Journal of Kerbala for Agricultural Sciences Issue (4), Volume (10), (2023)

Morphological study of *Sinodiaptomus valkanovi* (Kiefer, 1938) (Copepoda /Calanoida) in Holy Karbala / Iraq

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https://doi.org/10.59658/jkas.v10i4.1305

Received:
Oct. 29, 2023

Accepted:
Nov. 30, 2023

Published:
Dec. 15, 2023

Abstract

After specifying the date and location for sample collection, the present research focused on studying the external appearance of the species *Sinodiaptomus valkanovi* (Kiefer, 1938). Samples were collected from the Al-Husseiniyah River, north of Karbala province. The genus Sinodiaptomus is found in most water systems. The species was identified within the sample based upon morphological characteristics of the body, namely shape along with other appendages; the number of segments in the antennules and copepods, how the spines on the base segment of the swimmeret were observed to be arranged, the caudal rami; and finally the shape of the specimen's fifth limb.

Keywords: Copepoda, Calanoida, Sinodiaptomus valkanovi, Taxonomy, Iraq

Introduction

The Holoplankton consists of both plants and animal organisms that drift along with water currents. They are most commonly found in surface waters, where sunlight and nutrients are abundantly available. Most Holoplankton are microscopic, unicellular or multicellular organisms, whose sizes range from mere micrometres, to upwards of several millimetres. In addition to size variations, the presence of differences in morphological characteristics and taxonomic classification is also observed [1]. Holoplanktonic animals perform a vital role within the food chain of aquatic organisms[2] and also serve as robust and reliable indicators of environmental changes [3] **.**

Copepods are a highly diverse group of holoplanktonic animals and are also a subclass of crustaceans. The term 'Copepoda' originates from the Greek words 'kope', which means 'oar'; and 'pods' for foot,—this is about their flattened swimming legs [4]Copepoda are among the most abundant multicellular holoplanktonic organisms on this planet, as they surpass insects in abundance, even though insects are more diverse [5]. The order *Calanoida* is mostly a homogeneous group and is primarily adapted to life as plankton [6]. Historically speaking, the study of Calanoida dates back to Italy with [7]. Members of the Calanoida order are well adapted to the planktonic way of life and dominate animal plankton communities[4].

The geographical distribution of copepods, in general, and the Calanoida order, in particular, varies significantly[8]. Members of the Calanoida order live in freshwater to a

lesser extent (25%) and in marine environments to a greater extent (75%)[9]. Calanoida organisms are of utmost importance in marine waters due to the fact that many herbivorous fishes feed on plant plankton, creating a direct link between copepods and fish like mackerel, sardines, and herring[9]. Copepods feed on algae and nanoplankton and have entirely bacteria-free intestines [10]. They also feed on appendicularians, although appendicularians possess various behavioral, morphological, and chemical defences that reduce their vulnerability to predation [11,12,13,14,15] Due to the limited detailed taxonomic studies of the Calanoida order and its taxonomic significance, this study aims to investigate the external appearance of the organisms, diagnose them, provide descriptions, and illustrate their parts.

Materials and Methods

Approximately 5 samples were collected from the Al-Husseiniyah River in the Karbala province, Iraq, on October 11, 2022, at 3:00 PM, using a net method with a mesh size of 335 micrometres. The samples were examined, isolated, and preserved in 80% ethanol alcohol with 20% glycerine in glass bottles. The specimens were fixed using lactic acid and red dye (Rose Bengal) to clarify body parts. A dissection microscope was used to dissect the samples, using micro pins to separate the prosoma from the urosoma. Subsequently, the appendages were separated in order, starting from the first leg and ending with the fifth leg appendage. A Lucida camera was used to photograph the appendages, and they were attached to the compound microscope at different magnifications according to the model's clarity. The images were then redrawn on tracing paper, with emphasis being places on the finest details and a note of the scale on each image. The specimens were identified using a set of taxonomic keys (key sources provided in the appendix below).

Results and Discussion

The taxonomic classification of the species is as follows:
Kingdom : Animalia (Linnaeus , 1758)
Phylum : Arthropoda (Latreille , 1772)
Class : Crustacea (Brunnich , 1772)
Order : Calanoida (Sars , 1903)
Family : Diaptomidae (Baird , 1850)
Genus : *Sinodiaptomus* (Kiefer , 1932)
Species : *Sinodiaptomus valkanovi* (Kiefer , 1938)

The morphology of the species is as follows:

(Female) (Figure 1)

- Body: The total body length from the top of the cephalic region to the end of the posterior margin of the tail limbs is 1.49 millimeters.

Prosoma: Slightly elongated and somewhat ovoid in shape, comprising the cephalic thoracic region and four body segments. The anterior edge is slightly rounded and houses a single median eye at the front of the head. There are also a pair of long antennae extending across the posterior margin of the tail limbs.

Urosoma:

Consists of five segments: three abdominal segments and the segment to which a pair of tail limbs attaches. The genital segment is of medium size and roughly square in shape. The tail limbs are short and uniform in both shape and size, with each tail limb connecting to five of the caudal rami, which are feather-like in appearance and equal in size and length.

Antennule (A1) (Figure 2):

Consists of 26 identical pieces, each of them having appendages and spines. The arrangement is listed as follows: 1(0), 2(0), 3(0), 4(1se), 5(0), 6(1se), 7(0), 8(1sp), 9(0), 10(1se), 11(1se), 12(0),13(0),14(1se), 15(0), 16(1sp), 17(1se), 18(0), 19(1se), 20 (0), 21 (1se), 22(0), 23(1se), 24(1se), 25(1se), 26(3se).

Antenna (A2) (Figure 3):

The Basal Segment is irregularly shaped, slightly curved on the inner edge, and somewhat egg-shaped on the other side. It connects to both the outer and inner branches. The Exopod consists of nine small, irregularly shaped pieces, each of them being small in size. The sixth piece carries a small terminal spine, and the ninth piece bears three long setae (hair-like structures). The Endopod consists of two pieces that differ in size and shape. The second piece is irregularly shaped and carries three long setae (setae are bristle-like structures)

Mandible (Md) (Figure4): The jaw base, called Gnathobase, is large and irregular in shape. The basal segment is also large and irregular in shape, carrying two setae (bristle-like structures). It is connected to both the outer and inner branches. The outer branch, known as Exopod, consists of two pieces, with the second piece bearing three equal-length setae. The inner branch, known as Endopod, consists of two pieces, with the second piece being square in shape and carrying three equal-length setae.

Maxillule (Mx1)(Figure5): Consists of the pre-coxa, which has an irregular shape, and the coxa, which also has an irregular shape and bears five long setae. Connected to the coxa is the coxal epipodite, which carries four setae of equal length. The base holds three long setae and gives rise to the outer and inner branches. The outer branch consists of a single piece connected to three setae of equal length, while the inner branch is a single piece connected to four setae of equal length.

Maxilla (Mx2)(Figure6): A single leg consists of three parts: the first is the pre-coxa, the second is the coxa, which is connected to two coxal endites. The first part of the coxa carries two feathered lobes, while the second part carries a single feathered lobe. The third part is the base, which is connected to basal endites, each carrying two feathered lobes. The inner endopod of the leg consists of three parts: the first part carries

two feathered lobes, the second part carries a single feathered lobe, and the third part has two feathered lobes.

Maxilliped (Mxp)(figure7) : A single appendage consists of a large, rectangular-shaped base that carries five feathered lobes. The inner part of the appendage (Enp) is composed of five pieces. The first one is somewhat rectangular and carries two feathered lobes. The second one has three lobes. As for the third and fourth pieces, each of them carries a single feathered lobe. The fifth piece carries four feathered lobes of equal length.

Pereopod 1 (P1) (Figure 8) : Comprises of the part between the irregular I cx plates, with the Coxa plate having a projection on the upper right side. The Bases are square-shaped and are connected to the inner and outer appendages. The Exopod (Exp) consists of three pieces, each of the first two carrying a single feathered lobe, while the third piece carries three feathered lobes. The Endopod (Enp) consists of two pieces: the first piece carries a single feathered lobe, while the second piece carries four terminal feathered lobes of equal length.

Second Posterior Appendage Pereopod (P2) (Figure9): The coxa is rectangular in shape, and the base is irregular. It is connected to the branches of the outer and inner legs. The exopod consists of three pieces, the first and second pieces are devoid of lobes and spines, while the third piece carries a single feather. The fourth piece carries three feather lobes of equal length. As for the endopod, it consists of two pieces: the first piece has a single feather lobe, while the second piece carries four feather lobes of equal length.

Pereopod (P3)(Figure 10): It consists of a square-shaped piece between the I cx coxae, the coxa is irregular in shape, and the base is irregular, carrying a small spine and a single feather lobe. It is connected to the branches of the outer and inner legs. The exopod (Exp) consists of three pieces, the first piece carries a small-sized spine, the second piece carries a small terminal spine and a single feather lobe, while the third piece carries six equal-sized terminal lobes.As for the endopod (Enp): this consists of three parts, the first part carries a single feather lobe, the second part is devoid of lobes and spines, and the third component carries two equal-length feather lobes.

Pereopod (P4)(figure 11): "It consists of the piece between the large and irregularly shaped I cx coxae, the coxa is rectangular in shape, and the base (bases) is irregular (resembling a square). It is connected to the branches of the outer and inner legs. The exopod (Exp) consists of three pieces, the first and second pieces carry a small spine, while the third one carries four feather lobes. When examining the endopod (Enp), it is found that it consists of three pieces. The first piece carries a single feather lobe, the second piece carries two feather lobes and one spine, and the third piece carries three feather lobes.

Pereopod (P5)(figure12): Asymmetrical in shape, where the right leg is wider than the left leg, they consist of the coxa, the piece between the coxae, which is fused with the coxa. Left leg: Consists of a large and irregularly shaped base (bases). The outer leg (Exopod) consists of two pieces. The first piece is square-shaped and carries a

single feather lobe, while the second one has a claw-like tip. Right leg: The base is large and square-shaped. The outer leg (Exopod) consists of two pieces. The first piece is large and square-shaped, carrying one spine, while the second component has a claw-like tip.

0.5mm

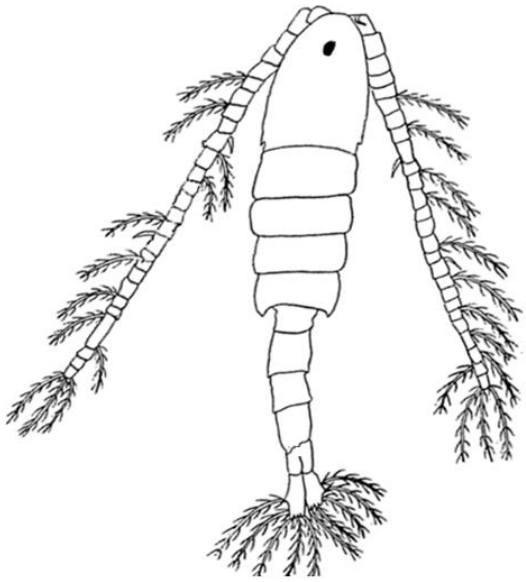


figure (1): External Appearance (Male) Type

0.5mm

Figure (2): Antennule (A1): *Sinodiaptomus valkanov*i (Kiefer, 1938)

0.5mm

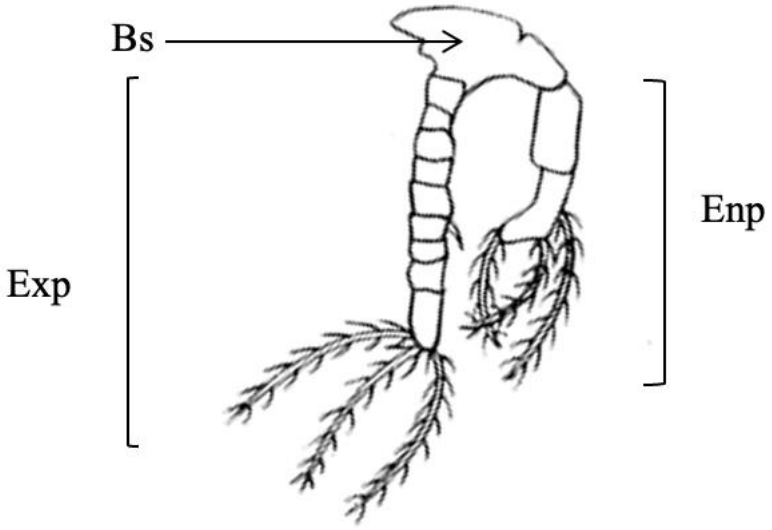


Figure (3): Antenna (A2): *Sinodiaptomus valkanov*i (Kiefer, 1938)

0.5mm

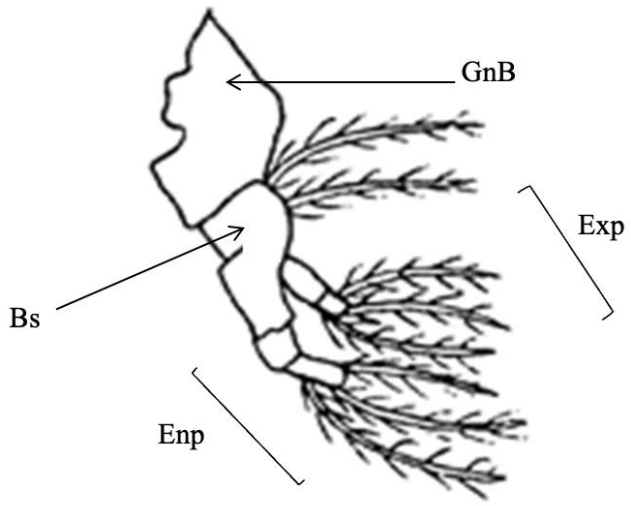


figure (4): Mandible (Md): *Sinodiaptomus valkanov*i (Kiefer, 1938)

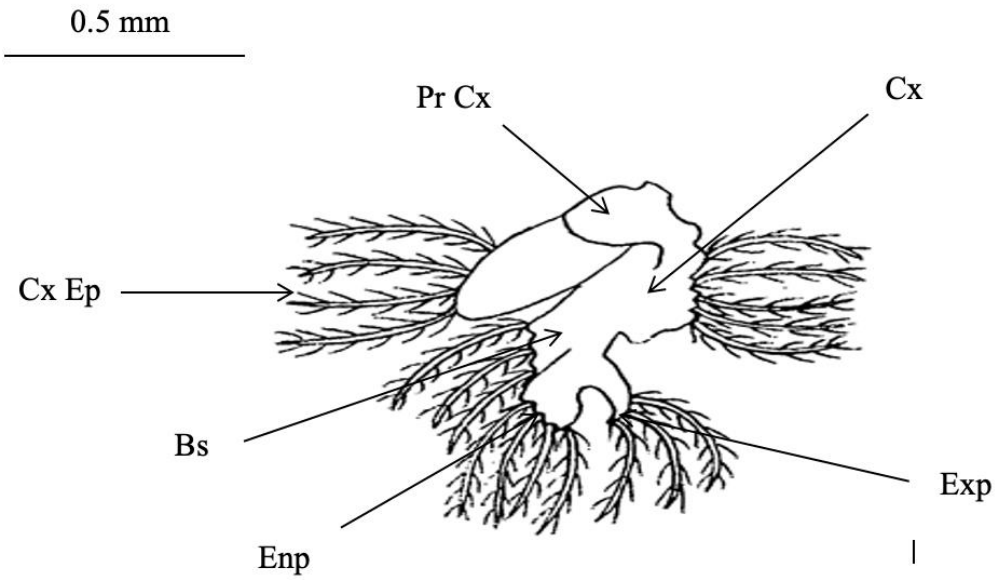


Figure (5): Maxillule (Mx1):*Sinodiaptomus valkanov*i (Kiefer, 1938)

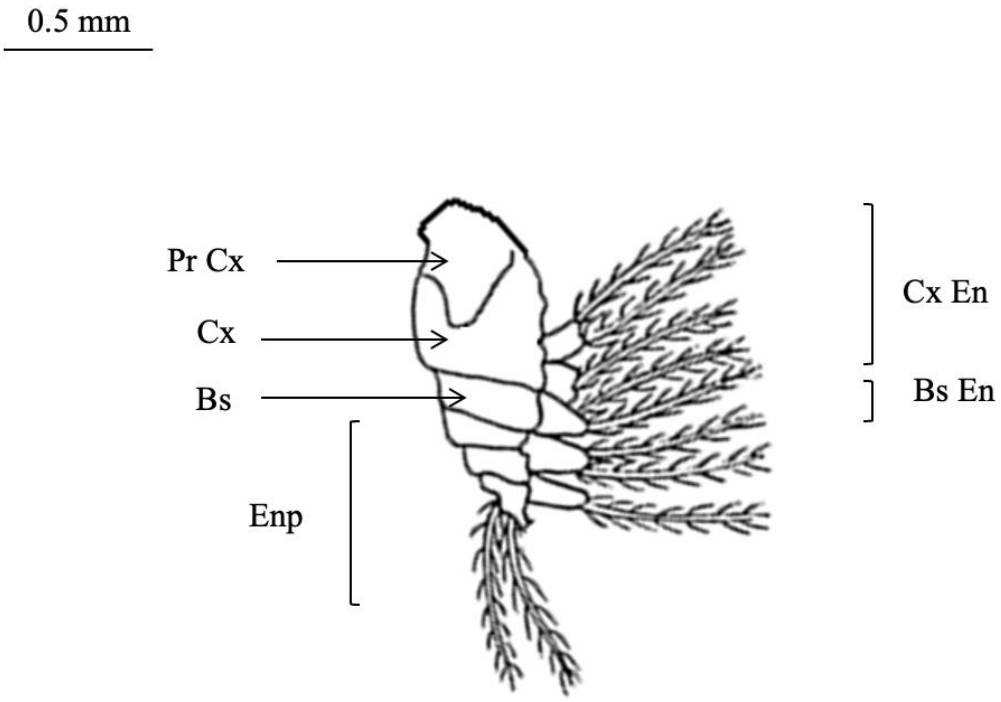


Figure (6): Maxilla (Mx2) *Sinodiaptomus valkanov*i (Kiefer, 1938)

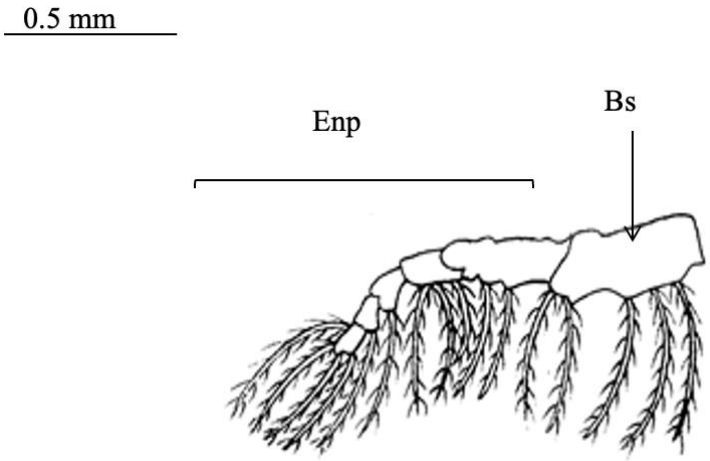


Figure (7): Maxilliped (Mxp) *Sinodiaptomus valkanov*i (Kiefer, 1938)

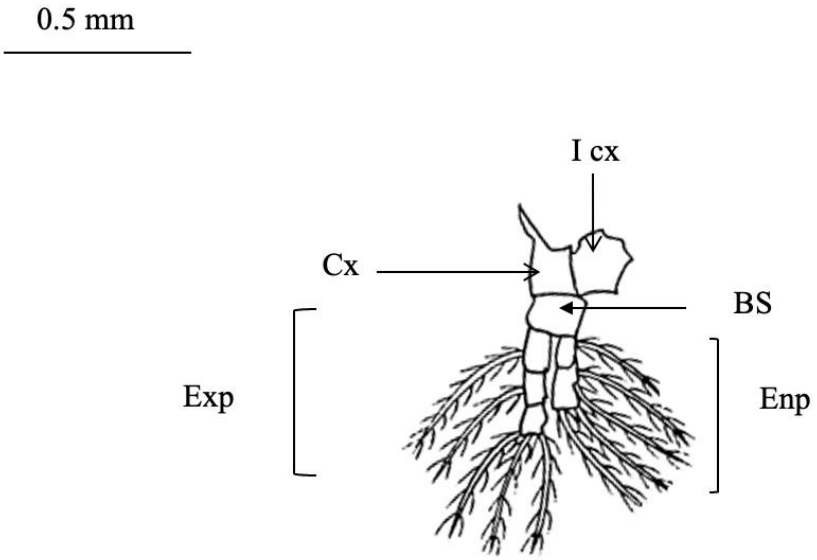
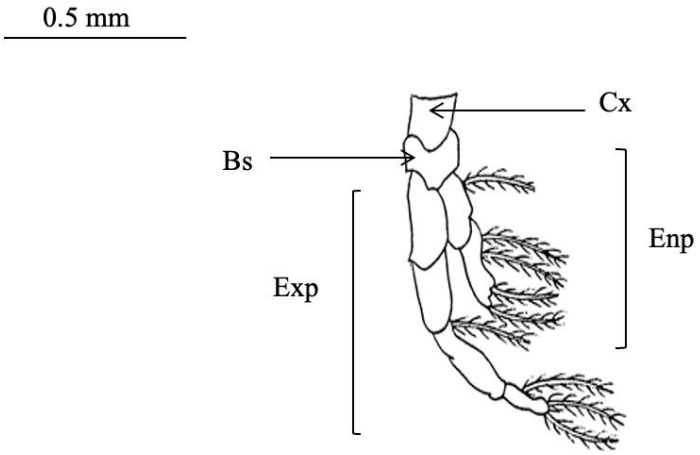


Figure (8): Pereopod 1 (P1) *Sinodiaptomus valkanov*i (Kiefer, 1938)



Figure(9): Pereopod 2 (P2) *Sinodiaptomus valkanov*i (Kiefer, 1938)

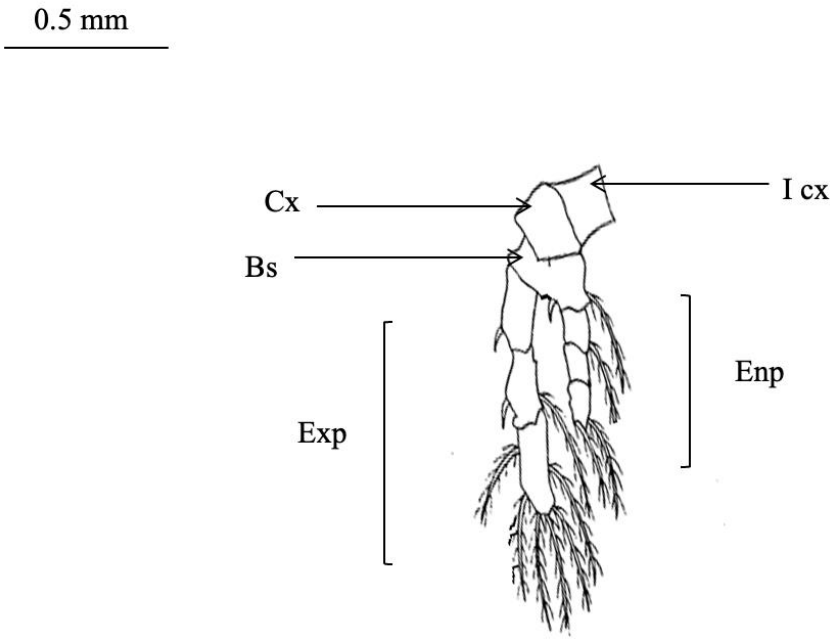


Figure (10): Pereopod 3 (P3) *Sinodiaptomus valkanov*i (Kiefer, 1938)

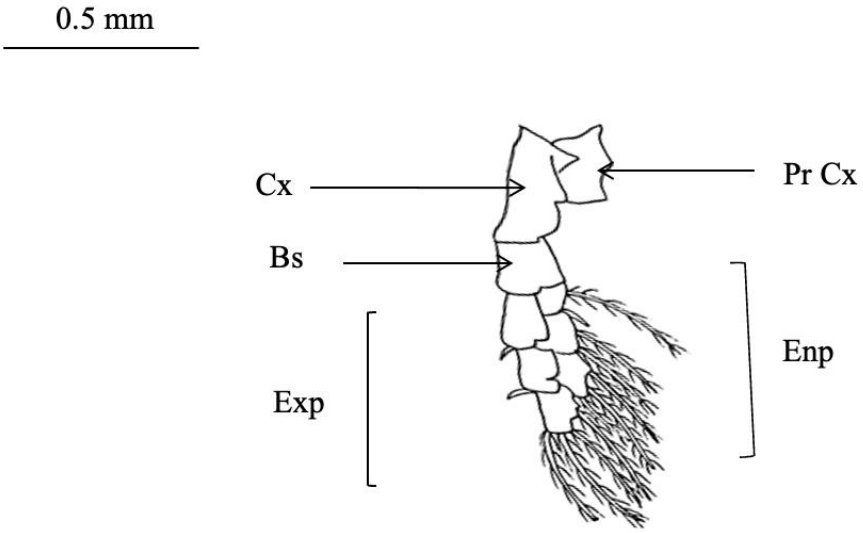
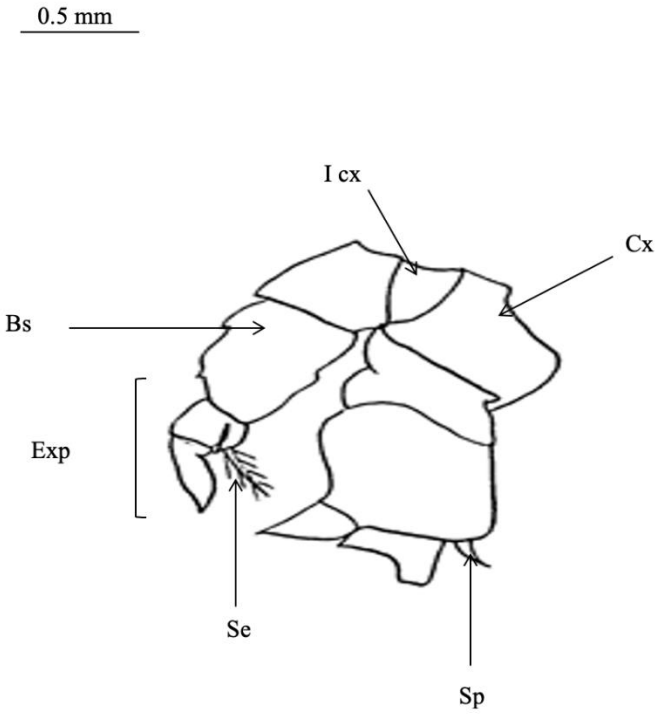


Figure (11): Pereopod 4 (P4) *Sinodiaptomus valkanov*i (Kiefer, 1938)



Figure(12): Pereopod 5 (P5) *Sinodiaptomus valkanov*i (Kiefer, 1938)

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