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Morphological, anatomical and reproductive features of *Loliolus (Loliolus) hardwickei* (Gray, 1849) caught from the Vizhinjam Coast, Kerala, India

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ABSTRACT

The morphological, anatomical and reproductive features of the little Indian squid, *Loliolus (Loliolus) hardwickei* (Gray, 1849) were studied based on samples collected from boat seine operated along the Vizhinjam Coast. The species was found to be a new entrant to the fishery along the Vizhinjam Coast. A total of 27 morphometric characters were measured and 13 indices were calculated and reported. Dorsal mantle length (DML) of the specimens ranged from 2.6 to 6.8 cm with a mean DML of 4.5±0.88 cm. The largest specimen observed was a male with DML 6.8 cm. Fully mature (Stage IV) specimens were found to have a higher gonadosomatic index (12.54±2.64 in females and 0.8±0.21 in males). Average length and width of spermatophores were 3.078±0.092 mm and 0.11±0.02 mm respectively. Samples with higher DML were in advanced maturity stages (Stage V). Size composition (DML) of samples revealed that 50% of squids were within the 4-5 cm size range.

Keywords: Anatomy, Gonadosomatic index, GSI, *Loliolus (Loliolus) hardwickei*, Morphology, Reproductive stages, Size composition

Introduction

The little Indian squid, *Loliolus (Loliolus) hardwickei* (Gray, 1849) (Synonym: *Loliolus investigatoris)* is known to inhabit estuarine and coastal waters to a maximum recorded depth of 30 m (Jereb *et al.*, 2010). These are small squids with short mantle, heart-shaped fins and have less market value as compared to other larger squid species and marketed locally. It has a wide distribution, from the northern Persian Gulf, Indian and Burmese coasts and throughout Indonesia and a single specimen has been recorded from the Chinese coast, opposite Taiwan (Lu *et al*., 985). Jereb *et al.* (2010), documented the occurrence of *L. hardwickei* (as *L. investigatoris*) among the cephalopod resources from the coast of Gujarat (northern part of the Arabian Sea) and the eastern coast of India and indicated this species as common along the Indo-Pacific region but little information on catch statistics is available. Silas *et al.* (1985) reported this species as *Loliolus investigatoris* from Indian Coast.

Steenstrup (1856) created the genus *Loliolus* for his new species *typus* and *affinis* from the Indian Ocean. Lu *et al.* (1985) showed that *L. typus* is a junior synonym for *Loliolus hardwickei* Gray, 1849; making the latter species the type for the genus *Loliolus*. In *Loliolus (Loliolus) hardwickei* the entire length of the left ventral arm in males is hectocotylised with the absence of suckers (except the occurrence of 2 or 3 minute suckers at the tapering end of the arm) with a large proximal crest. The percentage of hectocotylisation of the arm is considered to be a cline within this group with otherwise similar hectocotyli and arm-sucker dentition. Males and females of this species reach sexual maturity at a size of about 30-40 mm mantle length (Jereb *et al.*, 2010). Lu *et al*. (1985) gave a comparative account of some morphological characters of this species with *Loliolus (Loliolus) noctiluca* and *Loliolus affinis* from Australian waters. Norman and Lu (2000) and Norman *et al.* (2016), mentioned this species in the checklist of the cephalopods of the South China Sea. Though the comparison of inter-cohort growth rates of this species based on statolith analysis from the south-west coast of India was analysed (Sajikumar *et al.,* 2015), information on morphology, anatomy and reproduction of this species are lacking. The present study investigated the morphological, anatomical and reproductive characteristics of *L. (L.) hardwickei* along the south-west coast of India.

Materials and methods

Specimens of *Loliolus (Loliolus) hardwickei* (44 nos.) were collected from Vizhinjam Coast (8° 22'42.54"N; 76° 59'14.20"E) along the south-west coast of India, on

14th July 2015. This was the first record of this species from the Vizhinjam Coast. Squids were caught in boat seine operated during night (light fishing) at a distance of 3 to 10 km away from the shore within 20-30 m depth, from fibreglass coated plywood boats (18 feet long) fitted with outboard engine. The mesh size of the gear range from 0.6 to 15 mm. Along with this species, the catch comprised other miscellaneous fishes such as anchovies, lesser sardines, shrimps, sciaenids, *Nemipterus* spp., pomfrets, carangids, barracuda, ballistids, clupeids, *Sphyraena* sp. and *Acetes.*

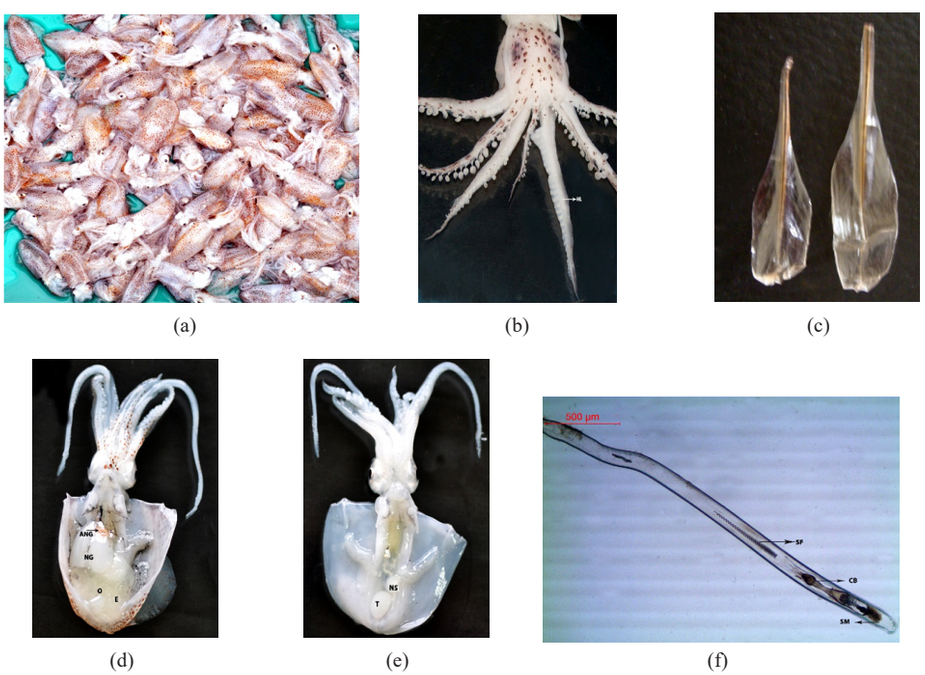
Samples of squids were brought to the laboratory at Vizhinjam Research centre of ICAR-CMFRI for further analysis. Identification was carried out as per Jereb *et al.* (2010) and Lu *et al.* (1985). Morphometric measurements and counts were made in fresh condition. Measurements, indices and abbreviations followed here are adopted from Roper and Voss (1983); Hopkins (1979) and Gabr *et al.* (1998). Indices of reproductive status for males and females were calculated by the methods proposed by Lipinski (1979); Durward *et al*. (1979); Juanico (1983); Ngoile (1987); Joy (1989) and Gabr *et al.* (1998). After taking measurements, specimens were preserved in neutral buffered formalin (Roper and Sweeney, 1983). Information regarding fishery was collected by direct observation and inquiry from fishermen.

Morphometric indices such as mantle width index (MWI), head length index (HLI), head width index (HWI), club length index (CLI), arm length index of long arm (ALI), fin length index (FLI), fin width index (FWI), gladius length index (GLI), gladius width index (GWI), gonadosomatic index (GSI), spermatophoric complex index (SCI) and nidamental gland index (NGI) were calculated.

Sex and maturity stage (Stage I - Stage V) was assigned by direct observation. Maturity stage allocation was done by referring the universal maturity scale adapted for squids by Arkhipkin (1992) and Lipinsky (1979). The ventral part of the buccal membrane was examined in females for the presence of attached spermatophores which would be an indication of the presence of mature spawning (Stage V) or mating females (Worms, 1983). Stomach content analysis was done as per Rohit *et al.* (2011).

Results

The specimens were identified as *Loliolus (Loliolus) hardwickei* (Fig. 1a) and are found to be a new entrant to the fishery along Vizhinjam Coast. The genus *Loliolus* Steenstrup (1856), has two subgenera, *Loliolus (Loliolus)* and *Loliolus (Nipponololigo)*. Under the first subgenera there are two species *viz.*, *L. (L.) hardwickei* and *L. (L.) affinis*.



(a) (b) (c) (d) (e) (f)

Fig . 1. *Loliolus (Loliolus) hardwickei*
(a): Specimens caught from Vizhinjam, (b): Male with hectocotylus, (c): Gladius, (d): Mature female, (e): Mature male, (f): Spermatophore. ANG: Accessory nidamental gland; NG: Nidamental gland; O: Ovary; E: Eggs; NS: Needham sac; T: Testis; HL: Hectocotylus arm; NHL: Non-hectocotylus arm; SF: Spiral filament; CB: Cement body; SM: Sperm mass

Morphometric measurements recorded are presented in Table 1. The average total length recorded was 15.2±2.45 cm for sexes pooled; 14.46±2.2 cm for males, 16.5±1.8 cm for females and 11.2±1.9 cm for juveniles. Entire body including tentacles was covered with brown, yellow and dark chromatophore pigment spots. Mantle wall thin, slightly transparent, gladius can be seen through the mid-dorsal part of the body wall.

Dorsal mantle length (DML) of specimens ranged from 2.6 to 6.8 cm with mean DML of 4.5±0.88 cm. The largest specimen observed was a male with 6.8 cm DML. Dorsal mantle length of the largest female was 5.8 cm. Various growth indices estimated are shown in Table 2. Mantle length index (MLI) calculated as % of total length was 29.7±2.69% for males, 29.1±2.0% for females and 28.9±2.05 % for juveniles. Mantle width index (MWI) as % of mantle length was found to be 56.53±7.2% in males, 55.0±5.3% in females and 62.5±5.9% in juveniles.

Fins together form a heart shape which is continuous around the posterior margin of the mantle and occupy 59% of mantle length in males, 56.2% in females and 53.1% in juveniles. Head is short, slightly flattened dorso-ventrally and little narrower than the mantle width. The average length of the head was 1.9±0.23 cm (1.52±0.22 cm in males, 1.7±0.2 cm in females, 1.2±0.10 cm in juveniles). The average length of the longest arm was 3.8±0.39 cm, which was found to be 3.67±0.4 cm in males, 4.0±0.3 cm in females and 3.0±0.32 cm in juveniles. In males, ventral left arm (4th arm) is hectocotylised (Fig. 1b), with arm suckers completely absent and modified to transfer spermatophores during copulation. The modified portion of the hectocotylus occupies the entire length of the arm. Tentacles thin and elongated, stalks bare (without suckers) but covered with chromatophore pigments. The average length of the 1st and 2nd tentacle was recorded as 9.2±1.04 and 9.6±1.08 cm respectively. Tentacular clubs are small, tapering, slightly expanded and covered with club suckers. Average length of the club was 1.8±0.28 cm; 1.60±0.18 cm in males; 1.2±0.3 cm in females and 1.4±0.31 cm in juveniles.

Gladius (Fig. 1c) is transparent, broad, fragile, slightly curved inside and wider about more than half of its length. Gladius width showed much variation in males,

Table 1. Morphometric measurements of *L. (L.) hardwickei* recorded from Vizhinjam Coast

Measurements	Total samples analysed (Mean±SD)	Male (Mean±SD)	Female (Mean±SD)	Juvenile (Mean±SD)
Total length (cm)	15.2±2.45	14.46±2.2	16.5±1.8	11.2±1.9
Mantle length (cm)	4.5±0.88	4.34±1.01	4.8±0.6	3.2±0.55
Mantle width (cm)	2.5±0.30	2.39±0.2	2.6±0.3	2.0±0.17
Head length (cm)	1.6±0.23	1.52±0.22	1.7±0.2	1.2±0.10
Head width (cm)	1.9±0.26	1.82±0.2	2.1±0.2	1.5±0.25
Tentacle length (1) (cm)	9.2±1.04	8.72±0.91	9.8±0.8	6.0±1.61
Tentacle length (2) (cm)	9.6±1.06	8.80±0.8	10.5±0.6	7.3±1.62
Club length	1.8±0.19	1.60±0.18	2.0±0.3	1.4±0.31
Arm length (cm)	3.8±0.39	3.67±0.4	4.0±0.3	3.0±0.32
Fin length (cm)	2.6±0.31	2.56±0.30	2.7±0.2	1.7±0.38
Width of single fin (cm)	1.6±0.19	1.54±0.2	1.7±0.1	1.2±0.15
Fin width (including mantle) (cm)	4.4±0.51	4.19±0.42	4.8±0.4	3.6±0.21
Total weight (g)	8.0±3.91	6.67±3.7	9.8±3.4	3.5±1.37
Ovary length (cm)		-	2.2±0.9	-
Ovary width (cm)		-	1.0±0.6	-
Ovary weight (g)		-	0.6±0.7	-
Nidamental gland length (cm)		-	1.4±0.6	-
Nidamental gland width (cm)		-	1.1±0.5	-
Nidamental gland weight (g)		-	0.38±0.36	-
Testis length (cm)	-	0.94±0.2	-	-
Testis width (cm)	-	0.50±0.14	-	-
Testis weight (g)	-	0.03±0.02	-	-
Needham sac length (cm)	-	0.89±0.6	-	-
Needham sac width (cm)	-	0.37±0.31	-	-
Needham sac weight (cm)	-	0.04±0.03	-	-
Gladius length (cm)	4.4±1.3	4.16±1.38	4.9±0.7	3.2±0.52
Gladius width (cm)	1.14±0.28	1.12±0.2	1.5±0.3	1.1±0.12

Table 2. Morphometric indices of *L. (L)* hardwickei recorded from Vizhinjam Coast

Morphometric indices	Male		Female		Juveniles	
	N	Mean ± SD	N	Mean ± SD	N	Mean ± SD
MWI	19	56.53±7.2	22	55±5.3	3	62.5±5.9
HLI	19	35.52±3.16	22	35.3±3.3	3	37.6±4.2
HWI	19	43.06±6.7	22	43.3±3.5	3	45.4±2.3
CLI	11	11.32±1.24	10	12.2±1.7	3	12.1±0.74
ALI (Long arm)	11	25.93±1.96	10	22.8±2.2	3	27.3±2.42
FLI	11	63.47±5.08	10	59.4±5.1	3	53.3±2.91
FWI (single fin)	11	38.1±3.82	10	36.5±2.5	3	36.3±2.09
FWI (Including mantle)	11	104.01±8.6	10	104±8	3	114±14.51
GLI	19	28.52±6.49	22	29.5±2.9	3	27.3±2.42
GWI	19	26.84±5.72	22	31.1±3.9	3	33.5±14.32

MWI: Mantle width index, HLI: Head length index, HWI: Head width index, CLI: Club length index, ALI: Arm length index of the long arm, FLI: Fin length index, FWI: Fin width index, GLI: Gladius length index, GWI: Gladius width index

females and juveniles. Females found to have broader gladius (average width 1.5±0.3 cm, GWI=31.1±3.9) than males (average width 1.12±0.2 cm, GWI=26.84±5.72). Average gladius width was found to be 1.14±0.28 cm and in juveniles, it was 1.1±0.12 cm (GWI=33.5±5.38).

Reproductive system

In *L. (L.) hardwickei,* the reproductive system lies along the dorsal inner wall of the mantle cavity. The reproductive structures are suspended in position by mesenteries.

Female reproductive system

The female reproductive system (Fig. 1d) consists of an ovary, glandular oviduct, lace-like oviducal funnel, paired nidamental gland, accessory nidamental glands and seminal receptacle. The relationship of size (DML), gonadosomatic index (GSI) and nidamental gland index (NGI) of females in each maturity stage are shown in Table 3.

Stage I, Immature (Physiological maturation): Sex can be distinguished visually. Ovary appears as whitish, small and non-granulate form. Nidamental glands appear as thin whitish strips. Accessory nidamental glands and oviduct not apparent. Average size (DML) of specimens in this stage was 4.29±0.56 cm and GSI was estimated as 2.07±0.74.

Stage II, Maturing: Accessory gland differentiation and gonad maturation advances at this stage and was apparently visible. The average size of specimens was 5.01 ± 0.56 cm and GSI was 4.51±2.9%.

Stage III, Mature: Gonad and accessory glands fully formed. Ovary visible as granulate form. The average DML of available specimens was 4.8 cm and GSI was 8.06%.

Stage IV, Fully mature: Mature gonads and eggs were clearly visible. Eggs were present in the oviduct in some specimens which could be an indication of commencement of spawning. Average size of specimens was noticed as 5.18±0.21 cm and GSI as 12.54±2.64%.

Stage V, Fully mature (spawning): Mature eggs were seen in the gonoduct. Spawning advances at this stage. The average size of samples was 5.25±0.21 and GSI was 2.89±1.61%.

Male reproductive system

The male reproductive system (Fig. 1e) of *L. (L.) hardwickei* comprises testis, vas deferens, spermatophoric organ, spermduct, the system of spermatophoric glands (SG) and spermatophoric sac (Needham sac) and penis. The testis is connected to thin-walled Needham sac by the spermatophoric duct. The testis is whitish, bean-shaped and found to attain 22.65±6.78% of DML. Size

Table 3. The relationship between size and maturity stages in females

Gonad stage	N	DML (Mean ± SD)	GSI (Mean + SD)	NGI (Mean + SD)
I	8	4.29±0.56	2.07±0.74	1.28±1.16
II	7	5.01±0.56	4.51±2.9	3±1.93
III	1	4.8±0	8.06±00	7.41±0
IV	4	5.18±0.21	12.54±2.64	6.07+1.91
V	2	5.25±0.21	2.89±1.61	4.51±3.89

GSI: Gonadosomatic index, NGI: Nidamental gland index

of Needham sac varies according to the number of spermatophores present inside the sac. Sac is continuous with the muscular penis.

Spermatophore: Slender, cylindrical, transparent and slightly curved spermatophores (Fig. 1f) are stored inside the Needham sac. Outer sheath of spermatophore is made up of outer, middle and inner membranes. A large number of spermatozoa present inside the seminal reservoir region, which is present in the posterior part of the spermatophore. Sperms inside the sperm reservoir are embedded in a fluid under pressure. The seminal reservoir is connected to cement body by a connecting cylinder; ejaculatory apparatus containing spiral filament is present above the cement body. Tightly coiled ejaculatory apparatus enables the ejection of sperm outside the reservoir. The average length of spermatophore was found to be 3.078±0.092 mm and average width was 0.11±0.02 mm. The size of spermatophore showed slight variations in different samples.

The relationship of size (DML), gonadosomatic index (GSI) and spermatophoric complex index (SCI) of males in each maturity stage are shown in Table 4

Stage I, Immature (Physiological maturation): The testis is small, whitish, thin and elongated. Spermatophoric sac (Needham sac) small, vas deferens not visible and spermatophores absent inside the Needham sac. The average size of specimens in this stage was 3.8±0.71 cm and GSI was 0.31±0.17.

Stage II, Maturing: Accessory gland differentiation and gonad maturation further progress in this stage. Vas deferens visible, but spermatophores are not present inside the Needham sac. The average DML of specimens was 4.1±0.86 cm and GSI was 0.52±0.2. Hectocotylisation in the left 4th arm is more apparent than the previous stage. Needham sac contained few spermatophores.

Stage III, Mature: Testis and Needham sac fully formed. Testis whitish, bean-shaped and swollen. Spermatophoric gland fully formed. The average DML of available specimens was 4.16±0.26 cm and GSI was 0.8±0.21.

Stage IV, Fully mature: Testis fully formed. Needham sac appears swelled as compared to previous stages. Average DML of available specimens were 4.68±1.46 and GSI 0.8±0.69. Spermatophoric sac filled with abundant mature spermatophores.

Stage V, Fully mature (spawning): Testis and Needham sac appear small and shrunk which is an indication of spawning. Average DML of samples was 6.6 cm and GSI was 0.07. A copious number of spermatophores present inside the Needham sac, which can be seen up to the penis.

In the current study, the DML of male and female specimens in different maturity stages showed slight variations. In the stage I females, the GSI and NGI were found to be less as compared to the subsequent stages. Also these indices were lesser in stage V than in stage IV. For males in stage I, the GSI and SCI were found to be very less as compared to the succeeding stages. In stage V, the values of both GSI and SCI were lesser than the preceding stage and this reduction is associated with spawning activity.

Size composition (DML) of samples analysed are depicted in Fig. 2. Fifty percent of the samples were within 4-5 cm size range, 22.7% in 3-4 cm range, 20.4% in 5-6 cm range, 2.27% were in 2-3 cm range and 4.5% were in 6-7 cm size range.

Stomach content analysis

The stomach of most of the squids was found to be empty and very few specimens contained digested fish

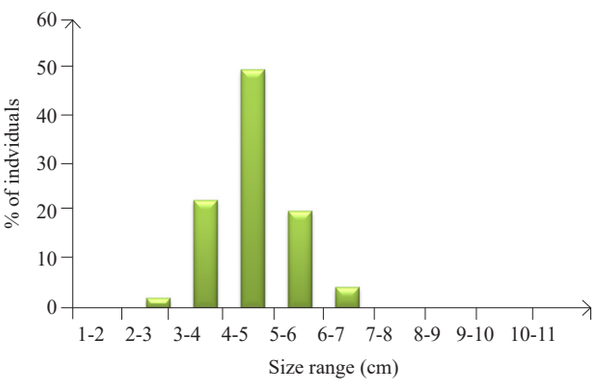


Fig. 2. Graph showing size composition of *Loliolus (Loliolus) hardwickei*

Table 4. Relationship between size and maturity stages in males

Gonad stage	N	DML (Mean±SE)	GSI (Mean±SE)	SCI (Mean±SE)
I	2	3.8±0.71	0.31±0.17	0.31±0.16
II	7	4.1±0.86	0.52±0.2	0.62±0.46
III	5	4.16±0.26	0.8±0.21	0.79±0.10
IV	4	4.68±1.46	0.8±0.69	0.82±0.41
V	1	6.6±0	0.07±0	0.54±0

GSI: Gonadosomatic index, NGI: Nidamental gland index

and crustacean tissue. Exoskeleton remains of crustaceans were unidentifiable. No apparent relation was found between sexes with regard to feeding.

Discussion

The commercially important loliginid squids reported from Vizhinjam Coast are *Uroteuthis* (*Photololigo) duvaucelii*, *Sepioteuthis lessoniana, Uroteuthis* (*Photololigo) singhalensis, Uroteuthis* (*Photololigo) edulis* and *Uroteuthis* (*Photololigo) sibogae* (Silas *et al.,* 1985; Neethu *et al.,* 2015). The little Indian squid *L. (L.) hardwickei* is the first record from the coast. Silas *et al.* (1985) mentioned *L. investigatoris* (Goodrich, 1886) among the common species of cephalopods in India; which is the junior synonym for *L. (L.) hardwickei* (Grey, 1849). Sajikumar (2014) reported this species from waters off Cochin (south-west coast of India) at a depth of about 20 m. The biological studies related to this species are lacking which may be due to its lesser availability and less market value. Lu *et al.* (1985) conducted a comparative study on *Loliolus* (Cephalopoda: Loliginidae) species from Australian waters. The study comprised *L. (L.) hardwickei* along with *L. (L.) affinis* and *L. noctiluca* a new species from the coast.

The analysis of morphological data of samples in the present study supports the descriptions given by Lu *et al.* (1985) as well as Jereb *et al.* (2010). Identification of sample was hard as it showed much similarities with *L. (L.) affinis.* The hectocotylus arm of the male has been a useful diagnostic character for identification. *L. (L.) hardwickei* bears a large proximal crest which is absent in *L. (L.) affinis* and suckers in the dorsal row were found to be comparatively larger. Heart shaped fin is also a distinguishing character from other loliginid species as most loliginid species have 'rhomboid' fins.

Silas (1985) and Lu *et al.* (1985) stated that adult females were always slightly larger in size and relatively broader than males. In the present study, females were found to be larger and broader than males (sexual dimorphism). Average mantle length was recorded as 4.8±0.6 cm for females and 4.34±1.01 cm for males; even though the largest specimen observed was a male with DML of 6.8 cm and largest female was recorded with DML of 5.8 cm. Silas (1985) reported the maximum mantle length of female *L. investigatoris* as 5.5 cm. The mantle length of the largest specimen observed by Lu *et al.* (1985) was a female of 6.9 cm.

In the present study, GSI of mature specimens did not show direct relation with DML. In males, a higher GSI was recorded with specimens in IVth stage with mantle length of 4.16±0.26 cm and a lower GSI was recorded in individuals in spawning stage (Stage V) with an average DML of 6.6 cm. In mature females, a higher GSI was recorded in individuals in stage IV with an average DML of 5.18±0.21 cm; lower GSI was recorded with individuals in stage I and stage V. High gonad index (GI) and nidamental gland index (NGI) suggest conditions favourable to gonad maturation (Bakhayokho, 1983).

According to Chen Xinjun *et al.* (2007), squids in the same maturity stage varied greatly in size. The current study shows a relationship with body size (DML) and maturity stages. Animals in stage V were recorded with larger body size and smaller size was recorded in animals at stage 0 and stage I. Among the animals in stage II, III and IV, the size variation was comparatively less.

The reproductive systems of several myopsid squids have been described by Doring and Walter (1908), Williams (1909) and Marchand (1907) and these differ in varying aspects with *L. (L.) hardwickei.* Identification of sexual maturity stages was done following the maturity scales proposed by Arkhipkin (1992) and Lipinsky (1979). Lipinsky and Underhill (1995) identified 6 stage maturity scale in squid *Loligo vulgaris reynaudii*. Rao (1988) recognised 6 stages in *Loligo duvaucelii*, Hixon (1983) and Butler *et al.* (1999) identified 6 stages in *Loligo opalescens*. Sauer and Lipinsky (1990) identified and histologically validated the 6 sexual maturity stages in choker squid *Loligo vulgaris reynaudii*. Laptikhovsky and Arkhipkin (2001) studied oogenesis and gonad development in the cold water loliginid squid *Loligo gahi* (Cephalopoda: Myopsidae) on the Falkland Shelf and histologically described sexual maturity stages of the female. In the present study, specimens from Stage I to Stage V (fully mature spawning) were observed.

Spermatophore of *(L.) hardwickei* in their structure did not closely resemble those of *Loligo pealii* described by Drew (1919) and *L. opalescens* described by Fields (1965), but showed complete similarity with the descriptions given by Lu *et al.* (1985) on *L. (L.) hardwickei* from Australian waters. According to Nigmatullin *et al.* (2003), morphology of cement body and seminal reservoir varied in different species of ommastrephid (Suborder: Oegopsida) squids. Fields (1965) opined that size of spermatophores vary with the size of squids; larger squids tending to have relatively larger sperm masses; spermatophores produced by one animal are usually quite uniform in size but may vary as much as 10% and lengths are roughly proportional to the mantle length of the animal. *L. (L.) hardwickei* tend to have smaller spermatophore as compared with other loliginid squids such as *U.* (*P.) duvaucelii*, *S. lessoniana, U.* (*P.) singhalensis, U.* (*P.) edulis and U.* (*P.) sibogae*. This endorses the relationship between body size and spermatophore size among cephalopods.

In the current study, stomach of squids were found to be empty except for a few specimens in which small quantities of digested fish and crustacean tissue remains were found. Observations made by Fields (1965) in squid *L. opalescens* noticed the occurrence of a single type food (*e.g.* consisting only of crustacea, squid, fish, or polychaete worms) or two or even three of these types were found together or in some cases, stomach contained predominantly one type of crustacean mixed with varying proportions of other species. Euphausiids and mysids seemed to provide the bulk of the crustaceans of the squid's diet. Other crustaceans (amphipods and megalopa larvae) were present less often and in much smaller proportions and fish remains included flesh, bones scales and skin.

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