

Food and feeding of the Indian Squid *Loligo duvauceli* in the Gulf of Suez, Egypt

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ABSTRACT

Food and feeding of the Indian Squid *Loligo duvauceli* were studied through the analysis of 702 stomachs of Squid collected from commercial trawlers working in Attaka fishing harbour of the Gulf of Suez during September 2014 to April 2015. Food was presented only in about 36 of the total stomachs examined. The occurrence of 1/4-full, 1/2-full, 3/4-full and full were 33%, 39%, 17% and 11% respectively of the examined stomachs which contained food. The empty stomachs (0) were the majority of the examined stomachs during the whole fishing season (94.87%). The food mainly composed of fish, crustacean, cephalopods and unidentified remains, digested matters and sand grains. So this species may be described as carnivorous. For both sexes (male and female) of *L. duvauceli* the percentage of stomach fullness decreased with the increase in the maturity stages.

Keywords: Feeding, Indian Squid, *Loligo duvauceli*, Gulf of Suez.

INTRODUCTION

The investigated area “Gulf of Suez” is a long narrow body of water. It extends about 314 km in length from Suez city in the North to Shadwan Island in the South with width varies between 20 and 40 km. It is relatively shallow, with approximately 50 m depth in the main part. The bottom of the Gulf is relatively flat, formed of sand as well as a considerable content of silt and clay (REMIP, 2008).

Loligo duvauceli is one of the *loliginid* species that is abundant in the Egyptian Red Sea coast and the Gulf of Suez. Along these coasts, the commercial catch of *L. duvauceli* is mainly landed as by-catch of multispecies demersal trawling fisheries.

Squids are important components of food webs in most marine ecosystems (Clarke, 1996 and O'Dor *et al.*, 2005). They are organism with a fast metabolic rate and growth and they play an important role in the transfer of energy to higher trophic levels (Jackson and Domeier, 2003) and all living *coleoid* cephalopods (i.e. all modern cephalopods with the exception of the *Nautilidae*) are voracious carnivorous that consume a wide variety of available prey (Boyle and Rodhouse, 2005). Cannibalism has been reported for many cephalopod groups of both octopus and squids like e.g. such of the genus *Illex*, *Octopus*, *Sepia Dosidicus*, *Onychoteuthis*, *Todarodes*, *Ommastrephes* and *Loligo* (Caddy, 1983; Roper *et al.*, 1984; Hanlon & Messenger, 1996 and Boyle & Rodhouse, 2005).

The food and feeding habits of the squids therefore appear to be specific and vary with the species. The nature of the feeding behaviour whether selective or indiscriminate can be judged by noting the gut contents which suggest the true diet. Monthly data on the stomach contents further help studying the seasonal changes in the feeding (Mohamed, 2013).

The only previous large-scale study of the diet of this species was in India (Kore & Joshi, 1975). Oommen (1977) studied food, feeding and fishery of certain cephalopods from the west coast of India. Meiyappan *et al.* (2000) investigated the biology and stock assessment of the cephalopod resources in Indian seas. Recently, Mohamed (2013) studied food of the squid *Uroteuthis duvauceli* in the Suez Canal.

The main objective of the present study is to throw light on the food and feeding of *L. duvauceli*, including feeding intensity and food composition in the Gulf of Suez.

MATERIALS AND METHODS

Samples of *Loligo duvaucelii* were monthly collected during the period of September 2014 to April 2015. Samples were taken from the commercial trawlers that landed at Attaka fishing harbor. A total of 702 samples ranged in size from 5.1 to 28.1 cm dorsal mantle length (DML) were used for the present study.

Empty stomachs were discarded and the rest were preserved in 5% neutral formalin. Then, the stomach was cut and the food contents were removed and diluted with tap water to be ready for identification using a research microscope. The food items were identified to the lowest possible taxonomic level.

Feeding intensity

For quantitative analysis of the diet, stomach condition was assessed visually. The feeding intensity was determined by the degree of the fullness of the stomach. Fullness of each stomach was expressed as follows:

Feeding intensity	Description
0	Empty stomach.
1/4-full	Stomach contains a small but significant amount of food or bits of debris.
1/2-full	About half of the stomach volume is filled.
3/4-full	Full but not gorged-stomach.
Full	Fully and gorged stomach with clearly discernible foods.

Stomach contents

Contribution of different food items to the diet was determined and calculated by the frequency of occurrence (% F), according to this method, number (X) of every food item (Z) was expressed as percentage of total number of stomachs that contain food (Hyslop, 1980).

$$F_z = \frac{X * 100}{N}$$

where:

F_z = frequency occurrence of food item (z)

X = number of food item z

N = total number of stomachs containing food

RESULTS AND DISCUSSIONS

Feeding intensity

The fragmented and often well-digested state of the stomach contents made counts of individual prey difficult. A total of 702 stomachs of *L. duvauceli* (434 males and 268 females) were examined for studying the food and feeding during the fishing season 2014/2015. Food was present only in about 36 of the total stomachs examined. The occurrence of 1/4-full, 1/2-full, 3/4-full and full were 33%, 39%, 17% and 11% respectively of the stomachs with food (Fig. 1).

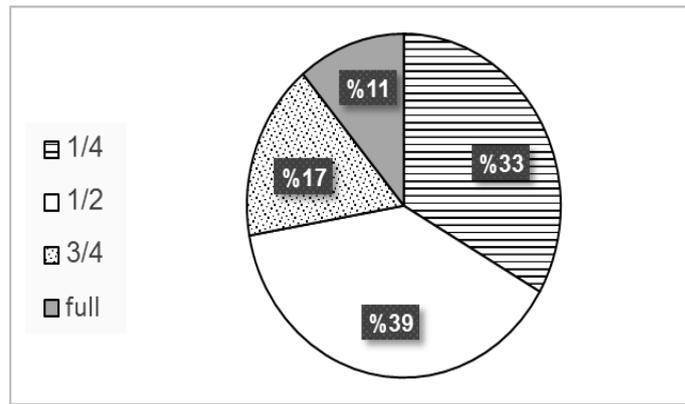


Fig. 1: Feeding intensity for the combined sexes of the stomachs of *L. duvauceli* from the Gulf of Suez during 2014/2015.

Monthly and seasonally variations were assessed for percentage occurrence of stomachs with different degrees of fullness in *L. duvauceli* (Figs. 2&3). The empty stomachs (0) were the majority during the whole fishing season (94.87%). The number of half full (1/2) came in the second rank, where it's occurred in all months but disappeared in November. The quarter full stomach (1/4) occurred in all months especially in January but disappeared in December and March. The 3/4-full stomach featured in the only two season (autumn and winter) and disappeared in the spring and summer, while the full stomach found in summer and autumn and disappeared in winter and spring (Figs. 2&3).

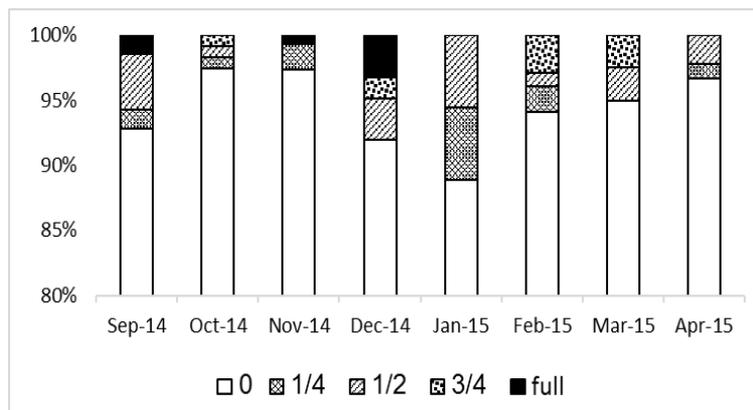


Fig. 2: Monthly variations in stomach fullness for *L. duvauceli* from the Gulf of Suez during 2014/2015.

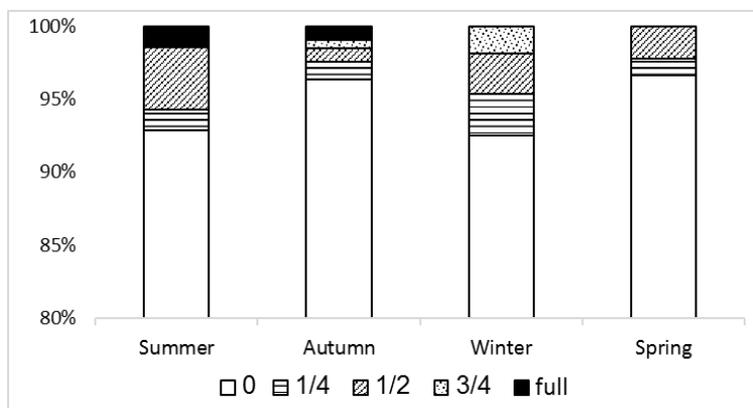


Fig. 3: Seasonal variations in stomach fullness for *L. duvauceli* from the Gulf of Suez during 2014/2015.

Kore & Joshi (1975) showed that normal feeding for *L. duvauceli* in India was noticed during the period from January to May 1970, but the slackness in the feeding was evident in October-November 1969. Also Mohamed (2013) noticed that normal feeding for *Uroteuthis duvauceli* in the Suez Canal was in January and February (winter), but the slackness in the feeding was evident in July and August (summer). So, it has already been pointed out that environmental conditions such as temperature, food availability and geographic differences are the main factors affecting on the growth pattern in squid (Forsythe, 1993; Hatfield, 2000; Jackson & Moltschaniwskyj, 2001 and Mohamed, 2013) and these findings coincide with our results.

Empty stomach

The empty stomachs were the majority during the whole fishing season about (94.87%) of the total stomachs examined. The data indicated that the occurrence of empty stomachs was more common in male than in female squids throughout four seasons. The percentage of empty stomachs of males was maximum (71.5%) in autumn while female was minimum (28.5%) in the same season (Fig. 4). This is may be due to the predominance of males (sex ratio M/F was 1.6:1) *L. duvauceli* during the period of study in the Gulf of Suez. But when we compare the empty stomach of both sexes with different maturity stages, it was found that the occurrence of empty stomachs was more common in female than in male of *L. duvauceli* in maturity stages III and IV (spawning season) (Fig. 5).

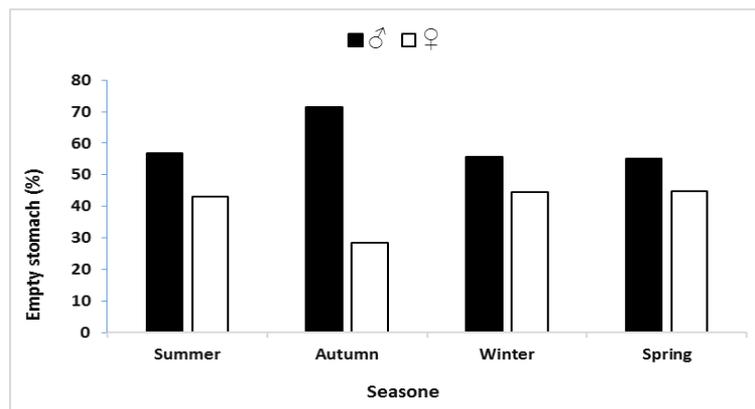


Fig. 4: Seasonal variations in percentage of empty stomach for males and females *L. duvauceli* during 2014/2015 from the Gulf of Suez.

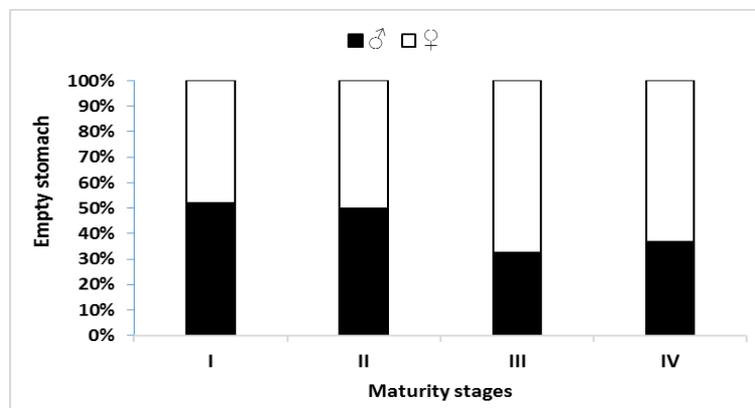


Fig. 5: percentage of empty stomach for each maturity stage of male and female *L. duvauceli* during 2014/2015 from the Gulf of Suez.

It may be due to females expend energy for spawning primarily from food supply (low feeding activity). This results agree with (Kore & Joshi, 1975 and Mohamed 2013) in the same species and (Macy, 1982; Pierce *et al.*, 1994 and Santos & Haimovici, 1997) in other squid species.

Stomach contents

In addition to the remarkable number of empty stomachs and as characteristic of cephalopods, most of the food items were found to be in unidentifiable highly crushed form and hence only the hard structure remains were relied upon for evaluation of food composition.

The stomach contents and food composition were broadly classified into four categories as follows:

Stomach contents	Description
Fish remains	Usually includes bones, scales and skin
Crustacean remains	Usually includes chitinous exoskeleton, appendages with setae, claws, mandibles and eyestalks.
Cephalopods remains	Mantle parts, pieces of arms, suckers and skin with chromatophores.
Unidentified remains	Clearly food particles which could not be classified into fish or crustacean remains e.g. flesh remains and some hard structures.
Digested matter	A bulk of mucilaginous material that exists without clear and definite composition.
Sand grains	Small stones.

Food components

The overall numerical percentage (N%) and percentage of frequency of occurrence (O%) of different food items found in the stomachs of *L. duvauceli* squid from the Gulf of Suez (Tab. 1) showed that remains of fish and remains of crustacean constituted the main food items. They accounted for about 42% and 22.6% of the diet percentage composition respectively. Kore & Joshi (1975) showed that *L. duvauceli* stomach contents in India are mainly the crustaceans, fish and squid. Major items of food differ significantly from month to month. Fish always occurs in the diet of the squids of all sizes. Santos & Haimovici (1997) observed that fish occurred in 43.8%, cephalopods in 27.5% and crustaceans in 18.7% of the stomachs with food for short-finned squid *Illex argentines* off southern Brazil. Macy (1982) showed that crustaceans were more frequently consumed than either fish or squid, but fish were eaten by a wider size range of squid and more frequently inshore for long-finned squid, *Loligo pealei*, in new England waters.

Table 1: Percentage of numerical (N%) and occurrence (O%) of the different food items in the stomachs of *L. duvauceli* from the Gulf of Suez during 2014/2015.

Food category	N%	O%
Fish remains	42	100
Crustacean remains	22.6	100
Cephalopods remains	12	85.7
Unidentified remains	7.5	71.4
Digested matter	14.2	100
Sand grains	1.7	28.6

Stomach Fullness in relation to maturity stages

The percentage of stomach fullness for each maturity stage of each sex is illustrated in (Figs. 6&7). The data indicate that empty stomachs predominates in all maturity stages especially in spawning stages and it was more common in female than male at maturity stages III and IV. This may be explained as females expend energy for spawning primarily from food supply. For male and female of *L. duvauceli* the percentage of stomach fullness decreased by the increase in the maturity stages (Fig. 8). This results agree with Kore and Joshi (1975) who studied food of the squid *Loligo duvauceli* in India and they found that a decrease in the feeding intensity in squids during the spawning season.

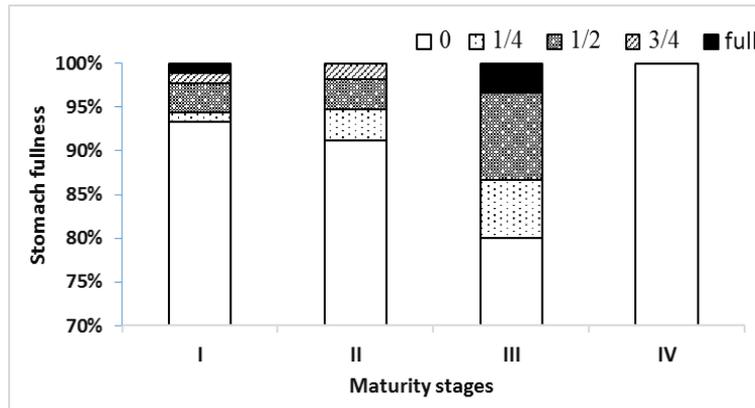


Fig. 6: Stomach fullness for each maturity stage of female *L. duvauceli* from the Gulf of Suez during 2014/2015.

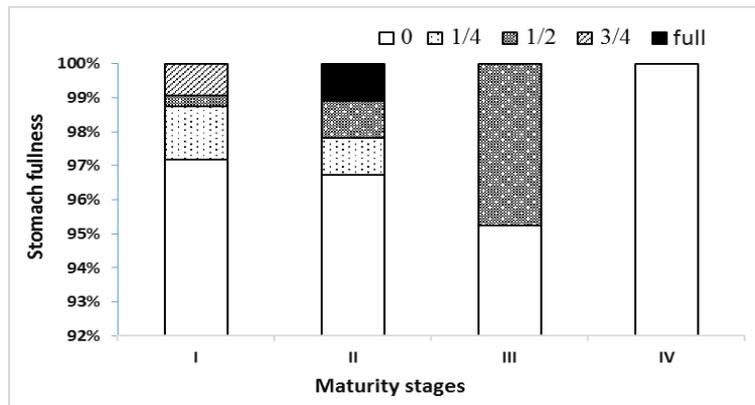


Fig. 7: Stomach fullness for each maturity stage of male *L. duvauceli* from the Gulf of Suez during 2014/2015.

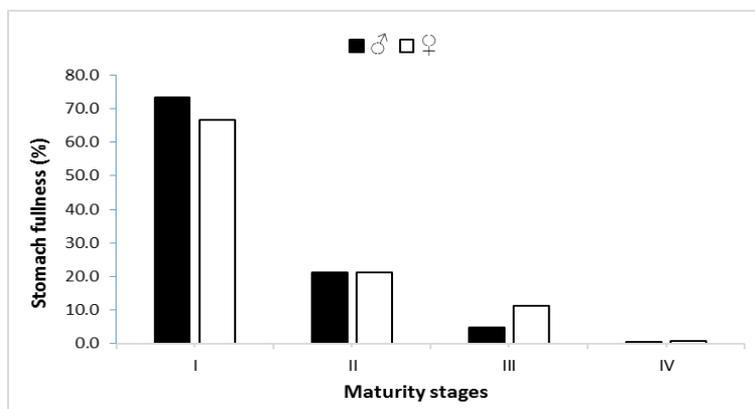


Fig. 8: percentage of stomach fullness for each maturity stage of male and female *L. duvauceli* during 2014/2015 from the Gulf of Suez.

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ARABIC SUMMARY

الغذاء والتغذية في الحبار الهندي "الكاليمارى" لوليجو دوفوسيلى فى خليج السويس، مصر

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يهدف البحث إلى دراسة نوعية وطبيعة الغذاء بالنسبة للكاليمارى لوليجو دوفوسيلى فى خليج السويس خلال موسم صيد 2015/2014م. تم فحص محتويات المعدة لهذا النوع من الحبار ووجد أن مكونات الغذاء الاساسية عبارة عن بقايا أسماك وقشريات وحباريات بالإضافة إلى أغذية مهضومة وغير معرفة وحببيات رمال. وعليه يمكن وصف هذا النوع بأنه من أكلة اللحوم. كما وجد أن المعدة الفارغة مثلت الغالبية العظمى طوال فترة الدراسة (94,87%). وبالنسبة لعلاقة النضج الجنسى بامتلاء المعدة فكانت نسبة المعدة الممتلئة فى كل من الإناث والذكور تتخفف بالزيادة فى النضج الجنسى، ونسبة تواجد المعدة الفارغة كانت أكثر شيوعا فى الإناث عن الذكور خاصة فى مراحل النضج الجنسى المتقدمة.