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Preliminary Studies on Diatoms Isolated from Shrimp and Fish Viscera Collected from Kuwaiti Waters

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ABSTRACT. Diatoms isolated from the viscera of some shrimps and fish and from gill rakers of fish of different sizes are investigated. A linear correlation, but not statistically significant was established for the number of diatoms and the volume of viscerae contents of the fish. More species of diatoms were found in the viscera of shrimps and benthic fish than in those from pelogic habitats.

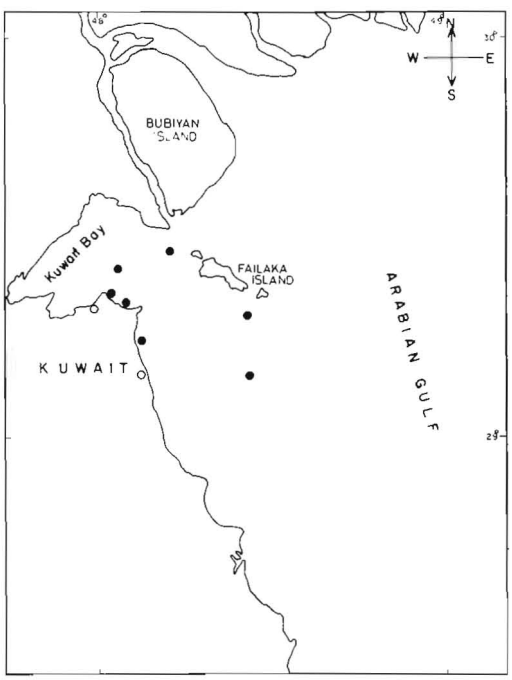
One of the key requirements for the culture of aquatic organims is the provision of a nutritionally adequate food source. This objective cannot be achieved unless the nutritional requirements or the species selected for culture have been previously determined. Commercial shrimp and fish farming for local consumption in Kuwait has been studied previously in the Kuwait Institute for Scientific Research [KISR] (Kuronuma and Abe 1972). Some nektonic fishes and shrimps obtain their essential nutrients by grazing amongst communities of planktonic primary producers (Enomoto 1971, Qasim and Jacob 1972 and Al-Attar and Ikenoue 1974). The occurrence and the diversity of diatomaceous species in the viscera of herbivorous fishes and shrimps shows that diatoms constitute a major part of their diet. Sarker *et al.* (1980) claims that 84% of the total phytoplankton consumed by the benthic mudskipper, *Pseudapocryptes dentatus* Cuvier & Valenciennes is made up of diatoms. Al-Nasiri *et al.* (1977) also found that diatoms comprise a major share in the food of the pelagic mullet *Liza abu* Heckel.

The present work provides a list of the diatoms which were isolated from the viscera of several fish and two shrimp species.

Experimental

A) Sample Collection

The present study was carried out on pelagic and benthic fishes as well as on shrimps of different sizes from Kuwait marine waters during the period October 1977 to July 1978. The specimens were either purchased from the local fish market in which fish from the whole Arabian Gulf are solid, or collected from the sampling stations shown in Fig. 1. Shrimps and fish species are identified from the treatise of Kuronum and Abe (1972).



Fi.g 1. Location of fish samples; ●: offshore, O: fish market.

B) Cleaning technique

Samples from gill rakers were removed by a fine brush and washed out with distilled water, then cleaned after the methods of Hasle and Fryxell (1970) and Hendey (1964). Using a plastic knife and sometimes a siphon (glass tube 4-5 mm diameter), organic matter from the digestive tract (viscera) of fishes and shrimps was removed, washed with distilled water and preserved in 4% formalin, then cleaned using the following technique:

To 2 ml of the sample was added 10 ml of 1N NaOH. This was left to stand for

30 minutes then centrifuged at 3,800 rpm for 30 minutes and washed with distilled water. 4 ml of 50% HNO_3 was added to the sample which was then placed on a hot plate inside a fume chamber for 10 minutes. It was then centrifuged as above and washed with distilled water. The remaining organic matter were removed by treating the sample with 4 ml of either 95% carbon tetrachloride or 95% dichloromethane, then centrifuged as above and washed with distilled water. The cleaned samples were preserved in 4% formalin for examination.

C) Counting technique

Diatom cells were counted on duplicate samples either in a Palmer-Maloney chamber or in settling chambers using an inverted microscope according to the method of Lund. *et al.* (1958). Diatoms were identified using Schmidt's Atlas (1874-1959) and Hendey (1964).

Results and Discussion

Two species of shrimps were examined: *Metapenaeus affinis* Edwards and *Penaeus semisulcatus* de Haan *[Decapoda penaeidae].* According to Boerema (1969), Enomota (1971), and Motoh (1975), the latter species is the most economically important crustacean in the Arabian Gulf. The following fish species were examined: *Pardachirus marmoratus* Lacépède, *Platycephalus indicus* Linnaeus, *Liza macrolepis* Smith, *Nemipterus japonicus* Bloch & Schneider, *Otolithus argenteus* Cuvier & Valencienne, *Acanthopagrus latus* Houttuyn, *Siganus oramin* Bloch & Schneider. *Johnius aneus* Bloch & Schneider, *Epinephelus tauvina* Forskal and *Pomadasys argenteus* Forskal (Table 1).

Table 1. Shrimps and fishes examined

Scientific name of fishes	No. of specimens	Total length of the body (cm)	Length of the viscera (cm)
Penaeus semisulcaltus	10	6—9	4—5
Metapenaeus affinis	10	10—14	6—8
Platycephalus indicus	2	25—35	12—18
Pardachirus marmoratus	2	up to 25	8—10
Nemipterus japonicus	4	16—20	8—13
Johnius aneus	4	10—15	8—10
Liza macrolepis	8	up to 20	10—15
Acanthopagrus latus	5	up to 35	12—15
Siganus oramin	4	up to 20	8—15
Otolithus argenteus	5	up to 70	20—30

While Helmut and Hug (1979) identified 114 diatomaceous species from the viscera of the mudskipper: *Pseudapocryptes dentatus,* only generic level identification of diatoms have been made in the present study (Table 2).

Table 2. Occurrence of various diatoms in the viscera of shrimps and fishes

Diatoms	Coscino-discus	Navicula	Rhizoso-lenia	Pleuro-sigma	Nitzschia-rudis	Grammato-phora	Licomo-phora	Diploneis	Stepha-nodiscus	Fragilaria	Synedra
Penaeus semisulcaltus	+++	++	+	v.r.	+++	r	+	+	++	+	++
Metapenaeus affinis	+	+	+	+	r	+	r	r	+	+	r
Platycephalus indicus	+	+	r	r	+	+	r	r	+	r	r
Pardachirus marmoratus	+	+	+	+	+	+	r	r	+	+	+
Johnius aneus	r	+	+	+	r	+	r	r	r	r	r
Liza macrolepis	v.r.	+++	r	r	r	r	r	r	r	++	r
Acanthopagrus latus	++	r	r	r	+	r	r	r	r	r	v.r.
Siganus oramin	r	+	+	+	+	r	r	r	+	+	v.r.
Otolithus argenteus	r	++	r	r	++	r	r	r	r	r	r

+ : present ++ : abundant +++ : dominant r : rare v.r.: very rare

Shrimps and benthic fishes consume a great variety of diatoms, while pelagic fishes, particularly *Liza macrolepis, Acanthopagrus latus* and *Johnius aneus* are more selective, being restricted to fewer species of diatoms from the genera *Coscinodiscus, Navicula, Nitzschia* and *Fragilaria* (Table 2). Fewer species of diatoms were detected in samples from the fish gill rakers (Table 3). However, these diatoms were also found in the viscera of the same fishes. This relationship between diatoms in the viscera and from gill rakers was also discussed by Durbin and Durbin (1975), who studied other fish species.

Table 3. Occurrence of diatoms in samples from the fish gill rakers

Diatoms, Shrimps & fishes	Coscinodiscus sp.	Stephano discus sp.	Nitzchia spp.	Fragilaria spp.
Nemipterus japonicus	+	+	+	–
Liza macrolepis	–	–	–	+
Johnius aneus	+	+	–	+
Acanthopagrus latus	+	+	–	–
Siganus oramin	–	–	+	+
Otolithus argenteus	–	–	+	+
Platycephalus indicus	+	+	+	–
Pardachirus marmoratus	+	+	+	+
Epinephelus tauvina	+	+	+	+
Pomadasys argenteus	+	+	–	+

Quantitative studies showed that shrimps and fishes being in the benthos consume greater amounts of diatoms than pelagic fishes (Fig. 2A). Sarker *et al.* (1980) report that the mudskipper *Pseudapocryptes dentatus* (a benthic gobioid fish) feeds entirely on microscopic organisms of which 84% are benthic diatoms. Al-Nasiri *et al.* (1977) found that the diatoms comprised a major portion of the food of *Liza abu.* Jacob and Zarba (1979) point out that the gut contents of some important benthic feeders in Kuwait coastal waters, such as *Penaeus semisulcatus,* mainly included the following diatoms: *Nitzschia* spp. (87%), *Coscinodiscus* spp. (4.7%). *Surirella* sp. (3.4%) and *Pleurosigma* sp. (1.4%). However, in *Liza macrolepis,* they found that *Surirella* sp. (34%), *Nitzschia* spp. (25%) and *Coscinodiscus* sp. (12%) constituted the main diatomaceous diet. As a result of the present investigation, it was found that the main diatoms in the viscera of *Liza macrolepis* were *Navicula* spp. (32%), *Nitzschia* sp. (20%), *Cyclotella* sp. (24%), *Surirella* sp. (16%), and *Pleurosigma* sp. (8%).

Benthic fishes, particularly *Pardachirus marmoratus,* as well as shrimps, showed an overwhelming consumption of *Nitzschia* spp. *Navicula* spp. and *Coscinodiscus* sp.; these were abundant in the sea water samples of the area of study (Fig. 2B). However, carnivorous fishes such as *Epinephelus tauvina* and *Pomadasya argenteus,* seem to have a preference for macroalgae, such as *Polysiphonia* (Rhodophyceae) over diatoms.

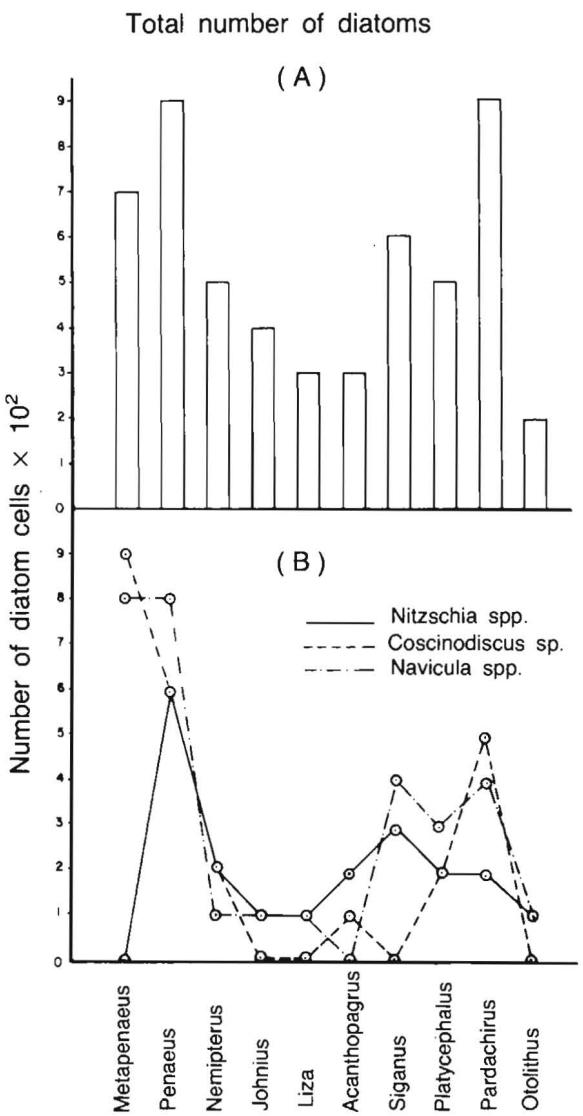


Fig. 2 (A+B) Diatom content of viscera in different consumers.

A linear correlation was determined between the number of diatom cells and the volume of the viscerae contents of *Liza macrolepis* (Fig. 3), however, with no statistical significance (correlation coefficient $r = 0.24$, $p<0.1$). The frequency of diatoms in the viscera of shrimps and fishes is correlated with the length of the viscera; the larger the viscera the more frequent the diatoms.

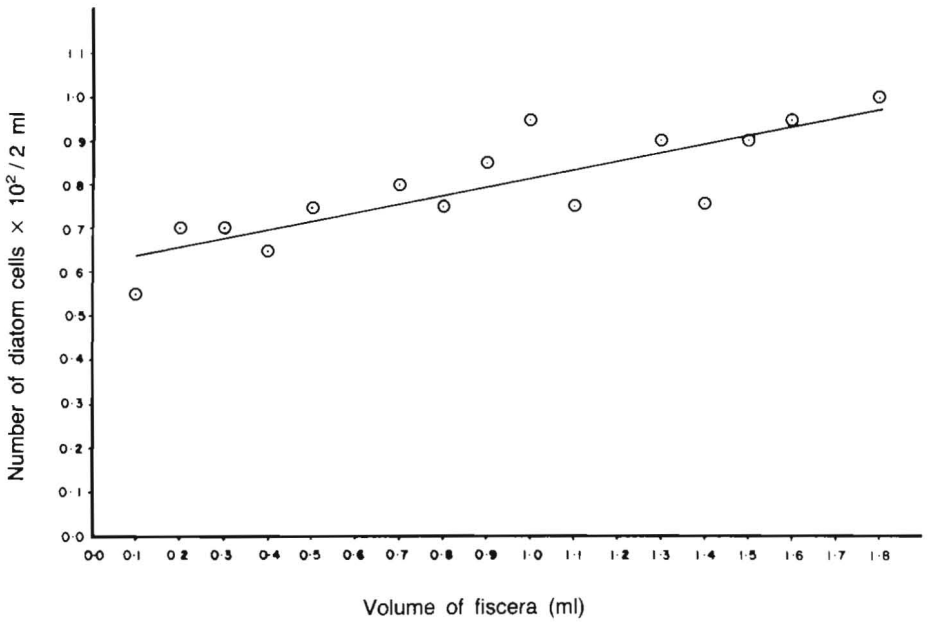


Fig. 3. Correlation between the volume of viscera *Liza macrolepis* and the content of diatom cells.

The presence of diatoms in ample quantities in the viscera of fishes and shrimps show the important role played by these organisms in the food chain of these grazers.

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دراسات أولية على الدياتومات المستخلصة من أحشاء الروبيان والأسماك من مياه السواحل الكويتية

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تم استخلاص وتعريف الدياتومات المتواجدة بأحشاء وخياشيم بعض أنواع الروبيان والأسماك التي جمعت من المياه السطحية والقاعية من السواحل الكويتية، وكذلك من الأسماك المتوفرة في الأسواق المحلية. واتضح وجود علاقة خطية (ليس لها مدلول إحصائي) بين عدد الدياتومات والحجم الكلي لمحتوى الإحشاء. كما اتضح أن عدد الدياتومات المستخلصة من أحشاء الروبيان والأسماك القاعية يفوق نظيره المستخلص من الأسماك السطحية.