JJBS

Volume 6, Number 1, March .2013
ISSN 1995-6673
Pages 39 - 44

Jordan Journal of Biological Sciences

Fecundity of Bigfin squid, *Sepioteuthis lessoniana* (Lesson, 1830) (Cephalopoda: Loliginidae)

Venkatesan Vellathi[1,*] and Rajagopal Santhanam[2]

[1] *Central Marine Fisheries Research Institute, Cochin, 682018; Kerala,*

[2] *Faculty of Marine Sciences, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, 608502, India.*

Received: August 16, 2012; Accepted: October 22, 2012

Abstract

A total of 25 mature female *Sepioteuthis lessoniana* (Lesson, 1830) specimens, with a dorsal mantle length between 120-196 mm, were investigated. Estimated potential fecundity varied from 180 to 1054 eggs with mean value of 497 eggs. The potential fecundity values of *S. lessoniana* in the Mandapam waters (Palk Bay) are found almost similar to those found in Tanzanian waters but higher than the ones in Sri Lankan lagoons. Larger females have higher potential fecundity. The correlation values showed that the fecundity is more closely related to the ovary weight and body weight than to the mantle length. Fecundity increased exponentially with mantle length. The Nidamental gland weight was also found more closely related to the ovary weight in logarithmic relationship. Fecundity vs. ovary weight (r = 0.899) and Nidamental gland weight vs. ovary weight (r = 0.942) exhibited a strong relationships while fecundity showed week correlations with mantle length (r = 0.658) and body weight (r = 0.663).

Keywords: *Sepioteuthis lessoniana*, fecundity, Mandapam Waters (Palk Bay).

1. Introduction

Cephalopods (squid, cuttlefish and octopus) form increasingly essential resources for human consumption and a chief food for many top predators (Lefkaditou *et al.*, 2003). Adult cephalopods are voracious and active carnivores feeding mainly on fishes and crustaceans. Loliginid squids play an important role in near-shore ecosystems both as prey and as predators (Jackson and Pecl, 2003).

The squids and cuttlefish have fewer eggs production compared to the finfishes and prawns (Nabhitabhata, 1995). There are very few reports of fecundity estimates of Indian Cephalopods (Asokan, 2000). With the increasing trawling activity and targeting the cephalopod, the cephalopods need regular monitoring to avoid a possible collapse of the fishery. In general, fecundity is low in cephalopods because of the absence of larval stage and hatchlings are virtually in miniature adults.

There are controversies in estimating cephalopod fecundity because of the different spawning strategies of cephalopods: single synchronous terminal spawning, or multiple spawning in which several batches are spawned. Therefore, it is better to use potential fecundity where the maximum number of eggs prior to spawning is counted (Boyle and Rodhouse, 2005).

In the past, many studies were conducted on the fecundity of other squids elsewhere (Macewicz *et al.*, 2004; Salman and Onsoy, 2004; Laptikhovsky and Nigmatullin, 2005; Salman and Laptikhovsky, 2005; Nigmatullin and Markaida, 2009; Salman and Onsoy, 2010). Previous fecundity studies on *S. lessoniana* have been done in tropical regions such as Tanzania (Mhitu *et al.*, 2001), Sri Lanka (Sivashanthini *et al.*, 2010). No data on the fecundity of *S. lessoniana* in the Palk Bay waters is currently available. Hence, the objective of the work reported here is to study potential fecundity and various logarithmic relationships of fecundity in mature females of squid, *S. lessoniana* in this region.

2. Materials and Methods

A total of 25 mature females with dorsal manltle length (DML) between 120-196 mm and body weight (BW) between 118.3-406.1g were used for estimation of potential fecundity.

Samples were collected from commercial bottom trawlers of Mandapam landing centre (Palk Bay) between 2009-2010 (Figure 1).

[*] Corresponding author. e-mail: venkatcmfri@yahoo.co.in.

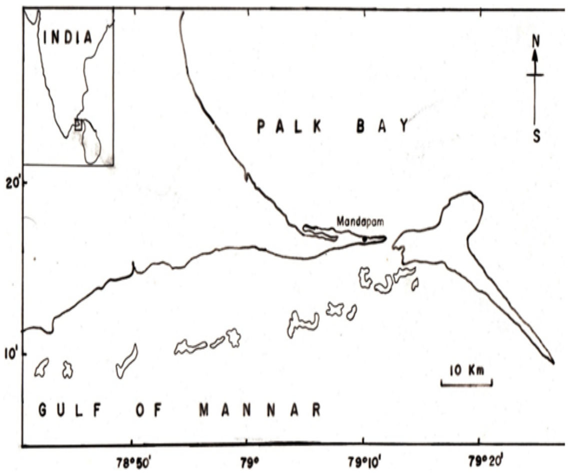

Figure 1. Map showing the location of sampling site (Mandapam, Palk Bay).

Collected specimens were kept in ice box and transferred to laboratory for the detailed study. For each animal, the DML was measured to the nearest 1mm and BW to the nearest 0.1g. After dissecting, gonad and nidamental glands were weighed to the nearest mg. The ovary comprises the proximal and distal oviducts where the former is chiefly a store for mature oocytes and the latter a store for immature and maturing oocytes (Lipinski and Underhill, 1995). Potential fecundity of mature squid was estimated by sub-sampling the eggs from both the proximal and distal oviducts throughout the postmonsoon sampling period i.e. January - June 2010. Eggs from both the oviducts were sub-sampled to about 0.1 - 0.5 g with eggs extracted in three regions (anterior, middle and posterior position) to minimize the variation due to the different stages of development of oocytes. Two or more subsamples were taken from each ovary, and the numbers of eggs in the samples were counted in a large petriplate by adding Gilson fluids with the help of stereo zoom microscope. Gilson fluid was prepared by mixing 10 ml 60% alcohol, 15 ml 80% nitric acid, 18 ml glacial acetic acid and 20 g mercuric acid with 880 ml of distilled water.

The total number of eggs from the known weight of the samples and the full ovary is calculated by the following formula;

Fecundity = (N X TOW)/SOW

Where, N = number of eggs in the sub-sample, TOW = Total ovary weight and SOW = sample ovary weight. The mean estimate of the number of eggs obtained in all individuals comprises the fecundity estimate of the species.

Regression analysis was used to estimate the relationship between fecundity (F) and the DML, BW, TOW and nidamental glands weight (NGW).

3. Results

Fecundity varied from 180 to 1054 in the individuals of DML of 120 to 196 mm (Table 1). The mean fecundity of *S. lessoniana* estimated from these samples was 497. Larger females have higher potential fecundity.

Table 1. Observations of potential fecundity in mature females of *S. lessoniana*.

Sl. No.	DML (mm)	BW (g)	TOW (g)	F (Nos)
1	120	118.3	7.45	309
2	125	126.1	1.982	187
3	126	140.8	6.44	342
4	127	143.5	2.185	180
5	132	142.2	5.463	221
6	133	183.0	13.279	744
7	134	175.7	8.24	477
8	135	158.2	8.21	316
9	136	170.1	16.72	912
10	138	166.9	1.41	167
11	141	166.4	3.975	300
12	142	199.3	8.05	403
13	144	200.4	8.15	411
14	145	196.2	5.04	347
15	148	204.6	5.14	328
16	148	240.3	16.9	357
17	152	230.2	8.89	470
18	153	190.7	17.254	805
19	166	270.6	9.88	400
20	170	271.7	10.68	441
21	170	240.4	13.794	904
22	170	270.2	27.2	918
23	174	300.5	13.7	521
24	194	378.5	18.44	918
25	196	406.1	21.9	1054

F, DML, BW, TOW, and NGW were transformed to logarithms (base 10) and by least square method, the following relations were obtained.

3.1. Relation between F and DML

A linear relationship between the F and the DML of the squid existed (r = 0.658) (Figure 2) and regression equation is

Log F = log (-3.1757) + 2.6795 log DML

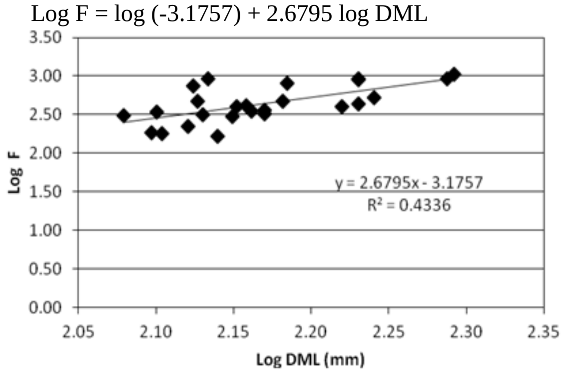

Figure 2. Relationship between fecundity (F) and dorsal mantle length (DML)

3.2. Relation between F and BW

The relation between the fecundity of squid and the weight of body was linear (r = 0.663) and the regression equation is

Log F = log (0.03) + 1.1315 log BW (Figure 3)

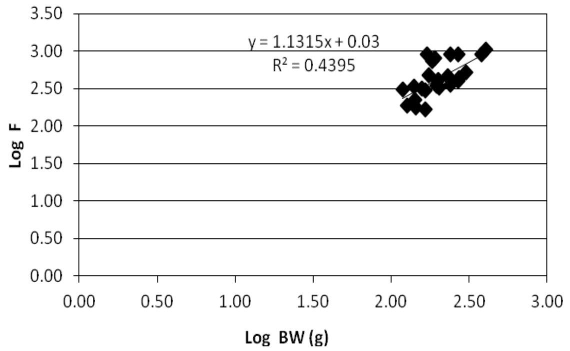

Figure 3. Relationship between fecundity (F) and body weight (BW)

3.3. Relation between F and OW

The relation between the fecundity of squid and the weight of ovary was linear (Figure 4) and the regression equation is

Log F = log (- 2.3453) + 1.2386 log OW (r = 0.899)

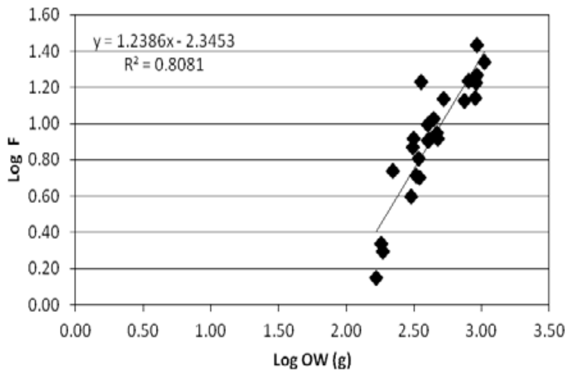

Figure 4. Relationship between fecundity (F) and ovary weight (OW)

3.4. Relation between NGW and OW

A linear relationship between the NGW and the OW of the squid existed (Figure 5) and regression equation is

Log NGW = log (0.1467) + 0.7657 log OW (r = 0.942)

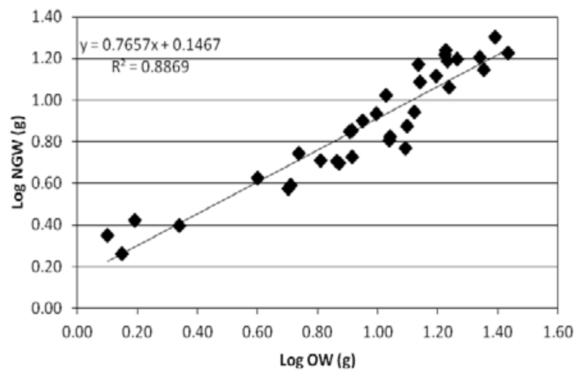

Figure 5. Relationship between nidamental gland weight (NGW) and ovary weight (OW)

4. Discussion

Knowledge on the fecundity is extremely important from the viewpoint of a successful management and exploitation of the fishery. The estimated fecundity for female *S. lessoniana* from Mandapam coastal waters ranged between 180 to 1054 for individual of 120-196 mm DML with a mean of 497 eggs. The fecundity values shows wide variations within the same species caught from different area. Fecundity for *S. lessoniana* in the Zanzibar coastal waters ranged from 180 to 1180 eggs for individuals of size range 140 –249 mm ML with a mean of 680 eggs (Mhitu *et al.*, 2001) which is higher than the present study. However, *S. lessoniana* of Mandapam water in this study found more fecund than those observed in Sri Lankan's lagoon waters by Sivashanthini *et al.,* (2010). Anon (1975) also estimated a low fecundity of 292 to 754 eggs on the same species in the Philippines and suggested that it may be due to multiple spawning. Tsuchiya (1981) studying in the same species in Okinawa, Japan estimated a lower fecundity of 86 to 728 eggs. However, Segawa (1987) noted the fecundity for the same species from Kominato, Japan ranged between 500 and 1000 eggs in one spawning for individuals of 200 to 250mm DML with a mean of 986 eggs. This lower and higher fecundity of *S. lessoniana* in different places may be due to the difference in short or long spawning period of the individuals in their respective places (Mhitu *et al.*, 2001). The variation in fecundity for the same species may be caused by varying environmental factors, food availability and different habitat (Sivashanthini *et al.*, 2010). In general, fecundity is low in cephalopods because of the absence of larval stage and the hatchlings are virtually miniature adults.

Fecundity increased with DML from 180 to 1054 (Figure 2) suggesting that larger individuals at maturity are likely to contribute more offspring to the next generation than smaller individuals. Nigmatullin and Markaida (2009) studying in jumbo squid *Dosidicus gigas* observed that the fecundity is closely related to female size. He also found that smaller sized female show lower fecundity compared to larger ones. A similar relationship was found in the squids *viz. Abraliopsis atlantica* (Laptikhovsky, 1999), *Loligo vulgaris* (Laptikhovsky, 2000), *L. duvaucelii* (Sang, 2007) and *S. lessoniana* (Mhitu *et al.*, 2001; Sivashanthini *et al.*, 2010). Different sizes of oocytes were observed in *S. lessoniana*, which means that the oocytes do not mature simultaneously. Lipinski and Underhill (1995) reported that there were always certain proportions of immature oocytes situated in distal portion of squid ovary. This indicates that *S. lessoniana* continue to produce eggs even after onset of spawning. This type of spawning pattern is also found in other loliginid squids, such as *L. vulgaris reynaudii* (Sauer and Lipinski, 1990) and *L. vulgaris* and *L. forbesi* (Rocha and Guerra, 1996). In Multiple spawning strategy, large eggs in the ovary causing the oviduct volume to be insufficient to accommodate all eggs. Hence, number of egg masses must be spawned in several batches (Rocha *et al.*, 2001).

There was high variation in oocyte numbers in each size (Table 1). This may be related to multiple spawning in which somatic growth occurs in between the separate batches of egg laying (Harman *et al.*, 1989) or it could be due to different growth rates among individuals (Rocha and Guerra, 1996; Jackson *et al.*, 1997) and environmental factors (Pecl *et al.*, 2004).

In the present study the fecundity of *S. lessoniana* bore a logarithmic relationship with the total weight, mantle length and ovary weight. Fecundity exhibited a week relationship with DML (r = 0.658) and BW (r = 0.663). A similar week correlation was also obtained in squids *L. duvaucelii* (Sang, 2007) and *S. lessoniana* (Mhitu *et al.*, 2001; Sivashanthini *et al.*, 2010). These week correlations could be related to their spawning condition in which some females of similar size have already been laid different numbers of oocytes or multiple spawning strategies. A similar observation has also been reported by Pecl (2001) in *S. lessoniana* and *S. australis* of Australian waters. The correlation values showed that the fecundity is more closely related to the ovary weight and body weight than to the mantle length. The nidamental gland weight of *S. lessoniana* shown a strong logarithmic relationship with the ovary weight (r = 0.942) suggesting that the gland is more closely related to the ovary weight. A similar strong relationship between OW and NGW was also found by Nigmatullin and Markaida (2009). Asokan (2000) also observed the positive relationship between OW and NGW. He observed that the size of the nidamental gland increases with one set of maturation and becomes larger in the mature squids. Neethiselvan *et al.*(2001) studying in squid *Doryteuthis sibogae* found that the weight of gonad and nidamental gland increased during maturation and proved as good indices of maturation.

Maturation was size-related process in female *S. lessoniana* individuals, because OW vs. NGW and F vs. OW, BW, DML was highly correlated. Cephalopods produce lower number of eggs both in absolute numbers and per unit biomass and this reduction in numbers is compensated by reduced mortality during early stages of life cycle arising from greater parental care of the eggs and the shorter planktoinc stage of the life cycle.

Acknowledgement

Authors would like to thank the Director, CMFRI and the Dean, Centre of Advanced study in marine biology, Annamalai University for providing physical facilities to carry out this research. Gratitude is expressed to the anonymous referees for their constructive comments on the manuscript. Authors would also like to express their sincere thanks to the editor for publishing this manuscript in the journal in time.

References

Anon.1975. Observation on the culture and life history of the broad finned *Sepioteuthi lessoniana*Fer. and Orb. Mindanao States Univ. *IFRO Ann Rept*.,**76 (19)**: 115-119.

Asokan PK. 2000. Biology and fishery of cephalopods (mollusca: cephalopoda) along the Malabar Coast, Zoological Institute, University of Calicut, India.121pp.

Boyle PR and Rodhouse PG. 2005. **Cephalopods: Ecology and Fisheries**. Blackwell Science Ltd. Oxford, 452 pp.

Harman RF, Young RE, Reid SB, Mangold KM, Suzuki T and Hixon RF. 1989. Evidence for multiple spawning in the tropical oceanic squid *Stenoteuthis oualaniensis* (Teuthoidea: Ommastrephidae). *Mar Biol.*, **101**: 513-519.

Jackson GD, Forsythe JW, Hixon RF and Hanlon RT. 1997. Age, Growth, and maturation of *Lolliguncula brevis* (Cephalopoda: Loliginidiae) in the northwestern Gulf of Mexico with a comparison of length-frequency versus statolith age analysis. *Can J Fish Aquat Sci.*, **54**: 2907-2919.

Jackson G D and Pecl G. 2003. The dynamics of the summer-spawning population of the loliginid squid (*Sepioteuthis australis*) in Tasmania, Australia - a conveyor belt of recruits. *ICES J Mar Sci.*, **60:** 290-296.

Laptikhovsky VV. 1999. Fecundity and spawning in squid of families Enoploteuthidae and Ancystrocheiridae (Cephalopoda: Oegopsida). *Sci Mar.*, **63(1):** 1 - 7.

Laptikhovsky VV. 2000. Fecundity of the squid *Loligo vulgaris* Lamarck, 1798 (Myopsida, Loliginidae) off northwest Africa. *Sci Mar.*, **64(3):**275-278.

Laptikhovsky VV and Nigmatullin CM. 2005. Aspects of female reproductive biology of the orange-back squid, *Sthenoteuthis pteropus* (Steenstup) eastern tropical Atlantic. *Sci Mar*, **69(3):** 383 - 390.

Lefkaditou E, Peristeraki P, Bekas P, Tserpes G, Politou CY and Petrakis G. 2003. Cephalopods distribution in the Southern Aegean Sea Mediterranean. *Mar Sci.*, **4(1):** 79 - 86.

Lipinski MR and Underhill LG. 1995. Sexual maturation in squid: Quantum or Continuum?" *S Afr J Mar Sci.*, **15:** 207 - 223.

Macewicz BJ, Hunter JR, Lo NCH and LaCasella EL. 2004. Fecundity, egg deposition and mortality of market squid (*Loligo opalescens*). *Fish Bull.*, **102**:306-327.

Mhitu H, Mgaya Y and Ngoile M. 2001.Western Indian Ocean Marine Science Association, Zanzibar (Tanzania) and Institute of Marine Sciences, Zanzibar (Tanzania) University of Dar es Salaam. In: Richmond MD and Francis J (eds.), **Growth and Reproduction of the Big Fin Squid, *Sepioteuthis lessoniana* in the Coastal Waters of Zanzibar.** IMS/WIOMSA, Zanzibar, Tanzania.

Nabhitabhata J. 1995. The culture of cephalopods: commercial scale attempt in Thailand. In: . Nambiar KPP and Singh T. (eds.), **Aquaculture towards the 21st Century**,INFOFISH, pp. 138-146.

Nigmatullin CM and Markaida U. 2009. Oocyte development, fecundity and spawning strategy of large sized jumbo squid *Dosidicus gigas* (Oegopsida: Ommastrephinae). *J Mar Biol Ass. U.K.*, **89(4):** 789-801.

Neethiselvan N, Venkataramani VK and Srikrishnadhas B. 2001. Reproductive biology of the Siboga squid *Doryteuthis sibogae* (Adam) from Thuthookkudi (Tuticorin), south east coast of India. *Indian J Mar Sci.*, **30(4**): 257-260.

Pecl GT. 2001. Flexible reproductive strategies in tropical and temperate *Sepioteuthis* squids. *Mar Biol.*, **138**: 93-101.

Pecl GT, Moltschaniwskyj NA, Tracey SR and Jordan AR. 2004. Inter-annual plasticity of squid life history and population structure: ecological and management implications. *Oecologia*, **139**: 515-524.

Rocha F, Guerra A and Gonzalez FA. 2001. A review of reproductive strategies in Cephalopods. *Biol Rev.*, **76**:291-304.

Rocha F and Guerra A. 1996. Signs of an extended and intermittent terminal spawning in the squids *Loligo vulgaris* Lamarck and *Loligo forbesi* Steenstrup (Cephalopoda: Loliginidae). *J Exp Mar Biol Ecol.*, **207**: 177-189.

Salman A and Laptikhovsky VV. 2005. Fecundity and spawning of *Abralia verany* (Ruppell, 1844) (Cephalopoda: Enoploteuthidae) in the Aegean Sea. *Sci Mar.*, **69(2):** 211 - 214.

Salman A and Önsoy B. 2004. Analysis of fecundity of some bobtail squids of the genus *Sepiola* (Cephalopoda : Sepiolida) in the Aegean Sea (Eastern Mediterranean). *J Mar Biol Ass U.K.*, **84**: 781-782.

Salman A and Önsoy B. 2010. Reproductive Biology of the Bobtail Squid *Rossia macrosoma*(Cephalopoda: Sepiolidea) from the Eastern Mediterranean. *Turk J Fish Aquat Sci.,* **10**: 81-86.

Sang CK. 2007. Reproductive biology and ecology of the loliginid squid, *Loligo duvaucelii* (O rbigny, 1835), in Hong Kong waters, Ph D. Thesis, University of Hong Kong. 183pp.

Sauer WHH and Lipinski MR. 1990. Histological validation of morphological stages of sexual maturity in chokka squid *Loligo vulgaris reynaudii D' Orb* (Cephalopoda: Loliginidae).*S. Afri. J Mar Sci.,* **9**: 189-200.

Segawa S. 1987. Life history of the oval squid, *Sepioteuthis lessoniana* in Kominato and adjacent waters,Central Honshu, Japan. *J Tokyo Univ Fish*., **74**:67-105.

Sivashanthini K, Thulasitha WS and Charles GA. 2010. Reproductive characteristics of squid *Sepioteuthis lessoniana* (Lesson, 1830) from the northern coast of Sri Lanka. *J Fish Aquat Sci.,* **5(1):** 12-22.

Tsuchiya M. 1981. On the spawning of the squid, *Sepioteuthis lessoniana* at Amitori Bay, Iriomote Island, Okinawa, Tokai Univ. Notes. *Bull Inst Oceanic Res Develop.,* **3**: 53-75.