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New Copepod Host Records for Ellobiopsid Parasites from the Northwestern Arabian Gulf

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ABSTRACT. We present new records of ellobiopsid parasites (*Ellobiopsis chattoni* and *Thalassomyces* sp.) on 18 species of copepods from the Arabian Gulf. These constitute new host records for the copepod species, as well as new geographical records of the parasites. The parasites were observed and identified during a post oil-spill zooplankton survey of the northwestern waters of the Arabian Gulf. The monthly plankton survey covered 13 stations in Kuwaiti coastal waters in the period September 1991 through February 1992. Intensity of parasitism varied both temporally and spatially during our survey. The highest incidence of parasitism was noted during October 1991. Parasite preference regarding either host size or sex was not observed. Although the occurrence of the parasites cannot be directly linked to the oil spill, their presence might be an indication of environment stress.

Copepods and their nauplii are the most abundant zooplankton groups in Kuwaiti waters of the Arabian Gulf and account for over 83% of the total zooplankton (Al-Yamani *et al.* 1993, Michel *et al.* 1986). They are considered to be an important component of larval fish diets. In January 1991, between 6 and 8 million barrels of oil were spilled into the Arabian Gulf potentially threatening the environment. Pre-spill zooplankton studies (*e.g.*, Jacob *et al.* 1980, Michel *et al.* 1986) focused on distribution, seasonal productivity and systematics. This study examines parasites of copepods observed during the post-spill zooplankton community survey.

Most parasites of zooplanktonic hosts are protists (Théodoridès 1989). Sewell (1951) reported 19 kinds of parasites (mainly protozoans, including the ellobiopsids) collected from pelagic copepods in the Red Sea and Indian Ocean during the John Murray Expedition. Ellobiopsids are parasites of planktonic marine crustaceans (mysids, euphausiids, amphipods and copepods) as well as polychaetes (Caullery 1910, Coutière 1911, Fage 1936, Nouvel 1941, Boschma 1949, Boschma 1956). In addition, a freshwater ellobiopsid has been discovered on the calanoid host, *Tropodiaptomus spectabilis* (Rayner and King 1986). According to Wasmer (1986) and Whisler (1990) the family Ellobiopsidae is a heterogeneous assemblage of five genera: *Ellobiopsis* (Caullery 1910), *Thalassomyces* (Niezbitowski 1913), *Parallobiopsis* (Collin 1913), *Rhizellobiopsis* (Hovasse 1926), and *Ellobiocystis* (Coutière 1911).

In this paper, we present new records of ellobiopsid parasites on pelagic marine copepods from the northwestern waters of the Arabian Gulf. For the sake of brevity, the nomenclatural authorities and dates for the different copepod species discussed below are not included.

Materials and Methods

Using a 50 cm diameter stainless steel frame with 110 µm mesh nets, 13 stations (selected from a national grid) were sampled monthly for zooplankton off the coast of Kuwait from September 1991 through February 1992 (Table 1). Depending on water depth, oblique tows filtered 2.5 to 16 m^3 of water. Samples preserved in 5% buffered formalin were analyzed, and identified to the lowest possible taxon for copepods and parasites. Observations of parasitized copepods, their densities (x m^{-3}), and parasite dimensions (mm) were recorded. All specimens were numbered and deposited at the Mariculture and Fisheries Department (MFD) of Kuwait Institute for Scientific Research (KISR) under the Parasitology Collections (PC) as follows: (a) copepods with *Ellobiopsis chattoni* (KISR-MFD-PC-60 for *Acrocalanus gibber,* KISR-MFD-PC-61 for *Paracalanus aculeatus,* KISR-MFD-PC-62 for *Paracalanus crassirostris,* KISR-MFD-PC-63 for *Paracalanus parvus*), and (b) copepods with *Thalassomyces* sp. (KISR-MFD-PC-64 for Acartia tonsa, KISR-MFD-PC-65 for *Acartia danae*, KISR-MFD-PC-66 for *Acrocalanus gibber,* KISR-MFD-PC-67 for *Candacia armata,* KISR-MFD-PC-68 for *Candacia bradyi,* KISR-MFD-PC-69 for *Calanus minor*, KISR-MFD-PC-70 for *Centropages furcatus,* KISR-MFD-PC-71 for *Corycaeus clausi,* KISR-MFD-PC-72 for Euterpina acutifrons, KISR-MFD-PC-73 for *Eucalanus subcrassus,* KISR-MFD-PC-74 for *Oithona nana,* KISR-MFD-PC-75 for *Oithona similis,* KISR-MFD-PC-76 for *Oncaea conifera,* KISR-MFD-PC-77 for *Paracalanus parvus,* KISR-MFD-PC-78

Table 1. Locations of Sampled Stations in Kuwaiti Waters

Station No.	Latitude	Longitude	Depth (m)
6	N 29° 20.0'	E 48° 10.0'	22
X-6	N 29° 21.8'	E 48° 08.1'	26
7	N 29° 10.0'	E 48° 10.0'	22.5
11	N 29° 40.0'	E 48° 12.0'	28
11-1	N 29° 11.6'	E 48° 14.1'	19.5
11-2	N 29° 07.7'	E 48° 09.0'	10
14	N 29° 00.0'	E 48°12.0'	9
28	N 28° 58.4'	E 48° 17.8'	17
34-D	N 28° 50.4'	E 48° 22.6'	21
K-6	N 29° 27.0'	E 47° 58.0'	7
K-6(1)	N 29° 24.8'	E 47° 57.8'	8
K-6(2)	N 29° 27.4'	E 47° 58.0'	10
K-10	N 29° 25.0'	E 47° 50.0'	14

K = Kuwait Bay.

for *Pontellina plumata,* KISR-MFD-PC-79 for *Pseudodiaptomus serricaudatus,* KISR-MFD-PC-80 for *Temora discaudata*, and KISR-MFD-PC-81 for *Temora turbinata*).

Results and Discussion

Copepods dominated the zooplankton of Kuwaiti waters. Mean total zooplankton per m^3 ranged from a high of 55,065 in November 1991 to a low of 10,155 in February 1992. The percentage of copepods ranged from a low of 24 to a high of 77 in February 1992 and September 1991, respectively (Table 2). Parasitized copepods accounted for a very small percentage of the total copepod population at all stations; usually less than 1% and never more than 7%. High prevalence of parasitism (> 5%) was found at stations 28 (6.65%) and 34-D (6.16%) in October 1991.

Table 2. Monthly average densities (no. m^{-3}) of total zooplankton, total copepods, parasitized copepods, and percentage composition of copepods and parasitized copepods from different stations in the Kuwaiti waters

Date	Total zooplankton	Total copepods	Parasitized copepods	% Copepods per zooplankton	% Parasitized copepods per total copepods
Sept. 1991	14479	11128	63	77	0.60
Oct. 1991	17743	13068	610	74	4.70
Nov. 1991	55065	36497	13	66	0.04
Dec. 1991	10940	6541	1	60	0.02
Jan. 1992	24361	17836	2	73	0.01
Feb. 1992	10155	2428	15	24	0.62

Infected adult and subadult copepods observed during this study include the following: *Acartia tonsa, A. danae, Acrocalanus gibber, Candacia armata, C. bradyi, Calanus minor, Centropages furcatus, Corycaeus clausi, Euterpina acutifrons, Eucalanus subcrassus, Oithona nana, O. similis, Oncaea conifera, Paracalanus aculeatus, P. crassirostris, P. parvus, Pontellina plumata, Pseudodiaptomus serricaudatus, Temora discaudata,* and *T. turbinata.*

Two distinct groups of ellobiopsid parasites were observed: *Ellobiopsis chattoni* (group 1) and *Thalassomyces* sp. (group 2). The frequency of occurrence of group 2 parasites exceeded that of group 1 (Table 3).

Group 1: *Ellobiopsis chattoni* (Caullery 1910)

a) Description

Mature *E. chattoni* is pyriform and possesses a stout stalk by which it is attached to the antennules, antennae, mandibles, maxillules, maxillae, and maxillipeds of its different calanoid host species. *E. chattoni* is found in form during its earliest stages and measures about 25 µm, however, as it increases in size, the head assumes a pyriform shape, and an apical structure becomes obvious when the parasite reaches 400 µm in length. At a size of about 650µm, it becomes segmented into two, by simple constriction. Dimensions of the mature parasite are about 700 µm in length by 350 µm in breadth which agrees with previous measurements by Caullery (1910) and Santhakumari and Saraswathy (1979). In moderately large specimens, a root-like structure (stalk) measuring 27 to 94.5 µm in length and 13.5 to 20 µm in width is visible penetrating the appendage. The length of the stalk

appears to vary with the development of the parasite (Sewell 1951). Jepps (1937) indicated that stalk length may vary from as long as the body in small forms, to about one-quarter the length of the body or less in larger specimens. Therefore, our stalk length measurements agree with previous description.

b) Copepod hosts

E. chattoni infected some of the common calanoid copepods from the Kuwaiti waters such as: *Acrocalanus gibber, Paracalanus aculeatus, P. crassirostris,* and *P. parvus* as well as their copepodite stages. Previous studies reported *E. chattoni* from the following marine calanoid copepods: *Acartia claussi* (Sewell 1951), *Calanus finmarchicus* (Jepps 1937), *C. helgolandicus* (Sewell 1951), *Cosmocalanus darwinii* (Santhakumari and Saraswahty 1979), *Ctenocalanus vanus* (Steuer 1932), *Euchaeta marina* (Sewell 1951, Santhakumari and Saraswathy 1979), *E. wolfendeni* (Sewell 1951), *Metridia longa* (Hoffman and Yancey 1966), *Pleuromamma borealis* (Sewell 1951), *P. gracilis* (Sewell 1951), *Pseudocalanus elongatus* (Sewell 1951), *P. minutus* (Hoffman and Yancey 1966) and *Undinula vulgaris* (Santhakumari and Saraswathy 1979).

The number of parasites per copepod host ranged from 1 to 3 individuals, but the majority of infected copepods had only 1 parasite. The parasite infected both male and female hosts, with no evident preference for host size, stage of development, or sex.

c) Depth and geographical distributions

All the parasitized copepods with E. chattoni from the current samples were obtained from a shallow depth range of 7 to 28 m. Wickstead (1963) found this species in the upper 41 m in the Zanzibar Channel, and Santhakumari and Saraswathy (1979) reported it in depths as shallow as 25 m. Specimens obtained from the Arabian Sea were found in the surface layer (Sewell 1951).

E. chattoni is distributed world-wide (Steuer 1932). It has been reported from various species of calanoids in the Adriatic Sea (Hoenigman 1958), Arabian Sea (Sewell 1951), Black Sea (Elian and Petran 1971), Indian Ocean (Krishnaswamy 1950, Wickstead 1963, Santhakumari and Saraswathy 1979), Mediterranean Sea (Caullery 1910), northeastern Pacific Ocean (Hoffman and Yancey 1966) and North Sea (Caullery 1910, Jepps 1937), but it has never previously reported in the Arabian Gulf.

d) Seasonality

In our study, highest incidence of parasitism by *E. chattoni* on calanoid copepods was evident during October 1991 (Table 3), with the highest intensity being at station 34-D, followed by station K-10. These results suggest a possible seasonal cycle in occurrence of *E. chattoni* in Kuwaiti waters, Hoffman and Yancey (1966) reported that during their monthly sampling in Auke Bay, Alaska, peak infestation of the calanoid copepod *Metridia longa* with *E. chattoni* occurred in late October and early November, suggesting seasonal variation in the rate of infection by ellobiopsids. However, in another study by Wing (1975) in Auke Bay, *E. chattoni* infecting *Pseudocalanus minutus*, showed no distinct seasonal trend in infection.

Table 3. Monthly total number of parasitized copepods (no. m^{-3}) and percentage composition of parasitized copepods with groups 1 and 2 per total number of parasitized copepods at stations with positive observations for parasites. (Group 1= *E. chattoni,* and Group 2 = *Thalassomyces* sp.)

Date	Station	Total no. of parasitized copepods	Copepods parasitized with group 1 parasite	% Group 1 parasite per total no. of parasitized copepods	Copepods parasitized with group 2 parasite	% Group 2 parasite per total no. of parasitized copepods
24/9/91	K-6	60	0	0	60	100
24/9/91	K-6(2)	66	0	0	66	100
20/10/91	11	329	1	0.30	328	99.7
20/10/91	K-10	1705	10	0.60	1695	99.4
21/10/91	28	361	4	1.11	357	98.8
21/10/91	X-6	25	0	0	25	100
21/11/91	34-D	631	66	10.46	565	89.5
27/11/91	K-6(1)	36	0	0	36	100
27/11/91	K-10	2	2	100	0	0
29/12/91	K-10	3	0	0	3	100
7/1/92	11-2	2	0	0	2	100
7/1/92	11-1	1	0	0	1	100
14/1/92	K-10	1	0	0	1	100
14/1/92	K-6	2	0	0	2	100
16/2/92	6	33	0	0	33	100
17/2/92	11	35	0	0	35	100
17/2/92	11-2	1	0	0	1	100
20/2/92	K-10	1	0	0	1	100
20/2/92	K-6	14	0	0	14	100
20/2/92	K-6(1)	9	0	0	9	100
20/2/92	34-D	12	0	0	12	100

Group 2: *Thalassomyces* sp. (Niezbitowski 1913)

a) Description

The genus *Thalassomyces* includes the largest and most complex species of the Ellobiopsidae (Kane 1964). Various pelagic members of the Malacostraca such as mysids, amphipods, euphausiids, and carideans were reported as hosts for several species of *Thalassomyces* (Vader 1973, Wing 1975). There are 12 known species of *Thalassomyces* (Wing 1975) that are separated on the basis of number, size and shape of the gonomeres, host-type, and position on the host-animal (Whisler 1990). This is the first record of *Thalassomyces* from marine copepods, as well as from the Arabian Gulf region, and could be considered as a new species, however, more materials of all specimens for all the developmental stages of the parasite are needed in order to identify it and compare it with other described species from different hosts.

The *Thalassomyces* from the Gulf samples are branched in form. The body or thallus of the parasite is divided into a basal rooting section, which supports and secures the external trophomeres carrying the terminal gonomeres. Internally, the parasite forms a central organ of fixation. In all Gulf specimens, the parasite was attached to the body segments of the host, mainly the thoracic segments, either dorsally or laterally. The parasite infected both male and female calanoid and cyclopoid hosts, with no evident preference for host size or sex.

b) Copepod hosts, depth and geographical distribution

The *Thalassomyces* parasites parasitized calanoid as well as cyclopoid and poecilostomatoid copepods of the following species: *Acartia tonsa, A. danae, Acrocalanus gibber, Candacia armata, C. bradyi, Calanus minor, Centropages furcatus, Corycaeus clausi, Euterpina acutifrons, Eucalanus subcrassus, Oithona nana, O. similis, Oncaea conifera, Paracalanus parvus, Pontellina plumata, Pseudodiaptomus serricaudatus, Temora discaudata,* and *T. turbinata.* The above copepod species constitute the first host records for the parasite as well as new geographical records in the Arabian Gulf. All samples were obtained from depths not exceeding 28 m.

c) Seasonality

The maximum infection of *Thalassomyces* on copepods was found in October 1991, as with *E. chattoni* (Table 3). The highest numbers of infected hosts were found at stations K-10 and 34-D.

Effect of Parsites on Host

Few studies have addressed the possible harmful role of parasites on their zooplanktonic hosts. Some observations indicate that there no pathogenic effects on the host population (Weinstein 1972), while other studies displayed different results. Ho and Perkins (1985) discussed the role of the *E. chattoni* parasite in regulating host populations, especially the rare copepod species, by affecting larval recruitment. The root of *E. chattoni* penetrates the appendages of the host and serves not only as an organ of attachment but also as an organ of absorption (Santhakumari and Saraswathy 1979). Several studies suggest that *E. chattoni* affects the female copepod reproductive system (Jepps 1937) and causes a reduction in the number of eggs in the ovary (Santhakumari and Saraswathy 1979). Nevertheless, Wickstead (1963) stated that the egg production, which is inhibited as a consequence of parasitization and resultant starvation, could revert to normal after the parasite is lost. Some of the parasitized copepods in this Gulf study were slightly deformed in shape, and smaller in size than their non-parasitized counterparts, possibly because the parasites draw heavily on the metabolic resources of their hosts.

Reports of the effects of *Thalassomyces* parasitism on the host vary from no apparent effect (Boschma 1949) to suppression of sexual maturation of the host (Mauchline 1966, Wing 1975), modification of normal morphology (Hoffman and Yancey 1966, Wing 1975) or decreasing reproductive success, and increasing host mortality (Wing 1975).

Conclusions

This study constitutes first records of two ellobiopsid parasites (*E. chattoni* and *Thalassomyces* sp.) on 18 different species of copepods from the Arabian Gulf. Maximum host infection by the two parasites was observed in October 1991, suggesting possible seasonal variation in the rate of infection. The parasites infected both male and female copepods, with no evident preference for host size, stage of development, or sex. Infected copepods looked slightly deformed and smaller in size than the non-infected individuals. Moreover, although the occurrence of these parasites can not be blamed on the recent spill, their presence might be an indication of environmental stress.

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ظهور التطفل على مجدافيات الأقدام في الجزء الشمال غربي من الخليج العربي بعد حادثة التلوث ببقعة الزيت والتعرف لأول مرة على طفيل الوبيوبسيد (Ellobiopsid)

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دائرة الزراعة البحرية والثروة السمكية

معهد الكويت للأبحاث العلمية

ص .ب (٢٤٨٨٥) - صفاة ١٣١٠٩ - الكويت

تعتبر مجدافيات الأقدام من أكثر مجموعات العوالق الحيوانية إنتشاراً في مياه الجزء الشمال غربي من الخليج العربي . ومن خلال دراستنا للعوالق في الخليج العربي عام ١٩٩١ بعد حادثة التلوث ببقعة الزيت لوحظ لأول مرة جنس الوبيوبسس *(Ellobiopsis)* يتطفل على أربع أنواع من مجدافيات الأقدام الكالانويدية (Calanoid Copepods) في المياه الساحلية الكويتية . ولوحظ أيضًا طفيل آخر من نوع ثلاسومايسيس *(Thalassomyces)* على أنواع متعددة من مجدافيات الأقدام الكالانويدية والسايكلوبويدية (Calanoid and Cyclopoid Copepods) . إن قوة التطفل تباينت زمنيًا ومكانياً خلال فترة دراستنا للعينات من سبتمبر ١٩٩١ إلى فبراير ١٩٩٢ .

وقد ظهر أن أعلى نسبة حدوث للتطفل كانت خلال أكتوبر ١٩٩١ وبالإضافة إلى ذلك لايوجد أي دليل على تفضيل الطفيل لحجم أو جنس معين للعائل .