected aboard fishing vessels by Falkland Islands Government Fisheries observers between 1987 and 1989. Dorsal mantle length (ML) of samples taken from the catch were routinely measured to the nearest 10 mm below and specimens sexed and assigned a maturity stage (I: juvenile; II: immature; III: preparatory; IV: maturing; V: mature) according to Lipinski’s (1979) scheme.

No data are available outside the commercial fishing season, which lasts from February/March to June. This study therefore considers only that part of the life cycle between recruitment into the fishery and commencement of the spawning migration.

**Results**

**Distribution of the catch within the FICZ**

Monthly distribution of the catch within the FICZ for the period 1987–1989 is shown in Figure 2. A broadly similar pattern has been observed in each year. During the early part of the season the fishery is concentrated to the north of the Falkland Islands. As the season progresses the catch increases and squid are taken throughout the FICZ to as far south as approximately 53°S. The major concentrations remain to the north of the Islands. The fleet subsequently shifts away to the northwest of the Zone before the close of the season in June.

**Monthly catch and c.p.u.e.**

Total monthly catch within the FICZ for the period 1987–1989 is shown in Figure 3. In each year the catch has peaked in April and declined thereafter until the end of the season in June.

The seasonal distribution of c.p.u.e. within the FICZ for the period 1987–1989 is shown in Figure 4. Catch rates increase rapidly to a peak during the early part of the season and then decline steadily until the end of the season.

**Growth**

Monthly data for the modal length of the male and female population taken by the fishery for the period 1987–1989 are shown in Figure 5. For comparison, the
Figure 2. Monthly distribution of the catch of *Illex argentinus* within the FICZ for the period 1987-1989.
Figure 3. Total monthly catch of *Illex argentinus* within the FICZ for the period 1987–1989.

Figure 4. The seasonal distribution of c.p.u.e. for *Illex argentinus* within the FICZ for the period 1987–1989.

There is a greater proportion of early maturity stage females than males at the time of recruitment into the fishery. Female maturation continues during the course of the season and the population is dominated by maturity stages IV and V by June. Between 1987 and 1989 there has been a trend among females towards an increasing proportion of more maturing and mature squid by the end of the season.

The modal mantle length of each maturity stage in each month for the period 1987–1989 is shown in Figure 5. Squid of both sexes attain each maturity stage at a relatively small size early in the season. The size at which each maturity stage is attained increases as the season progresses.

Sex ratio

Seasonal change in the sex ratio of the catch for the period 1987–1989 is shown in Figure 8. The proportion of males increased in the early part of the season in each year and peaked at the time of maximum catch and c.p.u.e. Thereafter the proportion of males declined to a minimum in June.

Discussion

Recent fisheries data for *I. argentinus* from the FICZ are generally consistent with the current concept of the life cycle of this species (Hatanaka *et al.*, 1985). Squid usually arrive in the FICZ in February/March and there is generally a rapid increase in both catch and c.p.u.e. followed by a steady decline. The seasonal pattern of sex ratio suggests that females arrive in the FICZ grounds before the males and leave afterwards. The squid first appear in the northern part of the zone and spread southwards as the fishing season progresses. They then retreat towards the northwest of the zone at the end of the season. This is consistent with a southwards migration during the major feeding and growth phase of the life cycle, after hatching near the presumed spawning grounds over the northern part of the Patagonian Shelf. The southern limit of the feeding migration is apparently the continental slope to the south of the Falkland Islands. As the population approaches full sexual maturity it appears to seek the northerly flow of the Patagonian Current (see Brunetti *et al.*, 1990) to the west of the Falkland Islands (Fig. 9) to assist migration back towards the spawning grounds.

Growth of *I. argentinus*, as determined from analysis of growth increments in the statolith (Rodhouse and Hatfield, 1990), is generally consistent with shifts in the modal mantle length of the population seen in the fisher-
Figure 5. Monthly modal mantle lengths of male and female *Illex argentinus* caught in the FICZ during the period 1987–1989. Broken lines represent linear growth models fitted to size at age data for squid hatched in July (from Rodhouse and Hatfield, 1990).

Figure 6. Seasonal change in percent contribution of each maturity stage of the *Illex argentinus* catch in the FICZ for the period 1987–1989.
Figure 7. Seasonal change in the modal mantle length of each maturity stage of *Illex argentinus* caught in the FICZ in each month for the period 1987–1989.

Figure 8. Seasonal change in the male:female ratio of the *Illex argentinus* catch in the FICZ for the period 1987–1989.
the feeding grounds and the calculated time of hatching and, secondly, the large proportion of squid in the FICZ which are mature by the time they depart to spawn.

Knowledge of the life history of *I. argentinus* is still limited to the period from the arrival of the population on the feeding grounds, and recruitment into the fishery, until the start of the spawning migration when commercial catches cease. Future research will address the pre-recruitment phase through growth studies and by surveys of larval distribution in relation to the physical oceanography of the Southwest Atlantic and will monitor long-term variability of fecundity in the population. It will be important to sample specimens of *I. argentinus* during and after the spawning migration to obtain a fuller understanding of the species’ biology in the period immediately leading up to spawning (Hatfield et al., 1992; Rodhouse and Hatfield, 1992) and to locate the position of the spawning grounds.

**Acknowledgements**

We thank Dr G. R. Carvalho and Dr G. Tingley for reviewing the manuscript. Research at the British Antarctic Survey on the life history of *Illex argentinus* is funded by the Falkland Islands Government.

**References**


