Feeding of *Paracalanus parvus* (Claus, 1863) Order Calanoida (Copepoda) in the Coastal Waters of Baniyas (Eastern Mediterranean)

Dr. Kamal Al-Hanoun[1] and Wassim Mayya[2]

1: Professor - Department of Animal Biology - Faculty of Science - Tishreen University - Lattakia – Syria

2: Postgraduate student (PhD) - Department of Animal Biology - College of Science - Tishreen University - Lattakia - Syria

Abstract:

This study, included the feeding of (Paracalanus parvus (Claus, 1863) of crustacean zooplankton (Calanoida), by studying the structure of the Mandible and the intestinal content of this previous species to determine Their favorite food. 36 samples have been collected vertically in period between March and May 2020. The samples were also accompanied with different hydrophysical and hydrochemical measurements in three regions that differ from each other with their environmental properties. The number of members of (P.parvus) that were studied reached (32) individuals, of which (19) are female and (13) are male.On the other hand, determining the shape of the Mandible, studying its structure and knowing the intestinal content of the previous species helped to improve and know the feeding conditions and strategies of its the influence of different environmental factors.

Keywords:

The Feeding, Mandible, Intestinal Content, Hydrophysical And Hydrochemical Measurements, Feeding Strategies

I. INTRODUCTION

Crustacean zooplankton is a Heterotrophic and is an important component of marine ecosystems [1] through the primary role it plays in the food web [2]. As such, it is a biological structure in which the feeding methods vary [3], which increases the complexity and complexity of the food chain. [4], in addition to that herbivorous group dependent on phytoplankton [5], which creates a balanced biological composition [6].

Copepods are major components of marine food chains and operate either directly or indirectly as food sources for most commercially important fish [7], and their oral appendices have evolved to suit the nature and quality of their food [8]. On the other hand, the jaw's leg movement towards the mouth creates a stream of water that raises the pressure inside the mouth, which leads to water entering with food [9], and others are equipped with a special filtration system through which it filters the food particles entering with Water stream [10].

Copepods generally tend to feed on a mixed diet in their natural environment, especially in the first few layers (0-50) m [11], and the survival and success of copepods over the years may be due to their ability to determine prey [12], and the selection of the preferred and most abundant food in the surrounding environment [13]. It is worth noting, however, is the ability of many types of copepodes to shift from a plant-feeding pattern in the absence of it in the medium to feeding on small animals and vice versa as is The case with *Glausocalanus furcatus* [14].

Copepodes are dominant creatures in marine zooplankton [1]. Their diets often include large proportions of Diatoms that have Silesian structures to protect. Despite this protection, there are many types of copepodes that are capable of breaking and shattering these structures with high efficiency even the most supported and protected types [15]. The composition and shape of mandible teeth at copepodes also differ by species, and studies using electron microscopy have revealed These teeth are of complex microscopic structures that contain in their composition silica and this explains their ability to destroy the structures of Diatoms [16].

Various environmental factors such as temperature, salinity, dissolved oxygen, pH, and transparency affect marine copepodes and their nutritional activity [9], and the concentration and distribution of food particles in the surrounding medium [17].

The research aims to study feeding for *P.parvus*, determine the intestinal content of food, and study the shape and composition of its species, under the influence of various environmental factors.

The importance of economic research lies through clarifying the environmental and nutritional requirements of the studied species, which constitutes a basic rule that facilitates the prediction of the status of these species in terms of productivity, as they are of economic importance and constitute a major food for fish, crustaceans and many other marine creatures.

II. MATERIALS AND METHODS

The species collection processes were carried out from the three study areas that were chosen in the coastal waters of the city of Baniyas, which differ from each other in environmental terms, as shown in Figure 1, which are:

A.) *Sanitation area: (A):*

35°12′09″N 35°57′08″E

It is located opposite the Baniyas National Hospital, where the sewage of the hospital and the neighborhoods of Al-Morouj flows into a unified liquefaction line (a major sewage line), where its estuary ends in the coastal waters of a city, and this beach is away from the second area (the thermal station area) at a distance of 7 km.

B.) *The Thermal Station Area: (Estuary of hot water): (B):*

35°10′13″N 35°55′21″E

This region is located opposite the electrical power station in Baniyas, which is one of the five power stations responsible for supplying the country with electrical energy. The thermal plant is 5 km from the third clean area. The thermal water resulting from the cooling of the station and the steam of the boilers that unite with it is poured into marine waters.

C.) *Prince Beach Chalets: (C).*

35°09′02″N 35°55′20″E

The Prince Chalets Beach, on which the Prince's Resort and Chalets is located, and this beautiful beach is 1 km from the Archaeological Tower of Al-Sabi site. This beach is a very clean area and not exposed to pollution, and therefore it is a destination for tourism and summer vacation

Figure 1: Study areas in the coastal waters of the city of Baniyas.

Each region is divided into three sites (stations):
Zone A: Stations: A3-A2-A1.
Zone B: Stations: B3-B2-B1.
Zone C: Stations: C3-C2-C1.
The process of collecting samples of the two types in each site was as follows:
1. The first location: (50-0) m, (50-25) m, (25-0) m.
2. The second location: (100-0) m, (100-50) m, (50-25) m, (25-0) m.
3. The third location: (200-0) m, (200-100) m, (100-50) m, (50-25) m, (25-0) m.

Measurements were taken for the main environmental factors such as: (temperature (t), salinity (s), dissolved oxygen concentration (O2), pH, transparency).For the combination process, a universal quantum network with a 200 µ hole WP2 Closing Net with a locking device was used.

III. RESULTS AND DISCUSSION

A. *Taxonomic status and general description of the species:*

***Paracalanus parvus* (Claus, 1863)**.

a.Taxonomic status:

Phylum**: Arthropoda**
Subphylum:**Crustacea**
Class: **Copepoda**
Order: **Calanoida (Sars,19)**
Family: **Paracalanidae (Giesbrecht, 1893)**
Genus:**Paracalanus(Boeck,1865)**
Species: ***P. parvus* (Claus,1863)**

b. Male:

The length of the male (0.7-1.0mm) and in terms of its overall appearance is very similar to the female. His swiming legs have thorns on the branches. The fifth intercession of the legs is asymmetric [18] Figure (2).

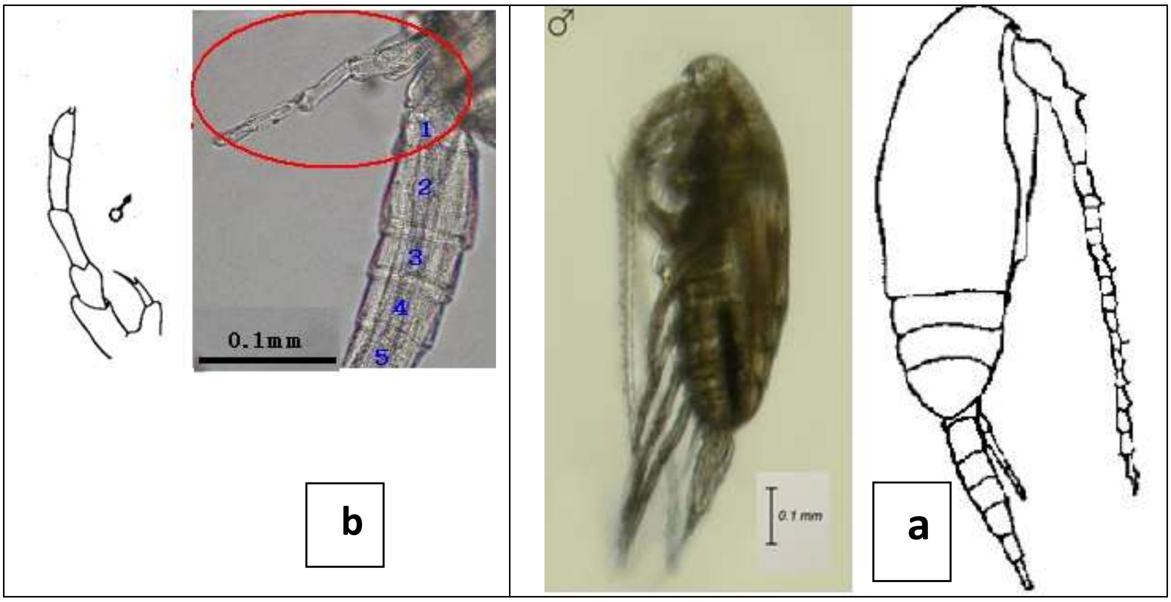


Figure (2): (a) a general shape from the side to the male, (b) the abdominal segmented and the p5 of the male.

c. Female:

The length of the female (0.7-0.8mm), her body is short and wide and the front end is regularly round, the antennule has slightly longer than the body, the fifth diplopia of the legs of the female atrophic [18] Figure (3).

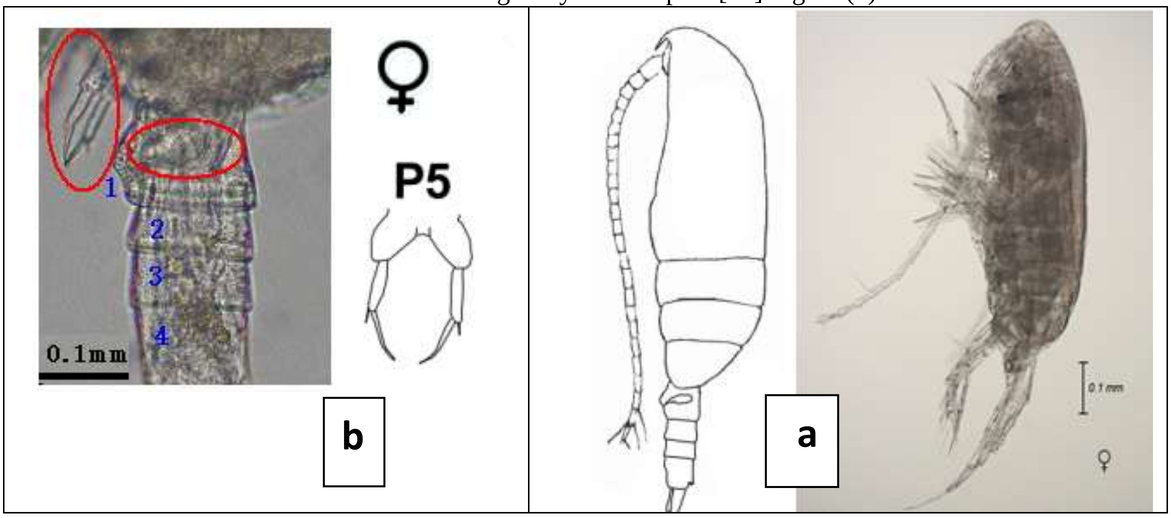


Figure (3): (a) a general shape from the female side, (b) the abdominal segmented and the p5 of the female .

B. Feeding of P. parvus:

P. parvus appeared in all study areas and stations, and the total number of individuals studied was (32) individuals, of which (19) are female and (13) male are distributed at different depths, and this explains that this species has wide environmental adaptation. Eurybiont with the values of different environmental factors [19] as shown in Table (1). The largest presence was in the layer with depth (0-50) m [20], due to the large number of nutrients in this layer, as it is the primary productivity layer [21], where the phytoplankton that exists Photosynthesis, The presence of marine currents and wave movement, and the exposure of the layer (0-50) m to significant changes in the values of environmental factors, as well as the Estuary drainage, whose water is loaded with organic materials and nutrients and which flows into station (A1), has made this layer a suitable place for the existence of the type Previous, and this type did not exist in station (B1) at all, and the reason is that this station is the mouth of the hot water resulting from cooling the turbine of the station and the boilers. Previous to bear it or even live in its field.

Table (1): Changes in the values of environmental factors during the period of emergence of *P.parvus* during the study months.

Depths (m)	15-0	25-0	50-0	50-25	100-50	200-100
Temperature (° C)	20.81	19.34	17.91	18.21	16.41	10.80
Salinity ‰	36.41	36.90	37.32	37.61	37.93	38.51
(pH)	6.81	7.42	7.51	7.63	7.84	7.91
Dissolved oxygen (mg / l)	6.82	7.13	7.31	7.43	7.71	7.94

Table (2): Some global studies that are compatible with the current study.

Re./History	Researcher	Study Title
[22]/ 2004	And G. A. Paffenho¨ Fer	Relation of behavior of copepod juveniles to potential predation by omnivorous copepods: An empirical-modeling study.
[23]/ 2004	Ricardo Giesecke H.E. González	Mandible characteristics and allometric relations in copepods.
[24]/ 2013	Peter Tiselius EnricSaiz Thomas Kiørboe	Sensory capabilities and food capture of two small copepods, Paracalanusparvus and Pseudocalanus sp.
[25]/ 2015	Jan Michels Stanislav N	Mandibular gnathobases of marine planktonic copepods
[16]/ 2020	Abigail S. Tyrell Houshuo Jiang Nicholas S. Fisher	Copepod feeding strategy determines response to seawater viscosity.

It was found through the study, which was compatible with many international studies, Table (2), that *P.parvus* is herbivorous [26] as shown in Table (3), and perhaps the most important food for him is (Dinophyceae) [27] and (Diatoms) [28], knowing that by studying the intestinal content of Figure (4) for individuals of the previous species within the layer (0-50) m, it was observed that there are several species of food and this explains that the previous species resort To mixed food [29] and feeding on more than one species due to the high availability of food within them [30], This is illustrated in Table (3), whereas at large depths (100-200 m), it resorted to the use of only one species of food, according to what is available in the medium and most likely from Diatoms [25]. The reason is that these depths Light does not reach it, and phytoplankton does not exist to carry out photosynthesis, and consequently, it is poor layers of food, in which species resort if there is dependence on food available in the medium [7].

Table (3): the species of phytoplankton that formed the food of *P.parvus* during the study months.

species	Taxonomic status	Image	Depth (m)
Thalassiosiraweissflogii	**Mediophyceae**		15-0 25-0 50-25

Protoceratiumreticulatum	**Dinophyceae**		25-0 50-25 100-50
Ceratiumfusus	**Dinophyceae**		15-0 25-0 50-25 100-50
Ceratiumtrichoceros	**Dinophyceae**		25-0 50-25 100-50
Ceratiumhorridum	**Dinophyceae**		25-0 50-25 100-50
Ceratiumplatycorne	**Dinophyceae**		15-0 25-0 50-25 100-50
Coscinodiscussp	**Diatoms**		15-0 25-0 50-25 200-100
BacteriastrumfurcatumShadbolt	**Diatoms** **Bacillariophyceae**		15-0 25-0 50-25 200-100

Rhodomonassalina	**Cryptophyceae**		15-0 25-0 50-25

P.parvus diets include large proportions of Diatoms that possess protective silicic structures, and despite this protection, the former species is able to break and destroy these structures with high efficiency even the most supported and protected types of Diatoms [14], and returns The reason for this is the mandible shape of the teeth (4,3), which has short sharp edges that are used for grinding Diatoms and the rest of the phytoplankton species.

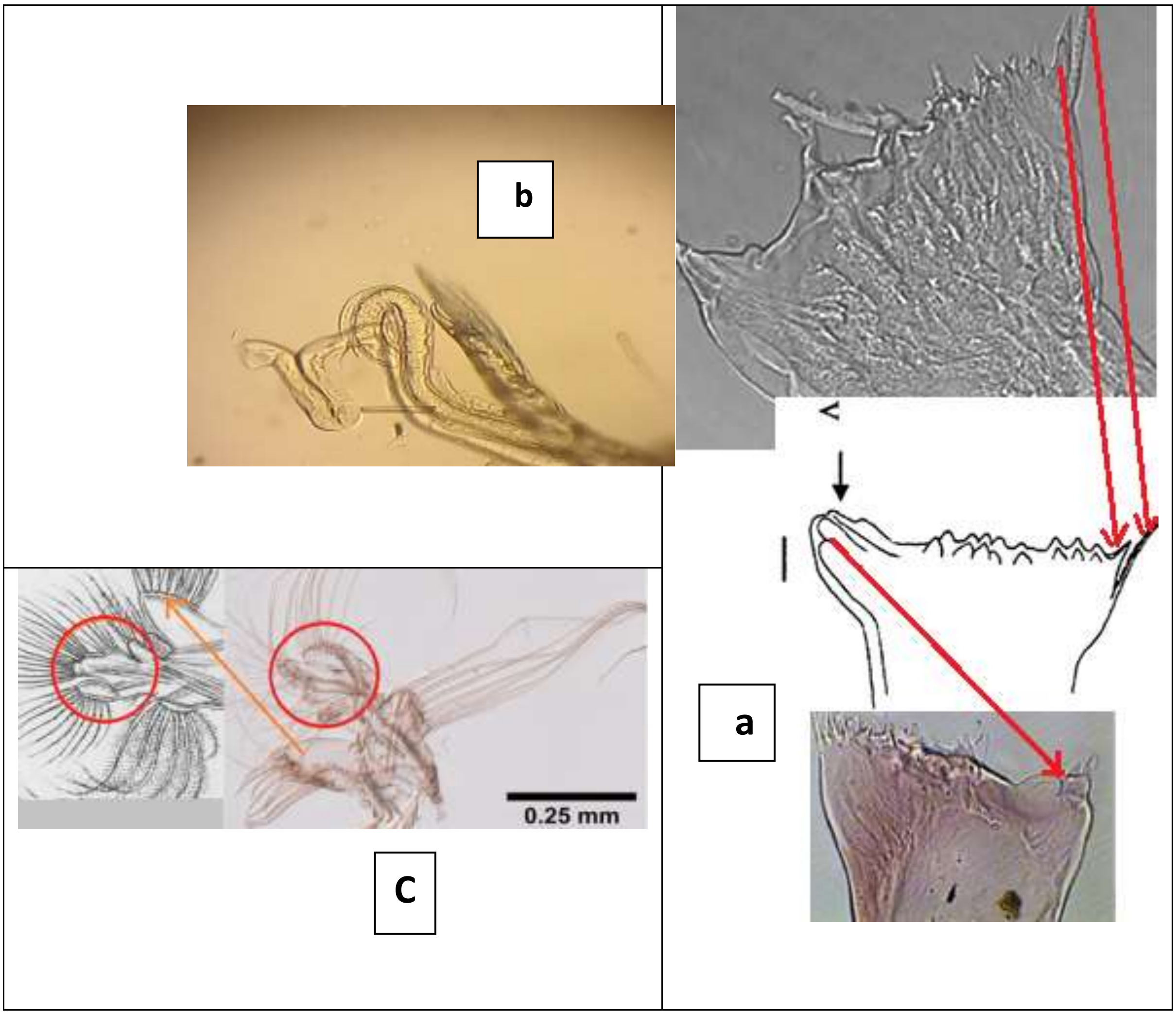
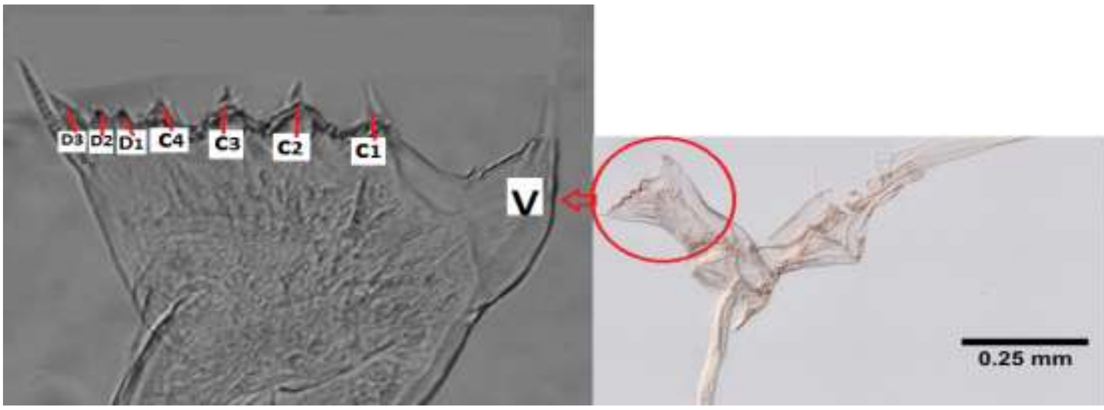


Figure (4): (a) mandible structure, (b) general view of the intestine, (C) Maxilla, *P.parvus*.



Mandibular Gnathobasis V: Ventral Teeth. C1-C2-C3-C4: Central Teeth. D1-D2- D3: Dorsal Tooth.

According to many international studies, Table (2), which was done using an electron microscope, mandible teeth show a nanoparticular structure containing a little amorphous silica and a large percentage of crystalline silica that is spread in the form of a network of micro-ketinic fibers [9]. It is also likely that these fibers will serve as the mainstay during the feeding process [26], and the ventral tooth (V) Figure (4) is the most important tooth in mandible at ***P.parvus*** and at the rest of the copepods, especially Calanoida, which is the most important teeth varies according to species, on the other hand (MxI) plays an important role in this species (Figure 4) in preserving and holding food particles and preventing their exit as a prelude to their entry and push into the body of the organism [30].

IV. CONCLUSION

From the above we find that ***P.parvus*** plays with the rest of the copepods a major role in marine food webs, as they form the link between phytoplankton on the one hand and secondary consumers .

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