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Research Article

FOOD AND FEEDING BIOLOGY OF *KALINGA ORNATA* (ALDER & HANCOCK, 1864) FROM PAZHAYAR, SOUTHEAST COAST OF INDIA

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ABSTRACT

Seven species of sea slugs *Kalinga ornata*, *Armina maculata*, *A. tigrina*, *A. babai*, *Bulla ampulla*, *Hydatina zonata*, and *Philine orientalis* were observed at Pazhayar landing centre from Jan. 2014 to Dec. 2014. A total of 187 individuals were collected and measured their length-weight which was ranged between 45 to 136 mm and 75 to 80.44 g. Among them *Kalinga ornata* was highly dominant and hence, their food and feeding behavior, compositions of their gut content were studied. The morphology of *K. ornata* were observed under stereo-microscope and the overall percentage of food composition preyed is 30 % of echinoderms skeleton, 22 % of gastropods juveniles, 17 % of bivalve juveniles, 12 % of molluscan broken shells, 10 % of sand and muddy particles and 9 % of foraminiferans.

Key words: Gut contents, foraminifera, *Kalinga ornata*, sea slugs

INTRODUCTION

Kalinga ornata is highly carnivores species and marine shell-less molluscan group, herphrodite in nature, dorid like nudibranchs (naked gills) and fascinating with variety of color and body forms, commonly called "*Kalinga*". This specimen is classified by one individual genus and species, which belong to the family Polyceridae and subfamily Kalinginae. They are nocturnal animal and their original anatomy was first described by Alder and Hancock (1864) from Coromandel coast, but still scanty information is available on their biology and gut content (Sethi and Pttnaik, 2012; Shrinivaasu *et al.* 2013). The spicules of holothurians (Berg, 1890) and their skeletal parts (Jensen, 2007) in the gut were noticed and reported that *K. ornata* feeds on ophiurids based on field examination and faecal analysis (Rie *et al.,* 2011). It acts as macro-predator which feeds on sponges, corals, anemones, hydroids, bryozoans, tunicates, echinoderms, polycheatans, crustaceans, and sometimes other nudibranchs. Length and weight are the two components in the biology of species at the individual and population level which is possibly because of its significant size and risky structure. Since, few studies related to the radular morphology and feeding biology of *K. ornata* along the southeast coast, India, the present study has been carried out to understand the feeding behavior and gut content of *K. ornata*.

MATERIALS AND METHODS

Seven species of sea slugs were collected at Pazhaiyar landing centre (Lat.11° 34'N; Long.79 ° 81'E) from Jan. 2014 to Dec. 2014 and the study area were shown in Figure 1. Collected specimens were washed with native sea water, transported to the laboratory and frozen immediately for further analysis. The total length (from the anterior and posterior side) of each specimens measured with a measuring scale to the nearest centimeter and the body weight was measured in gram (at an accuracy of 0.000g, model: AUX220) by an electronic balance.

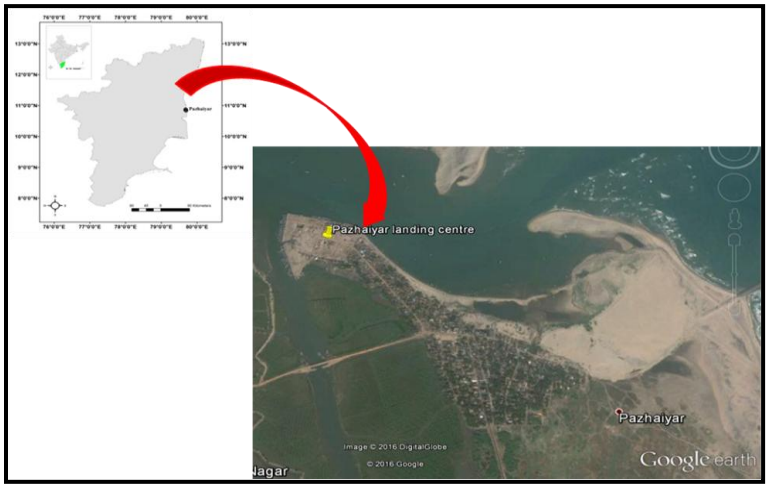

Figure 1: Map showing the Pazhayar fish landing centers

Based on the species dominance in the study area, food and feeding behavior and their gut content was observed. The species was dissected and gut contents were collected in a vial and were fixing it in 4% formalin. To study the organisms present in the gut and their feeding behavior were studied based on guts observation and fecal analysis. The radula morphology was drawn by camera lucida.

RESULTS AND DISCUSSION

A total of seven species with 187 individuals were collected from the Pazhayar landing centre and length-weight were measured which was ranged between 45 and 136 mm in length and 75 and 80.44 g in weight. The species collected in the present study is *Kalinga ornata* (166), *Armina maculata* (3), *A. tigrina* (2), *A. babai* (1), *Bulla ampulla* (4), *Hydatina zonata* (3), and *Philine orientalis* (8). *Kalinga ornata* was found to be highly dominant among all the species. The dorsal and ventral views of *K. ornata* (Fig. 2A and B).

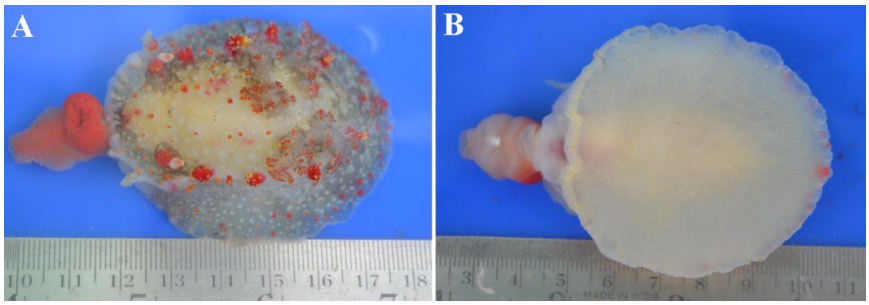

Figure 2: *Kalinga ornata*: A: dorsal view, B: Ventral view

In the laboratory, *K. ornata* was dissected (Fig. 3) for the gut and their length ranging between 30-90 mm and gut fullness weight ranging between 7-10 g.

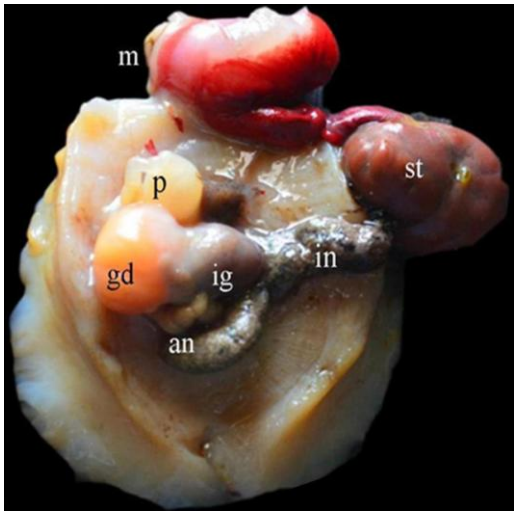

Figure 3: Dissection of *Kalinga ornata*: (m) mouth, (st) stomach, (in) intestine, (p) penis, (gd) gonad, (ig) ink gland (an) anus with dorsal side.

The gut contents of *K. ornata* were observed under stereo-microscope and found that *K. ornata* gut contains 0.5-20 mm bivalves juveniles, 10-20 mm gastropods juveniles, 10-90 mm molluscan broken shells, 50-200 mm echinoderms skeleton, 90-100 µm foraminiferans and 10-100 μm sands. The overall percentage of food composition in *K. ornata* gut was showed in Fig. 4.

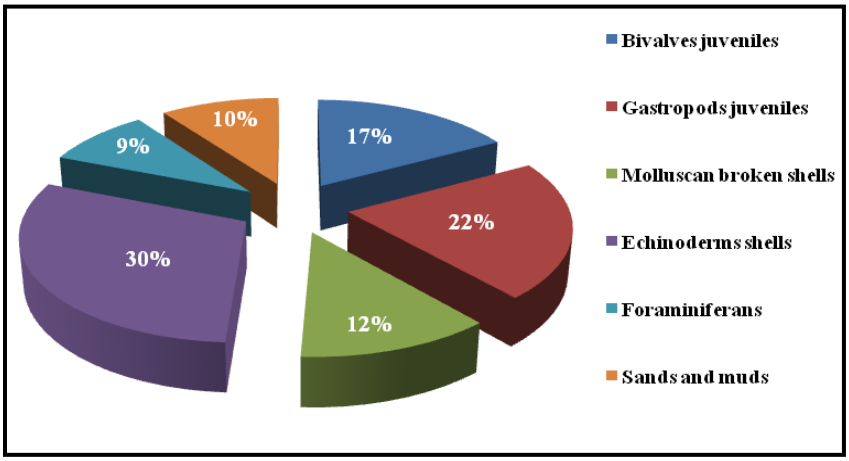

Figure 4: Overall % of food composition of *Kalinga ornata*

Echinoderm shells was found to be high and showed maximum of 30 %, followed by gastropod juveniles (22 %), bivalve juveniles (17 %), molluscan broken shells (12 %), sand and muds (10 %) and foramniferans (9 %). Nakona *et al.* (2011) conducted the field experiments to study the feeding behavior of *K. ornata* and found that *K. ornata* ate only ophiuroids and other organisms such as algae, nemerteans, bryozoans. The organisms present in the gut of *K. ornata* (Fig. 5 A, B, C and D). In the present study, a total of 32 forminiferan species were found in the gut content of *K. ornata.* Foraminiferans were identified to genus or species using the taxonomic keys by Thilagavathi *et al.* (2012). It was found that 32 species of foraminiferans belonging to 17 families, 15 genus, such as *Ammonia advena*, *A. batavus*, *A. pauciloculata*, *Amhistegina lessonii*, *Asterorotalia triszpinosa*, *Baculogypsina* sp., *Calarina calcar*, *Chrysocythe rekeiji*, *Discorbis orbicularis*, *Elphidium clavatum*, *E. craticulatum*, *E. discoidale, E. excavatum, E. mexicanum*, *E. poeyanum*, *Eponide srepandus*, *Globigerinita glutinata*, *Miliolinella* sp., *Micro metulahyalostriata*, *Nonion asteriszens*, *N. elongatum*, *N. grateloupi*, *N. incisum*, *N. labradorica*, *N. monicana*, *N. scapha*, *N. stella*, *Orbulina universa*, *Oridorsalis umbonatus*, *Quinqeuloculina laevigata*, *Rosalina globularis* and *R. macropora* present in the gut of *K. ornata* and their presence varied in depends on the month. The mode of feeding for *K. ornata* depends on the prey size and/or species.

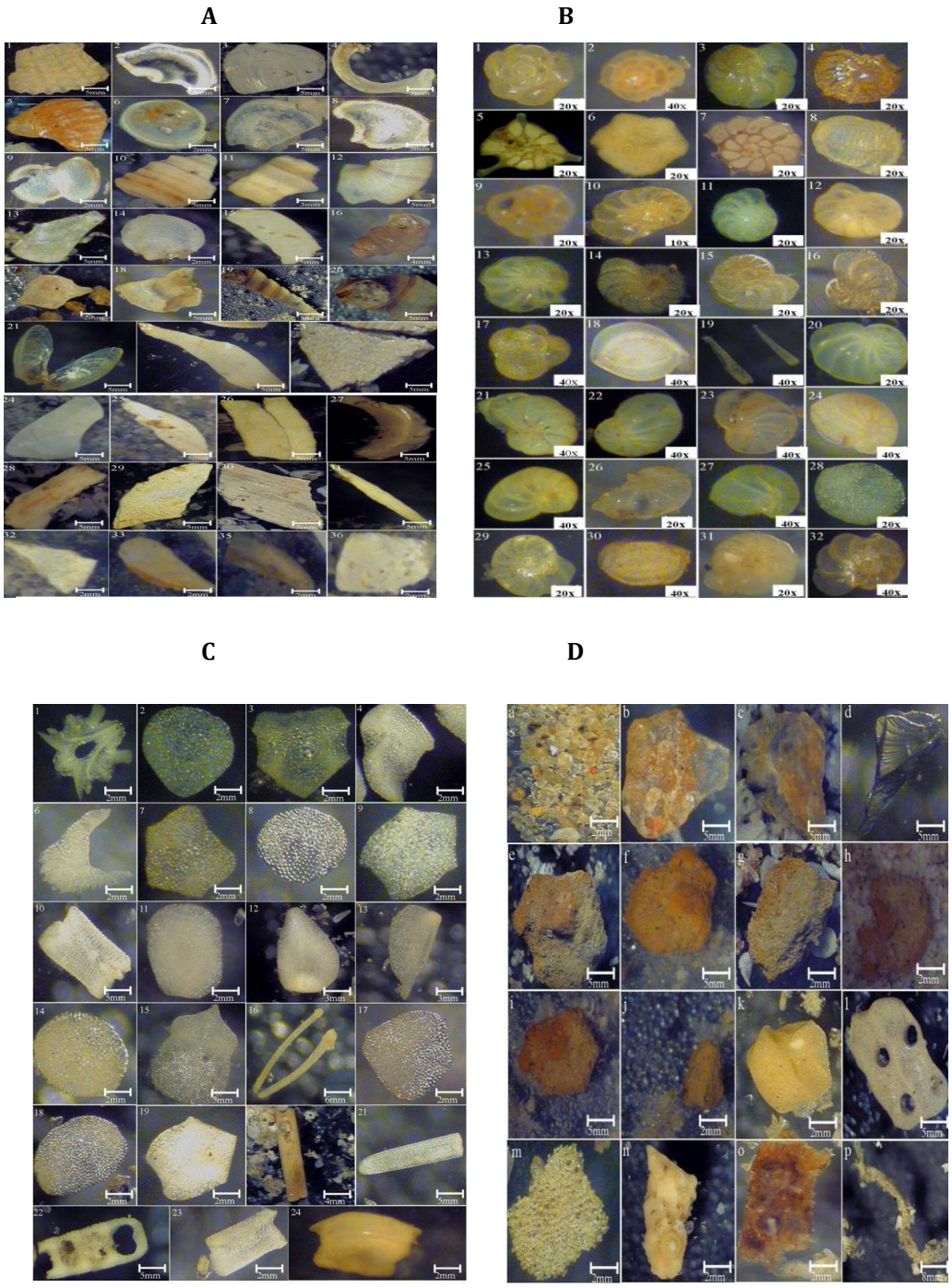

Figure 5: Gut content analysis of *Kalinga ornata* A. Foramniferans, B. Bivalve, Gastropod juveniles and Molluscans broken shells, C. Echnoderm skeletons, D. Sand and Muddy particles

The dietary compositions of the *K. ornata* were attempted for month-wise in the present study (Table 1). Maximum percentage of bivalve juveniles (37.05 %) was recorded during the August 2014 and minimum

in December 2014 (12.29 %). Gastropod juveniles (29.53 %) found to be high in January 2014 and minimum in December 2014 (15.12 %) was recorded during in December 2014). Molluscan broken shells (30.32 %) recorded maximum during February 2014 and minimum in April 2014 (10.09 %). Echinoderm skeletons (33.28 %) found to be higher in September 2014 and lowered in (12.14 %) in December 2014, whereas the presence of forminiferans (9.26 %) was recorded maximum in January 2014 and minimum was recorded in August 2014 (0.43 %). Sands and muds (20.24 %) were recorded maximum during April 2014 and minimum was recorded in September 2014 (3.26 %).

Month-wise	Bivalves juveniles (%)	Gastropods juveniles (%)	Molluscan broken shells (%)	Echnoderm skeletons (%)	Foramaniferans (%)	Sand and Muddy particles
January	25.05	29.53	18.31	31.02	9.26	15.71
February	19.03	23.12	30.32	16.91	6.3	4.32
March	21.02	17	20.06	22.03	7.01	12.88
April	20.34	14.09	10.09	29.03	9.21	20.24
June	20.43	22.4	15.25	18.01	8.05	15.86
July	22.30	22.03	17.05	19.05	5.06	17.51
August	37.05	18.04	12.29	19.21	0.43	13.19
September	17.31	25.04	16.01	33.28	5.11	3.26
October	20.27	23.11	15.24	28.32	7.91	5.15
November	19.03	25.02	22.16	27.36	1.09	5.42
December	12.29	15.12	27.05	12.14	2.33	12.21

Table 1: Month-wise percentage gut content of *Kalinga ornata* during January to December 2014

Radula of *Kalinga ornate:*

Numerous tricuspid microscopical teeth were observed and arranged in transverse rows on the radular membrane (Fig. 6). Each tooth showed a long curved root embedded in the substance of membrane and exposed a broad crown bearing the three recurved cusps. Eliot (1910) says of Doris that the radula can be drawn backwards and forwards over the odontophore as over a pulley and thus tear to pieces any substance which may be pressed against it. The anterior-most rows of the teeth of the radula are close together and much worn out by use but the middle expanded portion reveals fairly big teeth in perfect condition. The radular formula given by Farran (1905) was 90. 0. 90. In the present study, several specimens show that the number of teeth varies from 85 to 100 in a row on each side.

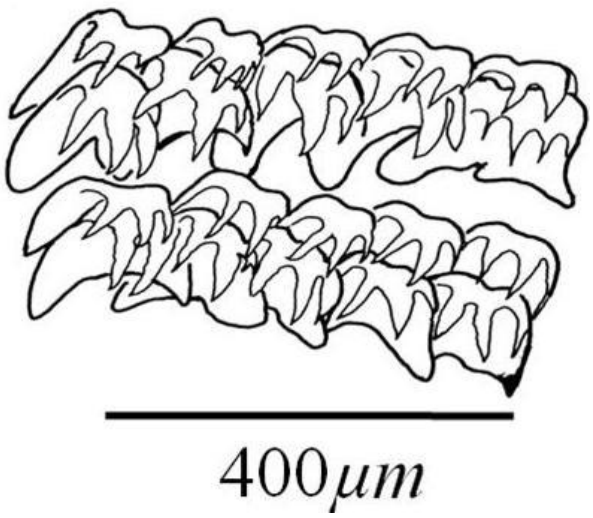

Figure 6: Teeth of the radula

In the young specimen examined by Farran there were about 130 transverse rows of teeth, whereas in a full grown specimen I counted nearly 200 rows in the part of the radula lying outside the radular sac, and a great many more on the posterior part in the radular sac; this agrees more closely with what was found by Bergh (1908). So far from the present study and earlier reports, it concludes that *Kalinga ornate* is the only nudibranch known to feed upon echinoderms such as ophiuroids and therefore there may be little competition for this food resource.

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