Information describing *Sthenoteuthis oualaniensis* fisheries relating to the South Pacific Fisheries Management Organisation

FINAL
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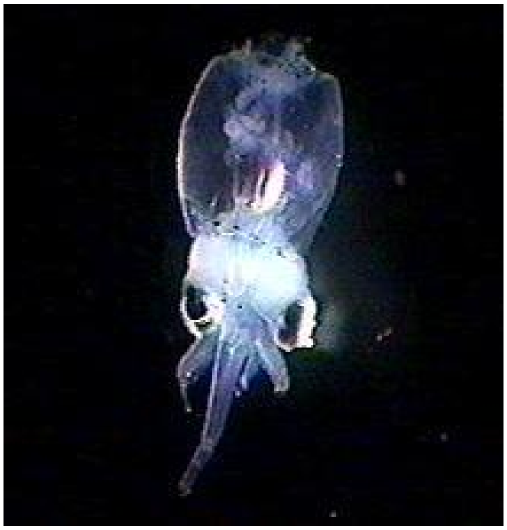
Purple-back flying squid *Sthenoteuthis oualaniensis*



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1. Overview

Sthenoteuthis oualaniensis is thought to be the most abundant large squid in the tropical and sub-tropical waters of the Indo-Pacific region (Young and Hirota 1998, Dunning 1998). It has a patchy distribution and occurs from the Red Sea to Australia and from the west coast of Central America to the east coast of Africa, occupying a band about 40˚ north and south of the equator.

The population structure of *S. oualaniensis* appears complex with sub-populations of small, medium and large forms whose geographic ranges partially overlap.

Little is known of their spawning behaviour. At present, *S. oualaniensis* is predominantly caught in the Northern Pacific as bycatch due to the low value of this squid. Little is known about catch history for this species.

S. oualaniensis are fast growing and relatively short lived therefore productivity is potentially high. There are currently no management measures in place for this species. Management of monocyclic species, such as *S. oualaniensis*, poses a problem. Their lifespan is approximately 1 year, they spawn and then die. Therefore every squid fishing season is then based on the incoming recruitment [cohort or age group]. That recruitment is highly dependent on environmental conditions and typically highly variable. Accordingly, it is not possible to calculate reliable yield estimates from historical catch and effort data.

2. Taxonomy

2.1 Phylum
Mollusca

2.2 Class
Cephalopoda

2.3 Order
Teuthida

2.4 Family
Ommastrephidae

2.5 Genus and species
Sthenoteuthis oualaniensis Lesson (1830)

2.6 Scientific synonyms

Symplectoteuthis oualaniensis Lesson (1830)
Loligo oualaniensis Lesson (1830)
Ommastrephes oceanicus Orbigny (1835)
Loligo vanicoriensis Quoy/Gaimard (1832)

2.7 Common names

Purpleback squid, Encornet bande violette, Pota cardena, Yellow backed squid, Tobiika, Hoyenjoo, Flying squid, Purple squid.

2.8 Molecular (DNA or biochemical) bar coding

S. *oualaniensis* rhodopsin gene partial cds, GenBank accession number AY545185.

3. Species characteristics

3.1 Global distribution and depth range

S. oualaniensis occurs from the Red Sea to Australia and from the west coast of Central America to the east coast of Africa, occupying a band from approximately 40˚ north to approximately 40° south of the equator (Roper et al. 1984) (Figure 1). However, it has a patchy distribution, being concentrated in areas of high primary productivity (Nesis 1977 as cited by Snyder 1998). Unlike *D. giga*s, it does not form dense aggregations (Nigmatullin et al. 2002).

Vertical distributions change during ontogenesis. Young *S. oualaniensis* (0.5-10 cm mantle lengths (ML) usually occur at depths of 15-50 m (Zuev et al. 1985 as cited by Shchetinnikov 1992). Medium sized *S. oualaniensis* (<15 cm ML) aggregate in shoals of up to 50-60 individuals. *S. oualaniensis* regularly appear in the surface waters at night and actively feed there (Zuev et al. 1985 as cited by Shchetinnikov 1992). The shoals become smaller as *S. oualaniensis* grow and larger females (>27 cm) often occur alone.

In the Arabian Sea large females have been observed between 400- 1100 m depths in the daytime and 50-500 m at night time. In contrast, medium sized females have been observed at 50-200 m in the day and at depths of 0-100 m in the night (Bizikov 1995).

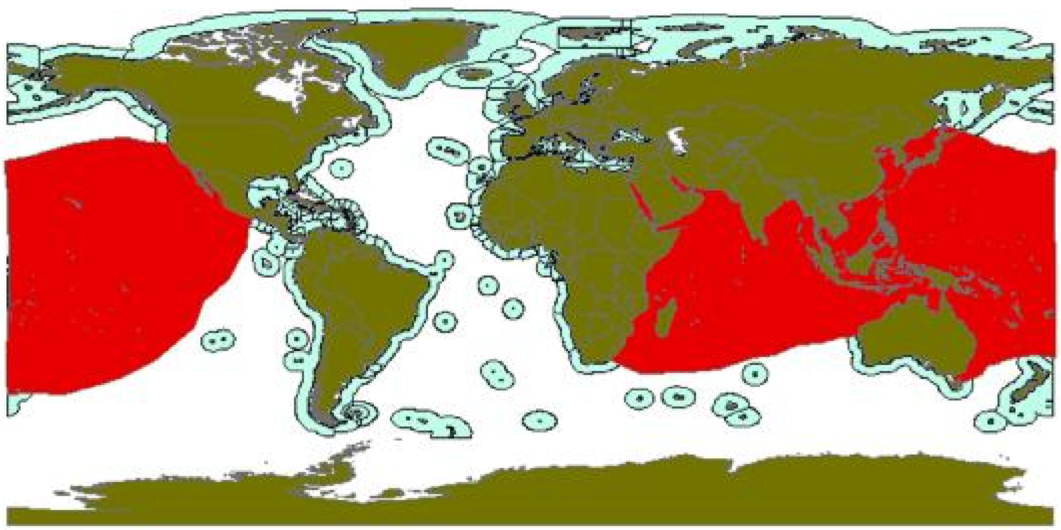

Figure 1: Global distribution of *Sthenoteuthis oualaniensis*. *Source: Adapted from: Roper C.F.E., M.J. Sweeney and C.E. Nauen 1984. Cephalopods of the world. Food and Agriculture Organization, Rome, Italy. Vol. 3: 277 pp.*

3.2 Distribution within South Pacific area

S. oualaniensis is found off the northern and eastern coasts of Australia, and extends down to 38˚ S. Their distribution extends across the Pacific Ocean to South America.

3.2.1 Inter-annual and/or seasonal variations in distribution

There is no information available.

3.2.2 Other potential areas where the species may be found

None known.

3.3 General habitat

S. oualaniensis are oceanic squid that live in the water column and undergo diel vertical migrations. Larvae are planktonic. Juveniles are often associated with the continental slope. *S. oualaniensis* can be found in both temperate and tropical waters.

3.4 Biological characteristics

Reproduction

Based on the available evidences, *S. oualaniensis* appears to be a “continuous spawner” (Harman et al. 1989, Young and Hirota, 1998. Rocha et al. 2001) with continuous asynchronous ovulation, ovulation during the spawning period, monocyclic maturation of oocytes, spawning over an extended period where spawning is intermittent but spawning events are continuous (i.e., as the oviducts fill, they are emptied) and somatic growth during the period of spawning. The batch fecundity of a female about 300 mm ML is 250,000 eggs in the combined oviducts (Harman et al. 1989). The number of oocytes in various stages of development – a proxy of potential fecundity – in a female of 251 mm ML was estimated to he 1,643,000 (Harman et al. 1989).

The length of the spawning period and the frequency of spawning episodes during this period are unknown. In addition, geographic variability in the spawning season might occur. Data from Australia suggest that S. oualaniensis spawn in summer Data from Australia suggest that *S. oualaniensis* spawn in summer along the continental shelf (Dunning & Brandt 1985); however, high numbers of paralarvae in the northern Pacific provide support for spring spawning (Chesalin & Zuyev 2002).

Growth

Growth studies of *S. oualaniensis* based on gladius microstructure from the North Pacific concluded that the duration of the life cycle was approximately 1 year. Females grow faster than males and mature at approximately 25 cm ML, whereas males were found to be mature at 15 cm ML (Bizikov 1995). In Australian waters female size at maturity was 19 cm ML and males was 20 cm ML (Dunning & Brandt 1985). *S. oualaniensis* from near New Caledonia (Rancurel 1980), Taiwan (Tung 1976), and in the Philippine Sea (Nesis 1979) all reach maturity at similar sizes. Maximum sizes recorded in Hawaiian waters for females are 335 mm ML (1.6 kg), and for males, 210 mm (Young & Hirota 1998).

S. oualaniensis are sexually dimorphic, with females growing much lager than males. Sex specific differences have also been observed in sucker ring dentition in the arms (Snyder 1998). Females have been observed to have a larger central tooth in the distal region of the ring and smaller teeth in the proximal region, both of which the males lacked. Large differences in parasite loads have also observed between males and females (Snyder 1998). Females had larger parasite loads than males even though both sexes were found in the same locations. It has been hypothesised that the main route for infection is via ingestion of infected prey. Therefore the difference of parasite loads between males and females may reflect a difference in the feeding spectrum between the two sexes. The dimorphism in sucker ring dentition, and the differences in size, also suggests a difference in the feeding spectrum of males and females (Snyder 1998).

In Hawaiian waters sex ratios are approximately equal among young squid but catches of larger squid show skewed sex ratios of 3:1 females to males (Young & Hirota 1998). In the Philippines the ratio of females to males caught by jigging machines has been observed as 4:1 (Siriraksophon & Nakamura 2001).

Depths occupied by this species are low in oxygen. *S. oualaniensis* has a very high metabolic rate (standard metabolism of 348 ml O_2/kg/hr) that exceeds that of many fast swimming oceanic fishes (Shulman et al. 2002). Common with other squid species, energy metabolism is based mostly on protein: however, in *S. oualaniensis,* during metabolism a considerable proportion of the protein is catabolised anaerobically (Shulman et al. 2002), thus enabling these squid to inhabit zones of very low oxygen concentration.

3.5 Population structure

Nesis (19931 has described a complex population structure that incorporates three major and two minor forms. A giant form that occurs only in the northern Indian Ocean in the region of the Red Sea, Gulf of Aden and Arabian Sea (modal sizes of 400-500mm ML in the Arabian Sea, maximum size of 650 mm ML), a medium form – the "typical" one – (modal sizes of 120-150 mm for mature males and 190-250 mm for mature females) that occurs throughout the range of the species and a dwarf form (modal size of 90-100 mm ML for mature males and 90-120 mm ML for mature females, 140-150 mm ML maximum) that occurs in equatorial waters and lacks the dorsal mantle photophore patch characteristic of the species. The medium form may be subdivided into two forms based on features of the giadius (double or single lateral axes of the rhachis). One of the two medium forms (single lateral axes of the rhachis) occurs only in the Red Sea, the Gulf of Aden and the Arabian Sea north of 15°-17° N. Complicating this picture is a small form, similar to the medium form but maturing at a smaller size (mode for females is 120-140 mm with a range of 90-160 mm ML) that is nearly the same size as the dwarf form and is found in the Western Indian Ocean and the eastern tropical Pacific Ocean. Of the five possible forms, giant, medium with single axis, medium with double axis (the typical *S. oualaniensis*), small and dwarf, the latter three occur in the Pacific Ocean. The dwarf equatorial form is found roughly within 10° latitude of the equator where it co-occurs with the typical form. The dwarf form has several morphological characters that separate it from the typical one (absence of the dorsal photophore patch, slightly different hectocotylus and slight differences in the spermatophore structure and in the gladius structure). Nesis (1993) could find no differences in the appearance of para-larvae between the dwarf and middle forms. Researchers have disagreed on whether or not the dwarf form is a distinct species (Clarke 1966, Wormuth 1976, Nesis 1993). Snyder (1998) suggests that the giant form results from a plastic phenotype in the species.

The complexity in the Indo-Pacific population structure suggests a highly plastic phenotype, allowing the species to best utilise available resources and oceanographic conditions.

The extent of sub-population mixing and genetic isolation is unknown. Several size classes have been observed around Australian waters (Dunning & Brandt, 1985).

3.6 Stock productivity

Very high – onset of maturity is early, fecundity is high, annual growth rate is relatively rapid and the species is very short lived. Based on the biological characteristics and phenotypic plasticity, the population(s) potential productivity might be expected to be high.

3.7 Role of species in the ecosystem

S. oualaniensis are prey to blue marlin, sooty tern, brown noddy, skipjack and yellowfin tuna, wahoo and scalloped hammerhead shark (Young, 1975). *S. oualaniensis* is also a large proponent of the tropical oceanic seabird *Phaethon rubricauda* diet (Corre et al., 2003) and a primary prey in the diet of some sperm whales (Wang et al. 2002).

Fast growth rates and high metabolism indicate the requirement of high food intake. It has been estimated that adult *S. oualaniensis* require 8-10% of their own body weight as a daily food ration (Shulman et al. 2002).

The feeding spectrum of *S. oualaniensis* was investigated in the southeast Pacific and was found to change considerably with mantle length. Young feed mainly on amphipods, euphausiids and fish larvae, whereas adults feed primarily on myctophids and secondarily on squid (predominantly *Dosidicus gigas*) (Shchetinnikov 1992). Similar prey items have been found in similar sized specimens for the Indian Ocean (Nigmatullin et al. 1983 as cited by Shchetinnikov 1992). Cannibalism is rarely observed in the south-eastern Pacific however, high rates have been recorded in the tropical Pacific and the Indian Ocean (Young 1975; Nigmatullin et al. 1983 as cited by Shchetinnikov 1992).

4. Fisheries characterisation

4.1 Distribution of fishing activity

There appears to be no directed fishing for this species at present in the Pacific.

In the North Pacific historic fishing activity for *S. oualaniensis* occurred predominantly off Okinawa (in the Ryukyu Chain), Taiwan, Vietnam and Hawaii.

There is no information on directed fishing within the South Pacific.

4.2 Fishing technology

Fishing occurs predominantly by automated jigging using night lights to attract the squid.

4.3 Catch history

Catch is used for tuna bait and for human consumption. However due to the relatively low value it receives for human consumption (due to its tough texture) there is no target fishery at present and it appears to be only taken as bycatch.

No information is available on catch figures. *S. oualaniensis* has been fished within the Australian EEZ but the extent of fishing occurring outside the EEZ is unknown.

NOTE: It would be useful if countries could supply a species specific catch history for this squid species.

4.4 Stock status

Not known or uncertain – Insufficient information is available to make a judgment.

4.5 Threats

None known.

4.6 Fishery value

Low.

5. Current Fishery Status and Trends

5.1 Stock size

There is no information available for the South Pacific.

5.2 Estimates of relevant biological reference points

There is no information available.

5.2.1 Fishing mortality

There is no information available.

5.2.2 Biomass

Nigmatullin et al. (2002) estimated the total stock of *S. oualaniensis* in the world's ocean to be between 8-11 million tonnes.

In the early 1980's Nigmatullin et al. (2002) described the distribution and biomass of ***D. gigas*** and ***S. oualaniensis*** in the eastern South Pacific both outside and inside the EEZ (3˚ N to 25˚ S). In the Western equatorial area (1˚ N to 1˚ S, 95 - 106˚ W, 123 000 km^2) the biomass in April to May 1981 was estimated at 940 000 metric tonnes. That biomass consisted of ***S. oualaniensis*** (75%) and ***D. gigas*** (25%). In the Eastern equatorial area (a narrow zone between the boundaries of the EEZ, 3˚ N to 5˚ S, 280 000 km^2) the biomass in the same period was estimated at 300 000 t (***D. gigas*** (83%) and ***S. oualaniensis*** (17%)).

5.2.3 Other relevant biological reference points

No information available.

6. Impacts of Fishing

6.1 Incidental catch of associated and dependent species

There is no information available for the jig fishery, but it is assumed to only catch squid.

6.2 Unobserved mortality of associated and dependent species

This is likely to be low due to the selectivity of the jig fishing method.

6.3 Bycatch of commercial species

No information available.

6.4 Habitat damage

There is likely to be minimal damage to the habitat due to the fishing methods employed.

7. Management

7.1 Existing management measures

There are currently no known management measures in place for this species in the South Pacific.

7.2 Fishery management

No information available.

7.3 Ecosystem Considerations

Squid jigging is assumed to be a very selective fishing method. The extent of the adverse impacts on the ecosystem from squid fishing is unknown. However, as with any large extraction of resources from the system, changes in community structure are likely. The loss of fishing gear from squid fisheries may also have an adverse effect.

8. Research

8.1 Research underway

There is currently no research underway.

8.2 Research needs

More research is required investigating the spawning behaviour of *S. oualaniensis*. Detailed catch and abundance information is also required to effectively manage this species.

9. Additional remarks

In the south-east Pacific *Dosidicus gigas* is the only other adult ommastrephid species found in areas where S. *oualaniensis* is abundant (Nigmatullin et al. 2001). Interspecific competition between *D. gigas* and S. *oualaniensis* may be acute as the food spectra overlap extensively for the middle sized *D. gigas* and large *S. oualaniensis*. Competition for food is decreased by preferences for different water temperatures (*S. oualaniensis* prefer warmer waters) and vertical distributions (at night *D. gigas* occur at shallower depths than *S. oualaniensis*). Despite possible competition for food *D. gigas* and *S. oualaniensis* commonly form mixed schools (Nigmatullin et al. 2001).

In the south-west Pacific *S. oualaniensis* overlaps with another larger relative in the same subfamily: *Ommastrephes bartrami*. It has been suggested that where this overlap occurs *O. bartrami* may be an important predator on *S. oualaniensis*. Analyses of diet of both *S. oualaniensis* and *O. bartrami* caught in the same waters showed *S. oualaniensis* to be a more specialised predator than *O. bartrami* (Parry 2006).

A related species *Sthenoteuthis pteropus*, the only other member of the genus, replaces *S. oualaniensis* in the Atlantic Ocean.

The potential for commercial fisheries for this species have been explored in other oceans by Russia (Arabian Sea, late 1980s). On the basis of that research there is a small possibility that a commercial fishery could be developed in the South Pacific in the future.

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