DOI: https://doi.org/10.3897/arphapreprints.e97090

Morphological variability of *Eucyclops serrulatus* (Fisher, 1851) (Crustacea, Copepoda, Cyclopoida) from Algerian water bodies

Safia Akli-Bidi

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 08/11/2022*. DOI: https://doi.org/10.3897/arphapreprints.e97090

Morphological variability of *Eucyclops serrulatus* (Fisher, 1851) (Crustacea, Copepoda, Cyclopoida) from Algerian water bodies

Safia AKLI-BIDI ‡

‡ Department of Ecology and Environment. Laboratory of Dynamic and Biodiversity. Faculty of Biological Sciences. University of Sciences and Technology Houari Boumediene, Bab Ezzouar, Algeria

Corresponding author: Safia AKLI-BIDI (safiabidi@yahoo.fr)

Abstract

Background

The identification of *Eucyclops serrulatus* (Fisher, 1851) coming from Algerian water bodies show three morphotypes 1, 2 and 3, based on the morphometric characters and the microcharacters. The morphotype 1 was the most abundant, collected in the East and the West of Algeria. The morphotype 2 was sampled in the south of the country, characterized by posterolaterally elongated thoracic segments and the fourth thoracic segment has cilia on its lateral angles. The morphotype 3 was found in a small temporary pond in the north and was the smallest one. Other differences were observed on surface microcharacters of basis antenna, coxa and intercoxal sclerite of the fourth leg. The characters of the most widespread morphotype (morphotype1) were stable in all localities despite the fact that these were located in two geographically separated regions (Eastern and western Algeria).

New information

Three morphological variability of *Eucyclops serrulatus* (Fisher, 1851) (Crustacea, Copepoda, Cyclopoida) from Algerian water bodies were identified. The characters of the most widespread morphotype (morphotype 1) were stable in all localities despite the fact that these were located in two geographically separated regions (Eastern and western Algeria). The morphotype 2 did not share some of microcharacters such as basis antenna (posterior face) did not show three parallel rows of hair-like setules.

Keywords

Distribution, *Eucyclops serrulatus*, morphotypes, morphometrics, microcharacters

Introduction

The genus *Eucyclops* comprises about one hundred species and 15 subspecies (Dussart and Defaye 2006, Alekseev and Defaye 2011, Mercado-Salas and Suárez-Morales 2014). The last revision of the whole genus was done by Lindberg (1957) for African *Eucyclops.* Several revisions of *Eucyclops* were observed: for Australia by Morton (1990), for Ukraine by Monchenko (1974), for Japan by Ishida (2002), for Mexico by Mercado-Salas and Suárez-Morales (2014), for Palearctic by Alekseev and Defaye (2011) and Alekseev (2019) .

Eucyclops serrulatus (Fischer, 1851) has been reported from water bodies around the world (Dussart and Defaye 1985, Dussart and Defaye 2006) and in consequence it has long been considered a cosmopolitan species until some species that look like *Eucyclops serrulatus* were separated from it (Dussart 1984, Reid 1995, Ishida 1997, Ishida 1998). Some of these may indeed be valid species; others were forms of *Eucyclops serrulatus.* In recent years the distributional area of the species was revised and restricted to a supposed Palearctic distribution. All records of the species in other zoogeographical regions are, possibly, the result of misidentifications (Alekseev and Defaye 2011). From the type locality (pond St.Petersburg area, Russia). *Eucyclops serrulatus* was represented by three morphological forms. These forms were also confirmed in Western Europe, differing in setae morphology of caudal rami and swimming legs (Alekseev et al. 2006). Considerable interpopulation variability in *E. serrulatus* was described; some of them are cryptic taxa and need to be revised (Sukhikh and Alekseev 2015). *Eucyclops serrulatus* has been observed in the samples collected in Algeria in the Hoggar, south of Tassili n'Ajjer, in Tamanrasset and in an artesianpond in Guelma (Roy and Gauthier 1927). The redescription of the type for *Eucyclops serrulatus* (Alekseev et al. 2006) using molecular-genetic and interspecific hybridization revealed several microcharacters, important for the species identification as ornamentation of antenna (A2) basis and the fourth leg (P4) coxa with coxal spine. The aim of this work is to describe and compare Algerian morphotypes coming from different localities.

Materials and methods

Several water bodies were sampled in different regions in Algeria. *Eucyclops serrulatus* (Fischer, 1851) was found in 21 localities (Fig. 1, Table 1). All samples were collected by horizontal trawl at 1 m depth in the near-shore areas using standard plankton net of 50-µm mesh size. Samples were collected by the author. The samples were preserved in 70% ethanol. *Eucyclops serrulatus* was identified using the key of Dussart (1969). For the measurements, six females of each population collected from the field were first placed in small petri dish containing a mixture of alcohol, water and glycerine. Once the water evaporated (1-2 days), body length, relative length of antennules, the fourth and fifth legs and caudal rami were measured (Table 2). The specimens were dissected in the concentrated glycerine and put on the dorsal view between slide and coverslip in a drop of

glycerol. The measurements and the drawings were made using a drawing tube attached to the microscope. The Algerian morphotypes were described based on the habitus and the microcharacters: the ornamentation of antennule (A1) and antenna (A2) basipodite, caudal surface ornamentation of coxa and the intercoxal sclerite in P4, using coding system for microcharacters in *Eucyclops* (Fig. 2) proposed by Alekseev et al. (2006).

Taxon treatment

Eucyclops serrulatus Fisher, 1851

Nomenclature

Synonymy in Dussart and Defaye (1985).

Cyclope serrulatus, Fischer, 1851

Eucyclops serrulatus, Claus, 1893a

Cyclope agilis, Gurney, 1933

Eucyclops agilis, Comita, 1951

Eucyclops serrulatus, Dussart, 1969; Kiefer, 1978

Synonymy in Dumont (1979)

Eucyclops asymmetricus, Dumont and Pensaert, 1979

Materials

a. scientificName: *Eucyclops serrulatus* Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: *Eucyclops*; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 1-Terni wadi (Tlemcen); verbatimElevation: 867 m; verbatimCoordinates: 34°47'45" N 01°21'32" W; sex: Females; occurrenceID: 5C9E285A-D100-5FC8-8009-93C13AF790AC

b. scientificName: *Eucyclops serrulatus* Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: *Eucyclops*; specificEpithet: *serrulatus*; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 2.Tafna source(Tlemcen); verbatimElevation: 867 m; verbatimCoordinates: 34° 39′ 48″ N 01° 20′ 02″ WW; sex: Males, Females; occurrenceID: 14A947EE-303A-52F3-8DEF-3EB006BB6B86

c. scientificName: *Eucyclops serrulatus* Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: *Eucyclops*; specificEpithet: *serrulatus*; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 3. Saida wadi (Saida);

verbatimElevation: 980 m; verbatimCoordinates: 34° 55′ 0″ N, 0° 13′ 0″ W; sex: Females; occurrenceID: 2FD504DC-199B-5E65-B014-05A1D1DA8E7A

d. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 4.Chellif wadi (Ech Chellif); verbatimElevation: 86 m; verbatimCoordinates: 36° 02′ 22″ N 0° 07′ 55″ E; sex: Males, Females; occurrenceID: 1232E5CE-F184-552A-AA2F-6A5668DCB691

e. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 5. Basins of Djurdjura (Bouira); verbatimElevation: 2308 m; verbatimCoordinates: 28° 00 N 03° 00 E; sex: Males, Females; occurrenceID: 3CD6FE83-3CB4-524D-A6FF-4F9F43C74F22

f. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 6.Rhumel wadi (Constantine); verbatimElevation: 1090 m; verbatimCoordinates: 36° 32' 17" N 61° 15' 59" E; sex: Females; occurrenceID: 87DBDDDF-2634-5B2B-BF44-8B0759B7E22A

g. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 7. Boumerzoug wadi (Constantine); verbatimElevation: 506 m; verbatimCoordinates: 36°21'3" N 06°37'2" E; sex: Males, Females; occurrenceID: 00F25A8E-E335-52B2-B1D0-52FE23E82A9A

h. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 8. Benazouz wadi (Skikda); verbatimElevation: 17 m; verbatimCoordinates: 35°27'0" N 03°51'0"E; sex: Males, Females; occurrenceID: 3DDF8C73-A750-5600-A511-B2748A3F9782

i. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 9. Seybouse wadi (Annaba); verbatimElevation: 0 m; verbatimCoordinates: 36° 52′ 01″ N 07° 46′ 18″ E; sex: Males, Females; occurrenceID: 8164B761-6D31-5261-A85D-739C07AA6313

j. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 10. Lake of Oubeira (El Taref);

verbatimElevation: 25 m; verbatimCoordinates: 36° 50' 695 N 8° 23’ 272 E; sex: Males, Females; occurrenceID: DFA3EDE7-EC34-5B3B-885D-225031DFE9D1

k. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 11. Lake of Tonga; verbatimElevation: 589-1061 m; verbatimCoordinates: 36° 51' 511 N 8° 30’ 100 E; sex: Males, Females; occurrenceID: B5CC8872-7634-584A-A5EA-304FAC22F860

l. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 12. Blue lake (El Taref); verbatimElevation: 1-123 m; verbatimCoordinates: 46°31'60" N 07°40'0" E; sex: Males, Females; occurrenceID: 89E5E399-7F02-5516-92D9-775FC5CBD09D

m. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 13. Messida wadi; verbatimElevation: 1 m; verbatimCoordinates: 36°54'0" N 08°31'0" E; sex: Males, Females; occurrenceID: B8156C24-230A-597D-9E74-EF58A1BFA74E

n. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 14. Basins (Tasslemt,Tissemssilt); verbatimElevation: 900 m; verbatimCoordinates: 35°36′00,00″ N 1°49′00,00″ E; sex: Males, Females; occurrenceID: C0DEC469-F205-5A2D-A4DB-FF0685167716

o. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 15. Basins (Tamezguida,Medea)”; verbatimElevation: 591 m; verbatimCoordinates: 36° 19′ 27″ N 02° 41′ 22″ E; sex: Males, Females; occurrenceID: 24355F53-CFE6-5D1E-B5F6-9CB4CEB1A72E

p. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 16.Seggerwadi(Biskra); verbatimElevation: 87 m; verbatimCoordinates: 534° 0′ 0″ N 5° 0′ 0″ E; sex: Males, Females; occurrenceID: 9292E5A9-139C-5198-AE7F-9388FC9CB2A6

q. scientificName: ***Eucyclops serrulatus*** Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: ***Eucyclops***; specificEpithet: ***serrulatus***; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 17. Lake of Ain Saadane (El Biodh

Sidi Cheich); verbatimElevation: 744 m; verbatimCoordinates: 32° 53′ 55″ N 0° 32′ 22″ E; sex: Males, Females; occurrenceID: B19E95B3-1297-5191-B661-EE87BF8ED1CE

r. scientificName: *Eucyclops serrulatus* Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: *Eucyclops*; specificEpithet: *serrulatus*; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 18. Source of Ain EL Hammam (Brezina-); verbatimElevation: 849 m; verbatimCoordinates: 33° 05′ 58″ N 1° 15′ 39″ E; sex: Males, Females; occurrenceID: 9578C4AD-98D8-5BAC-ABD9-2310308D4537

s. scientificName: *Eucyclops serrulatus* Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: *Eucyclops*; specificEpithet: *serrulatus*; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 19. Lake of Gue of Arsaouet (El Biodh Sidi Cheich); verbatimElevation: 744 m; verbatimCoordinates: 32° 53′ 55″ N 0° 32′ 22″ E; sex: Males, Females; occurrenceID: 69266BBF-F913-59C8-9083-040BD8E341C3

t. scientificName: *Eucyclops serrulatus* Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: *Eucyclops*; specificEpithet: *serrulatus*; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 20. Source of El Goleita (Brizina); verbatimElevation: 849 m; verbatimCoordinates: 33° 05′ 58″ N 01° 15′ 39″ E; sex: Males, Females; occurrenceID: 840FA853-8D14-56C7-86D7-AC28D2F0C4FD

u. scientificName: *Eucyclops serrulatus* Fisher, 1851; higherClassification: Animalia; kingdom: Animalia; phylum: Arthropoda; class: Maxillopoda; order: Cyclopoida; family: Cyclopidae; genus: *Eucyclops*; specificEpithet: *serrulatus*; scientificNameAuthorship: Fisher, 1851; higherGeography: North Africa; continent: Africa; waterBody: Freshwater; country: Algeria; countryCode: Algeria/DZ; locality: 21. Swamp (El-Harrach, Algiers); verbatimElevation: 0-178 m; verbatimCoordinates: 36° 43′ 16″ N 03° 08′ 15″ E; sex: Males, Females; occurrenceID: 39B75D63-170B-5CBD-A2F4-A546EFBD5955

Description

In Algerian water bodies, three morphotypes of *Eucyclops serrulatus* were identified. The morphotype 1 was recorded in 15 localities, in the Eastern and the Western Algeria. The morphotype 2 was collected in 5 localities in the southern part of the country. The morphotype 3 was sampled in a small temporary pond in the north of the country.

Eucyclops serrulatus (Fischer, 1851) morphotype 1

Female: Body 0.86-1mm long, excluding caudal setae; maximum width at posterior end of cephalothorax. Antennule (A1) 12-segmented, reaching the middle of pediger 2. Last 3 segments elongate each with narrow, smooth hyaline membrane along anterior margin. A1 basis with curved row of spinules, outer spinules the longest, Posterior face of antenna basipodite shows apical group (1) with 3 long setules, a groupe (6) with 2 spinules, and three diagonal and parallel rows of spinules (3–5). Anterior face of basipodite shows 5 spinules subdistally (8), (11 + 12) composed of 16 spinules, (13)

represented by a group of 5 little spinules and two groups of marginal spinules (17) and (15).

Caudal rami somewhat divergent, about 4 – 4.4 times longer than wide. Postero - lateral spine-like seta with spinules along outer margin and long setules on inner edge.Serra with row of 51denticules,Terminal accessory setae with long setules on both sides, as long as postero lateral spine like seta. Inner and outer terminal setae show dense and long setules, at some distance from setal base, setules are relatively long and thick.

Endopodite and exopodite segments of P1–P4 were plumose, coxa of the first leg (P1) without ornamentation, inner edge of basis with group of long setules.P1 intercoxal sclerite with two groups of finest spinules, on body of protuberances. Inner apical spine of endopodite 3 of the fourth leg (P4) is about 1.3–1.4 times as long as outer apical spine and about 1.5-1.6 times as long as supporting segment. Outer seta of P4 enp3 long, reaching almost the top of outer apical spine. Two apical setae of exopodite 3 of P4 stylet-shaped. Coxopodite of P4 with a row of numerous fine spicule, comb like a long internal distal side and several groups of spinules (A, B, (C + D), E, G, H, I). Group F of spinules did not exist.Intercoxal sclerite of P4 with dense setules extending beyond edge of sclerite. Posterior surface of the sclerite shows two groups of little setules and spinules. Coxal setae of P4 with a strong spine. The fifth leg (P5) with a spine as long as outer seta. The spine is slender and long. Genital segment (Th6) is as long as wide (Figs 3, 4).

***Eucyclops serrulatus* (Fischer, 1851) morphotype 2**

Female: Body 0.81-1mm long, excluding caudal setae; maximum width at posterior end of cephalothorax. posterolaterally elongated thoracic segments bending over the succeeding segments and the fourth thoracic segment has cilia on its lateral angles.Antennule (A1) 12-segmented, reaching the middle of pediger 2. Last 3 segments elongate each with narrow, smooth hyaline membrane along anterior margin. A1 basis with curved row of spinules, outer spinules the longest. Posterior face of antenna basis shows apical group (1) with 5 long setules; a groupe (6) of 1 spinule. Anterior face of basipodite shows 4 spinules subdistally (8), (11 + 12) composed of 13 spinules; two groups of marginal spinules (17) and (15).

Caudal rami somewhat divergent, about 4.5 - 5 times longer than wide. Postero - lateral spine-like seta with spinules along outer margin and long setules on inner edge. Serra with 28 denticules. Terminal accessory setae with long setules on both sides, exceeds the postero lateral spine like seta. Inner and outer terminal setae show dense and long setules, at some distance from setal base, setules are relatively long and thick.

Endopodite and exopodite segments of P1–P4 were plumose, coxa of the first leg (P1) without ornamentation, inner edge of basis with group of long setules. Inner apical spine of endopodite 3 of the fourth leg (P4) is about 1.3–1.4 times as long as outer

apical spine and as long as supporting segment. Outer seta of P4 enp3 long reaching almost the top of outer apical spine. Coxopodite of P4, with several groups of spinules (A, B, (C + D), G, H, I). Groups E and F of spinules did not exist.

Intercoxal sclerite of P4 with dense setules, extending beyond edge of sclerite, setules are twice longer than those in groupe1. The posterior surface of the sclerite shows two groups of little spinules. Coxal setae of P4 with dense long setules. P5 with a spine as long as outer seta. The spine is robust. Genital segment (Th6) is as long as wide (Figs 5, 6).

***Eucyclops serrulatus* (Fischer, 1851) morphotype 3**

Female: Body 0.79-1 mm long, excluding caudal setae; maximum width at posterior end of cephalothorax. Antennule (A1) 12-segmented, reaching the posterior margin of pediger 2, the last three segments with large hyaline membrane. A1 basis with curved row of spinules; the longest ones are between two groups of smaller spines. Posterior face of antenna basipodite, shows apical group (1) with 3 long setules, a groupe (6) with 2 spinules, three diagonal and parallel rows of spinules (3–5). Anterior face of basipodite shows 5 spinules subdistally (8), (11 + 12) composed of 16 spinules, (13) represented by a group of 5 little spinules and two groups of marginal spinules (17) and (15). Antenna basipodite ornamentation of groups 1 and 3 are similar.

Caudal rami somewhat divergent, about 3.5 – 4.2 times longer than wide. Postero - lateral spine-like seta with spinules along outer margin and long setules on inner edge. Serra with 22 denticules. Terminal accessory setae with long setules on both sides, exceeds postero lateral spine like seta. Inner and outer terminal setae show dense and long setules, at some distance from setal base, setules are relatively long and thick.

Endopodite and exopodite segments of P1–P4 were plumose, coxa of the first leg (P1) without ornamentation, inner edge of basis with group of long setules. Inner apical spine of endopodite 3 of the fourth leg (P4) is about 1.3–1.4 times as long as outer apical spine and as long as supporting segment. Outer seta of P4 enp3 long, reaching almost the top of outer apical spine. Coxopodite of P4 with several groups of spinules (A, B, (C + D), E, G, H, I) Group F of spinules did not exist.

Intercoxal sclerite of P4 with dense setules, extending beyond edge of sclerite. The posterior surface of the sclerite shows one group of little setules. P4 coxal setae with a strong spine.

Outer seta of the fifth leg (P5) exceeds slightly in leng.th the spine. The spine is slender and long. Genital segment (Th6) is as long as wide (Figs 7, 8).

Distribution

This taxon was discovered in the mid-nineteenth century in a pond at Peterhof close to SaintPetersburg, Russia (Fischer 1851). In recent years, the distributional area of the species was revised and restricted to a Palearctic distribution. Previous data on

geographical distribution of the species outside this area are critically analysed. It is hypothesized that records of *E. serrulatus* from Japan, Australia, North America, and other zoogeographical zones, could be a result of recent invasions, possibly via human activities in relation to ship transport.

Ecology

Freshwater species (lakes, basins, ponds, wadis)

Taxon discussion

Eucyclops serrulatus (Fischer, 1851) has been reported from water bodies around the world and in consequence it has long been considered a cosmopolitan species until some species that look like *Eucyclops serrulatus* were separated from it. Some of these may indeed be valid species; others were forms of *Eucyclops serrulatus*.

Discussion

Basing on habitus, morphotype 3 of *Eucyclops serrulatus* was the smallest one (Table 2), the morphotype 1 is characterized by external articulation of its abdominal segments (Fig. 3a), while the morphotype 2 is identified by its elongated lateral thoracic segments which envelop the following segment and its fourth thoracic segment has cilia on its lateral angles (Fig. 5a).

P5 with a spine as long as outer seta in all morphotypes, slender and long in morphotype 1 and 3 (Fig. 4c, Fig. 8c) and large in morphotype 2 (Fig. 6c).

Caudal rami somewhat divergent: morphotype 1: 4 – 4.5 times longer than wide (Fig. 3b), morphotype 2: 4.5 – 5 times longer than wide (Fig. 5b), morphotype 3: 3.5 – 4 times longer than wide (Fig. 7b). Postero - lateral spine-like seta with spinules along outer margin and long setules on inner edge in all the morphotypes. Serra (row of denticules) with 51 denticules in morphotype 1, 28 denticules in morphotype 2 and 22 denticules in morphotype 3.Terminal accessory setae with long setules on both sides, about 1.3–1.4 times long than postero lateral spine like seta in morphotypes 2 and 3 but equal in morphotype 1. In all morphotypes, inner and outer terminal setae show dense and long setules, at some distance from setal base, setules are relatively long and thick (Fig. 3b, Fig. 5b, Fig. 7b).

Antennule 12-segmented, reaching caudal edge of the first thoracic segment in morphotypes 1 and 2 and the beginning of the third one, in morphotype 3 (Fig. 3a, Fig. 7a), the last three articles with hyaline membrane; finely in morphotypes 1 and 2, large in morphotype 3, the first segment with curved row of spinules at its base; outermost spinules the longest in morphotypes 1 and 2 (Fig. 3c, Fig. 5c). In morphotype 3, the longest ones were between two groups of little spines (Fig. 7c).

Posterior face of antenna basipodite showed apical group (N1) with 3 long setules in morphotypes 1 and 3 (Fig. 3d, Fig. 7d), 5 long setules in morphotype 2 (Fig. 5d); a group of 2 long spinules (N6) and three diagonal and parallel rows of spinules (N3–5) only in morphotypes 1 and 3.Anterior face of basipodite: (N8) composed of 3 long spinules subdistally in morphotypes 1 and 3 (Fig. 3e, Fig. 7e), 5 long spinules subdistally in morphotype 2 (Fig. 5e), (N11 + N12) formed of a long row of relatively small spinules with 17 spinules in morphotypes 1 and 3 (Fig. 3e, Fig. 7e), 13 spinules in morphotype 2 (Fig. 5 e); (N13) represented by a group of 5 little spinules only in morphotypes 1 and 3 (Fig. 3e, Fig. 7e), two groups of marginal spinules (N17) and (N15) in all morphotypes (Fig. 3e, Fig. 5e, Fig. 7e).

Endopodite and exopodite segments of P1–P4 were plumose, inner edge of basis of the first leg (P1) with group of long setules only in morphotypes 1 and 2 (Fig. 4a, Fig. 6a). Intercoxal sclerite of P1 with two groups of finest spinules on body of protuberances, not extending beyond edge only in morphotype 1 (Fig. 4a), external seta of exopodite 3 of P1 in all morphotypes with a row of little spinules along outer margin and with long setules on inner edge (Fig. 4a, Fig. 6a, Fig. 8a). Innermost apical spine of endopodite 3 of the fourth leg (P4) was 1.3–1.4 times as long as outermost apical spine in all morphotypes and about 1.5- 1.6 times as long as supporting segment in morphotype 1 (Fig. 4b) and as long as supporting segment in morphotypes 2 and 3 (Fig. 6b, Fig. 8b). Outer seta long reaching almost the top of outermost apical spine in all Algerian morphotypes (Fig. 4b, Fig. 6b, Fig. 8 b). Two apical setae of exopodite 3 of P4 stylet-shaped only in morphotype 1 (Fig. 4b). Inner edge of basis of P4 with group of long setules only in morphotypes 1 and 3 (Fig. 4b, Fig. 8b).

Coxopodite of P4 with a row of numerous fine spicule comb like a long internal distal side only in morphotype 1. Several groups of spinules: (A – B - (C + D) –E-G-H-I) in morphotype 1, (A – B- (C + D) – G - H –I) in morphotype 2 and (A – B- (C + D) – E- G- H- I) in morphotype 3. Morphotype 2 did not show group E. Group F did not exist in all morphotypes.Intercoxal sclerite of P4 with dense setules, extending beyond edge of sclerite in all morphotypes, but in morphotypes 2 and 3, setules are twice longer than those in morphotype 1. On body of sclerite, we found two groups of little setules and spinules in morphotype 1, two groups of little spinules in morphotype 2 and one group of little setules in morphotype 3. Caudal setae of P4 with dense long setules, but that of morphotypes 1 and 3 was a strong spine.

The characters of the most widespread morphotype (morphotype 1) were stable in all localities despite the fact that these were located in two geographically separated regions (Eastern and western Algeria). The morphotype 2 did not share some of microcharacters such as P4 coxa with setae in place of strong spine and basis antenna (posterior face) did not show three parallel rows of hair-like setules.

Acknowledgements

The author is grateful to Professor H. Dumont for welcoming her in his laboratory and to Doctor S. Maas for her availability and helping to confirm the species copepods.I thank doctor Alekseev for allowing me to use his illustration (Fig.2).I thank Professor L.Beladjal, Department of Biology, Ghent University for English translations.

References

- Alekseev V, Dumont HJ, Pensaert J, Baribwegure D, Vanfleteren JR, et al. (2006) A redescription of *Eucyclops serrulatus* (Fischer, 1851) (Crustacea: Copepoda: Cyclopoida) and some related taxa, with a phylogeny of the *E. serrulatus*-group. Zoologica Scripta 35: 123-147. https://doi.org/10.1111/j.1463-6409.2006.00223.x
- Alekseev V, Defaye D (2011) Taxonomic differentiation and world geographical distribution of the *Eucyclops serrulatus* Group (Copepoda, Cyclopidae, Eucyclopinae). In: Defaye D, Suarez Morales E, Von Vaupel Klein J (Eds) Studies on freshwater Copepoda. Honour of Bernard Dussart. Vol. 16. Brill, Leiden, 566 pp. [ISBN 9004181385]. https://doi.org/10.1163/ej.9789004181380.i-566
- Alekseev V (2019) Revision of the genus *Eucyclops* (Claus, 1893) and subfamily Eucyclopinae of the world fauna. Arthropoda Selecta 28 (4): 490-514. https://doi.org/ArthropodaSelecta
- Dumont HJ (1979) Limnologie van Sahara en Sahel. Thesis. Unpublished, Ghent University, 557 pp.
- Dussart BH (1969) Les Copépodes des eaux continentales d'Europe Occidentale. Vol. II. Cyclopoïdes et Biologie quantitative. Boubée & Cie, 292 pp.
- Dussart BH (1984) Some Crustacea Copepoda from Venezuela. Hydrobiologia 116: 25-67. https://doi.org/10.1007/BF00026592
- Dussart BH, Defaye D (1985) Répertoire mondial des copépodes cyclopoïdes. CNRS, 236 pp.
- Dussart BH, Defaye D (2006) World directory of Crustacea Copepoda of inland waters. Vol. II. Cyclopiformes. 2èm. Leiden, 354 pp.
- Ishida T (1997) Eucyclops roseus, a new Eurasian copepod, and the *E. serrulatus-speratus* problem in Japan. Japan Journal of Limnology 58: 349-358.
- Ishida T (1998) *Eucyclops biwensis*, a new cyclopoid copepod (Crustacea) from Lake Biwa, Japan, with records of a morphologically identical population of the new species and *Eucyclops roseus* from Lake Victoria. Bulletin of the Biogeographical Society of Japan 53: 23-27.
- Ishida T (2002) Illustrated fauna of the freshwater cyclopoid copepods of Japan. Bulletin of the Biogeographical Society of Japan 57: 37-106.
- Lindberg K (1957) Cyclopides (Crustacés copépodes) de la Côte d'Ivoire. Bulletin de l'Institut français d'Afrique noire. (19): 134-179.
- Mercado-Salas NF, Suárez-Morales E (2014) On Kiefer's American *Eucyclops* (Copepoda, Eucyclopinae): redescriptions and comments on the historical records of *E.*

delachauxi, E. prionophorus, E. bondi and E. leptacanthus. ZookKeys 402: 1-41. https://doi.org/10.3897/zookeys.402.6112

- Monchenko VI (1974) Cyclops (Cyclopidae). Fauna Ukrainy 27 (3): 1-452.
- Morton DW (1990) Revision of the Australian cyclopidae, (Copepoda: Cyclopoida). II. *Eucyclops* Claus and *Ectocyclops* Brady. Marine and Freshwater Research 41: 657-675. https://doi.org/10.1071/MF9900657
- Reid J (1995) Copepoda (Crustacea) from fresh waters of the Florida Everglades, USA, with a description of *Eucylops conrowae* n. sp. Transactions of the American Microscopical Society 111: 229-254. https://doi.org/10.2307/3226612
- Roy J, Gauthier H (1927) Sur les Copépodes d'Algérie et Tunisie (eaux douces et eaux saumâtres). Bulletin de la Société Zoologique de France 52: 558-575.
- Sukhikh N, Alekseev V (2015) Genetic and morphological heterogeneity within *Eucyclops serrulatus* (Fischer, 1851) (Crustacea: Copepoda: Cyclopidae). Journal of Natural History 49 (45-48): 2929-2953. https://doi.org/10.1080/00222933.2015.1056267

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

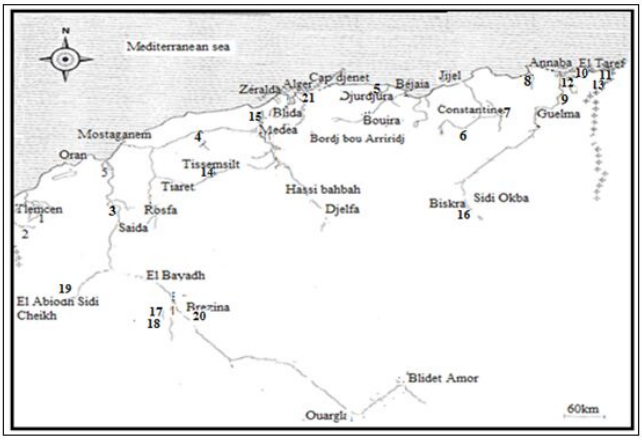

Figure 1.

Mapping of sampling localities (Numbers referred to localities) for species of the *Eucyclops serrulatus* (Fischer, 1851). Morphotype 1: (1-15); morphotype 2: (16-20); morphotype 3: (21).

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

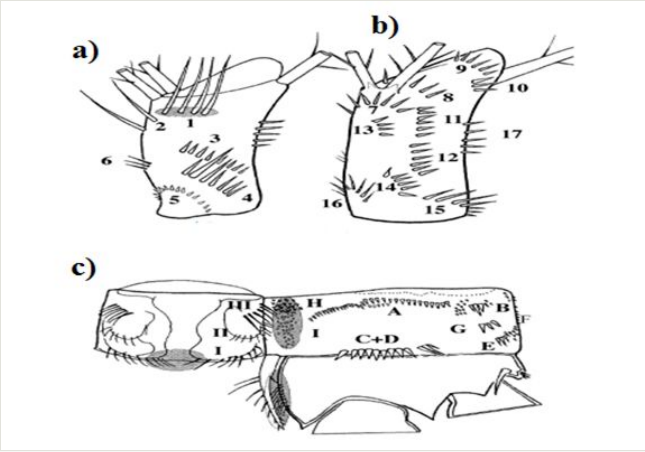

Figure 2.

Coding system for microcharacters in *Eucyclops* (Alekseev et al. 2006) **a** basipodite of A2, anterior **b** A2 basipodite, posterior **c** intercoxal sclerite and coxa of P4, posterior.

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

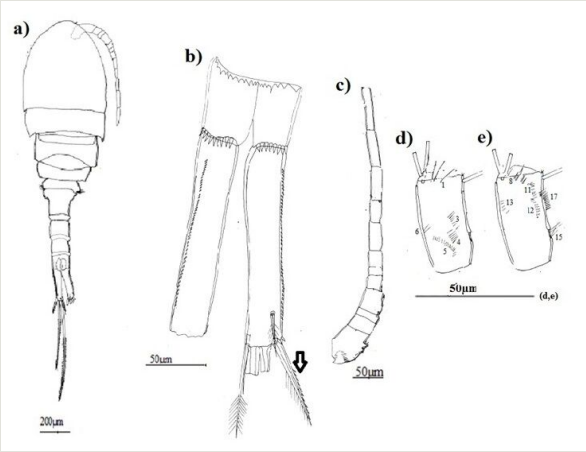

Figure 3.

Eucyclops serrulatus (Fischer, 1851). Morphotype 1: **a** Habitus (dorsal view) **b** caudal rami **c** A1 **d** A2 basis (posterior surface) **e** A2 basis (anterior surface), numbers of characters correspond to those in Fig. 2.

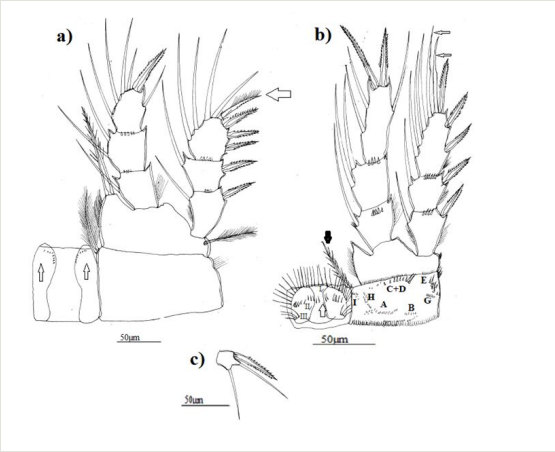

Figure 4.

Eucyclops serrulatus (Fischer, 1851). Morphotype 1: **a** first leg (P1) with coxa and intercoxal sclerite (with fine denticules), arrow show external seta of exopodite 3 with a row of little spinules along outer margin and with setules on inner edge **b** fourth leg (P4) with coxa and intercoxal sclerite, arrows show two apical setae of exopodite 3 stylet-shaped **c** fifth leg (P5).

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

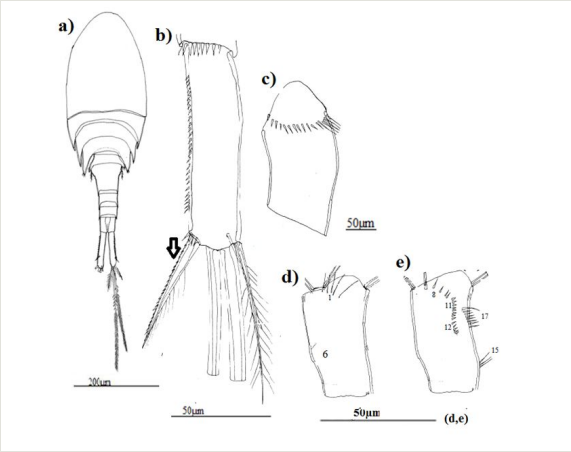

Figure 5.

Eucyclops serrulatus (Fischer, 1851). Morphotype 2: **a** Habitus (dorsal view) **b** caudal rami **c** A1 basis **d** A2 basis (posterior surface) **e** A2 basis (anterior surface), numbers of characters correspond to those in Fig. 2.

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

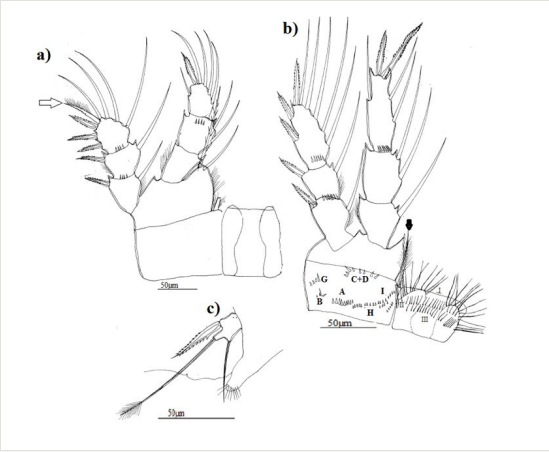

Figure 6.

Eucyclops serrulatus (Fischer, 1851). Morphotype 2: **a** first leg (P1) with coxa and intercoxal sclerite, arrow show external seta of exopodite 3 with a row of little spinules along outer margin and with setules on inner edge **b** fourth leg (P4) with coxa and intercoxal sclerite **c** fifth leg (P5).

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

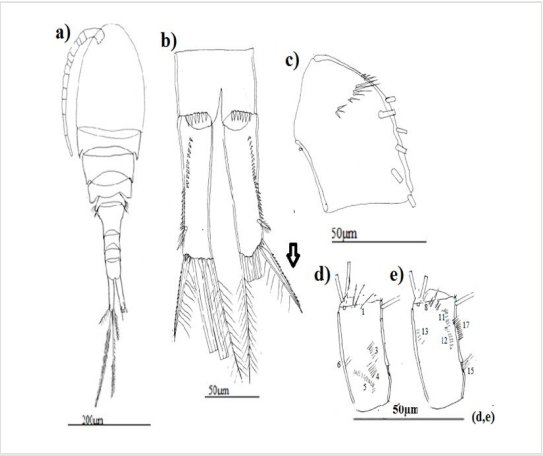

Figure 7.

Eucyclops serrulatus (Fischer, 1851). Morphotype 3: **a** Habitus (dorsal view) **b** caudal rami **c** A1 basis **d** A2 basis (posterior surface) **e** A2 basis (anterior surface), numbers of characters correspond to those in Fig. 2.

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

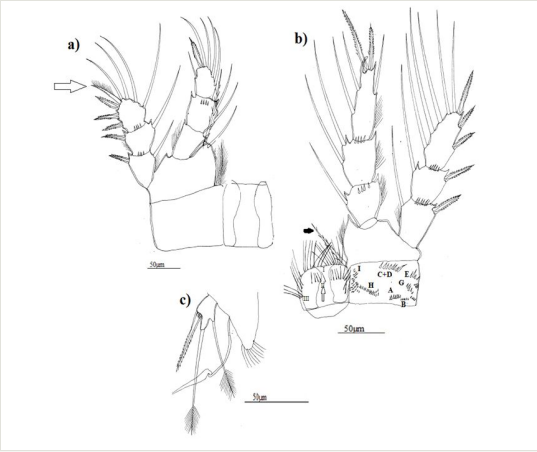

Figure 8.

Eucyclops serrulatus (Fischer, 1851). Morphotype 3: **a** first leg (P1) with coxa and intercoxal sclerite, arrow show external seta of exopodite 3 with a row of little spinules along outer margin and with setules on inner edge **b** fourth leg (P4) with coxa and intercoxal sclerite **c** fifth leg (P5).

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

Table 1.

Occurrences of *Eucyclops serrulatus* (Fisher, 1851) morphotypes in different localities. (Numbers referred to the localities).

Eucyclops serrulatus morphotypes	Localities with occurrences of the three morphotypes
Eucyclops serrulatus (morphotype 1)	(1) Females, (2) Males, females, (3) Females. (4) Males, females,(5) Several males, several females Males, females, (8) Males, females, (9) Females, (10) Males, females, (11) Males, females, (12) Mal females, (13) Females, (14) Several males, several females, (15) Males, females.
Eucyclops serrulatus (morphotype 2)	(16) Several male: Several females, (17) Several males, several females, (18) Several males, severa Several males, several females, (20) Several males, several females.
Eucyclops serrulatus (morphotype 3)	(21) Males, females.

Author-formatted, not peer-reviewed document posted on 08/11/2022. DOI:
https://doi.org/10.3897/arphapreprints.e97090

Table 2.

Female morphometric characters in Algerian morphotypes of *Eucyclops serrulatus*.

	morphotype **1**		morphotype **2**		morphotype **3**	
	range	**mean**	**range**	**mean**	**range**	**mean**
Body length	0.86 -1	0.93	0.81 - 1	0.93	0.79 -1	0.85
Cephalothorax, length / width	1-1.2	1.08	1-1.2	1.06	1-1.18	1.05
P5, length of outer seta / length of spine	0.98-1	0.97	0.98-1	0.97	0.97-1.2	1.05
Caudal rami, length/width	4-4.4	4.2	4.5-5	4.76	3.5-4.2	3.96
Caudal rami,length of terminal accessory setae/ length of postero lateral spine like seta	0.8-1	0.93	1.3-1.6	1.46	1.4-1.5	1.48
P4 enp3, length/width	2.5-3	2.8	2.3-2.9	2.6	2.4-2.7	2.6
P4 enp3, inner apical spine /outer apical spine	1.3-1.5	1.36	1.3-1.4	1.33	1.3-1.4	1.38
P4 enp3, inner apical spine/segment length	1.5-1.6	1.55	0.98-1	0.96	0.99-1	0.98
Genital segment (Th6), length/width.	1.1-1.2	1.15	1.1-1.3	1.14	1-1.1	0.95