

**NEW DATA ON THE POORLY-KNOWN MOUNTAIN
CYCLOPOID *CYCLOPS LADAKANUS* KIEFER, 1936
(COPEPODA: CYCLOPIDAE) FROM PAMIRS
(TAJIKISTAN)**

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ABSTRACT: Data on the morphology and variability of the poorly known cyclopoid *Cyclops ladakanus* from the mountain lakes Karakul (3950 m above sea level) and Shorkul (3782 m above sea level) in the Pamirs (Tajikistan) are presented. The synonymy of *Cyclops ladakanus* Kiefer, 1936 and *Cyclops pamirensis* Gurvich, 1959 is confirmed.

KEY WORDS: Cyclopoida, *Cyclops ladakanus*, redescription, Lake Karakul, Pamirs, Central Asia.

In 1958, the professor of Tashkent State University V. F. Gurvich (1958) described a new species of cyclopoid *Cyclops pamirensis* from the mountain Lake Karakul in the Pamirs. It is the only paper on this species. Later, U. Einsle (1992) proposed that *C. pamirensis* is a junior synonym of *C. ladakanus* Kiefer, 1936, which was described from mountain lakes in Ladakh, Himalayas. As *C. ladakanus* was described from a restricted area (Ladakh in the Hymalaya), its degree of variation and relationship to other congeners are unknown (Einsle, 1996).

Determination of the taxonomic position of *C. pamirensis* is difficult, because the description of the species given by V.F. Gurvich is too laconic and unsatisfactory according to modern standards in the taxonomy of Cyclopidae. No type specimens of *C. pamirensis* exist. While studying materials of V.F. Gurvich's collection, we found *C. pamirensis* in samples from Lake Karakul, the *type locality*, and from another Lake Shorkul in the Pamirs, which enabled us to study the morphology and variability of this poorly known cyclopoid in more detail.

MATERIAL AND METHODS

Material examined:

- Lake Karakul, Pamirs, Tajikistan. 06.09.1951. Coll. V.F. Gurvich. Many females and males.
- Lake Shorkul, Pamirs, Tajikistan. 23.07.1959. Coll. V.F. Gurvich. Many females and males.

All drawings have been made using a drawing tube.

Designations of furcal setae are given as follows: Ti, medialmost apical furcal seta; Te, lateralmost apical furcal seta; Tme, middle lateral apical

furcal seta; Tmi, middle medial apical furcal seta; Sd, dorsal furcal seta. Pereopods (legs) 1-5 are designated as P1-P5, endopodite as enp.

RESULTS

Cyclops ladakanus Kiefer, 1936

Female. Body length 1625-2000 μm . Body widest at cephalothorax (Fig. 1). Lateral sides of 5th thoracic somite without ornamentation. Genital double-somite L/W = 0.9 (Figs 2). Posterior margin of anal somite bearing spinules on dorsal, ventral and lateral sides (Figs. 3, 4). Anal operculum moderately developed, convex (Fig. 4).

Furcal rami: 5.5-7.1 times as long as wide, inner surface with hairs, dorsal surface with longitudinal furrows (Figs. 4). Insertions of Me and Te furcal setae provided with tiny spinules. Plumage of Tmi and Tme furcal setae homogenous. Lateral seta situated in posterior half, at about 70% of total length of ramus. Ti slightly shorter than caudal ramus, and 1.5-2.0 longer than Te and Sd. Tips of Tme and Tmi curved.

Labrum with 20 central and 2 of larger lateral teeth (Fig. 5).

Antennules (Fig. 6): 17-segmented, reaching caudal margin of second somite of cephalothorax, armored as follows (segment number in Roman numerals, setal number in Arabic numerals, aesth = aesthetasc, sp = spine):

I (8) – II (4) – III (2) – IV (6) – V (4) – VI (1 + sp) – VII (2) – VIII (1) – IX (1) – X (0) – XI (1) – XII (1 + aesth) – XIII (0) – XIV (1) – XV (2) – XVI (2 + aesth) – XVII (7 + aesth). Aesthetasc on segment XII is relatively long, almost reaching distal margin of segment XIV.

Antenna (Figs. 7): basis bearing 3 setae, inner seta much longer than outer setae. Its caudal side with 2 longitudinal rows of long spinules and oblique field of short spinules (Figs. 8). Frontal side with one short oblique row of spinules (Figs. 9). Second endopodite bearing 9 setae, last segment with 7 setae.

Mandible typical for the genus (Fig. 10). Mandibular palp with 2 long and 1 short setae.

Maxillule: The segmentation and setation follow the typical cyclopine pattern; surface of palp with a few tiny spinules (Figs. 11-12).

Maxilla as in Fig. 13, typical for the genus.

Maxilliped: consists of syncoxopodite, basipodite, and two-segmented endopodite, with 3, 2, 1, and 3 setae, respectively. Scale-like spinules on caudal surface of basipodite arranged in three groups (Fig. 14).

Natatorial legs with 3-segmented rami. Spine formula 2.4.3.3, setae formula 5.5.5.5 (Figs. 15-18). Caudal surface of coxopodite P4 with 4 rows of spinules (Fig. 18). Basis of P1 with long robust spine reaching beyond middle of P1enp2 and a slightly curved row of long spinules near insertion of endopodite frontally (Fig. 15). Inner margin of basis of P1 bearing setules, inner margins of P2-P4 smooth. Intercoxal plates of P2 and P3 with 2 rows of setules, plate of P1 mostly smooth, but about 30% of

specimens studied had 1 or 2 (more rarely) rows of setules. Intercoxal plates of P4 with 2 short semicircular rows of setules. Intercoxal plates of P1-P4 with broadly rounded prominences on distal margin. Spines of P1 exopodite with thin flexible ends (Fig. 15). P4enp3 L/W = 2.7-4.2. Inner terminal spine 0.62-0.86 as long as the article and 1.4-2.0 as long as lateral spine (Fig. 18).

P5 typical for the genus. Lateral spine is situated at the middle of apical segment and hardly reaches its distal end (Fig. 19).

Data on variability are presented in Table 1.

Male. Body length 1375-1650 μm . Morphology of furcal ramus, legs and mouthparts similar to that of female. However, in contrast to female, second endopodite of male antenna bearing 8 setae. Apical spines of P4enp3 of male slightly longer than in female (Fig. 20). Outer (longest) seta of P6 about 1.5 times as long as middle seta and 2.5-3 times as long as inner spine; insertion of the spine adorned with spinules (Fig. 21).

Ecology. Lake Karakul (39005'N, 73032'E) is situated at altitude 3950 m and is the largest lake in Pamir with an area of 370 km². The maximum depth is 238 m. Transparency of water 5-7 m. Summer surface temperature 11-13 oC. Mineral content of water from 9618 mg/l (surface) to 10580 mg/l (deeper 50 m).

Lake Shorkul (38027'N, 74008'E) is situated at altitude 3782 m. Its area is 15 km², mean depth 2 m, maximum depth 6 m; 75% of its area is covered with Potamogeton sp. Mineral content of water 1269-1287 mg/l.

DISCUSSION

Lakes Shorkul and Karakul are situated about 400-500 km north of Ladakh, the terra typica for *Cyclops ladakanus*. It was reported also from Chinese Tibet (Shen et al., 1979) and Iran (Löffler, 1961). *C. ladakanus* is a mountain species: F. Kiefer (1939) reported it from lakes in Kashmir situated at 4241-5217 m above sea level, and C. J. Shen and co-authors (Shen et al., 1979) reported the species in lakes at altitudes up to 4350 m. *C. ladakanus* can apparently live in fresh, as well as in brackish waterbodies (Kiefer, 1939).

The first description of *C. ladakanus* (Kiefer, 1936) was very short; later F. Kiefer (1939) presented more complete data on its morphology as well as biometrics. The morphology of specimens from Pamirs readily corresponds to the description of *C. ladakanus* from the Himalayas (Kiefer, 1939; Einsle, 1992), confirming the opinion of U. Einsle (1992) that *C. pamirensis* Gurvich, 1958 is conspecific with *C. ladakanus* Kiefer, 1936.

Recently, M. Holyńska and H.-U. Dahms (2004) carried out a large-scale study on the comparative morphology of cephalothoracic appendages of representatives of the genus *Cyclops* O. F. Müller, 1776. The antenna endopodite 2 of the female of *C. ladakanus* is armed with nine setae as in *C. furcifer* Claus, 1857, *C. heberti* Einsle, 1996, *C. singularis* Einsle, 1996, *C. scutifer* Sars, 1863, *C. canadensis* Einsle, 1988,

C. columbianus Lindberg, 1956, *C. strenuus* Fischer, 1851, *C. abyssorum* Sars, 1863 and *C. kolensis* Lilljeborg, 1901 (Holyńska and Dahms, 2004). *Cyclops ladakanus* belongs to the group of congeners with a long aesthetasc on antennule segment XII which unites *C. strenuus*, *C. abyssorum*, *C. furcifer*, *C. kolensis*, and *C. columbianus* (Holyńska and Dahms, 2004). Like all these species *C. ladakanus*, is pelagic cyclopoid.

It differs from all previously studied congeners (Holyńska and Dahms, 2004), *C. ladakanus* has a slightly curved row of long frontal spinules near the insertion of the endopodite P1, rather than between the insertions of the exopodite and endopodite.

There is some variability in the ornamentation of the intercoxal plates of P1 in *Cyclops ladakanus*. Variability in the ornamentation of the intercoxal plates of the swimming legs was reported previously for *Cyclops strenuus*, *C. abyssorum*, *C. vicinus*, *C. furcifer* (Einsle, 1985) and *Acanthocyclops trajani* (Mirabdullayev and Defaye, 2002).

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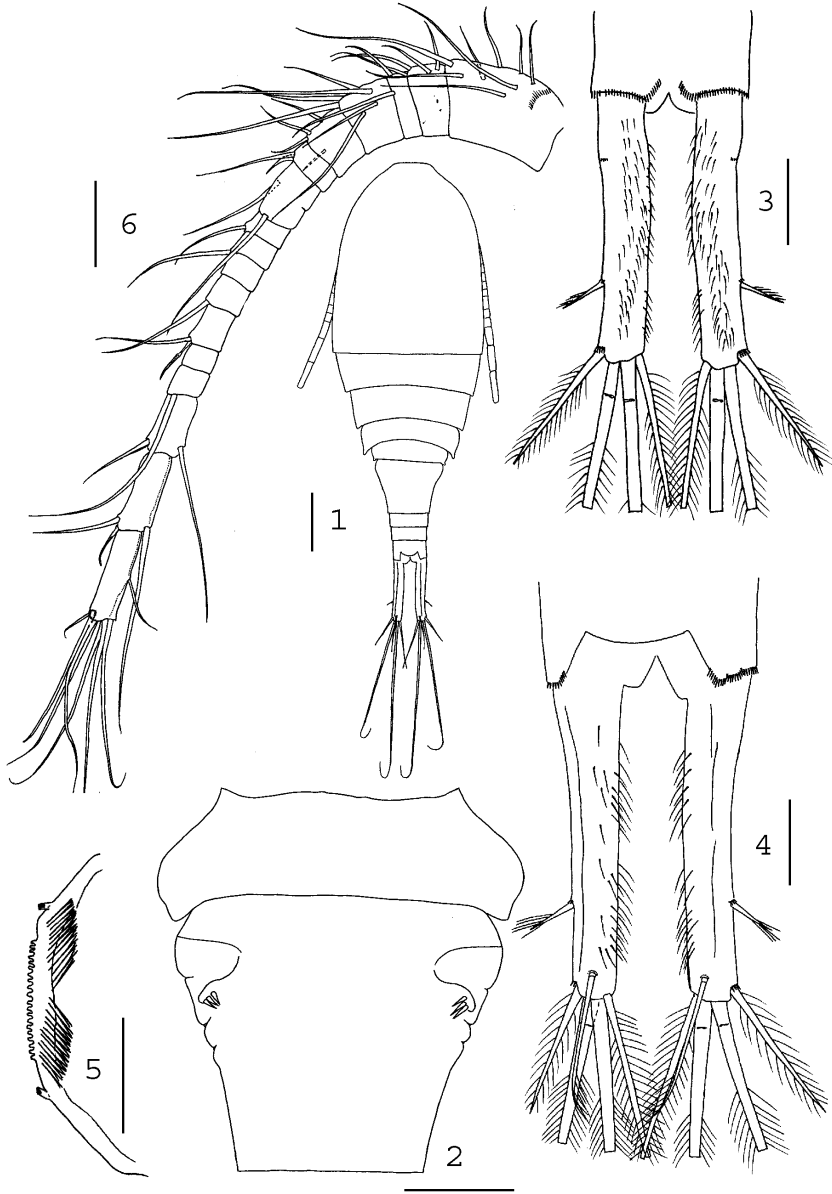
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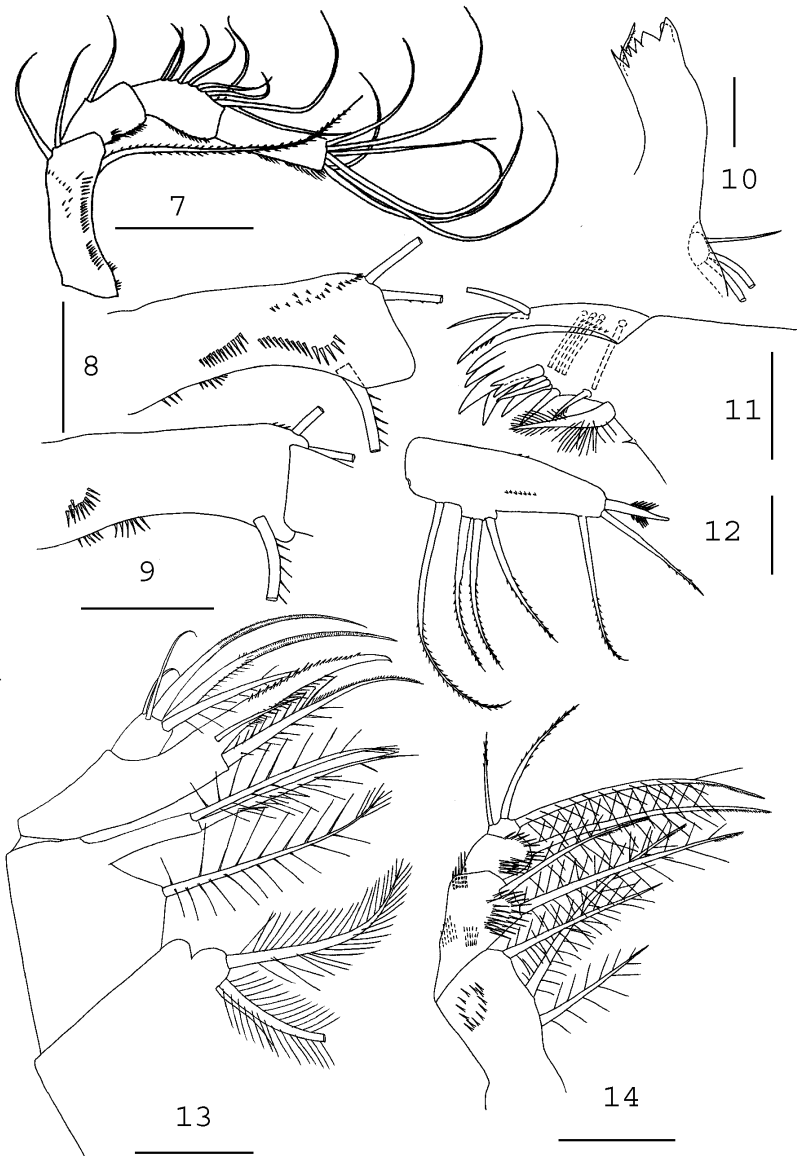
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Table 1. Measurements of *Cyclops ladakanus* Kiefer, 1936. Data in parenthesis are derived from F. Kiefer's drawings.

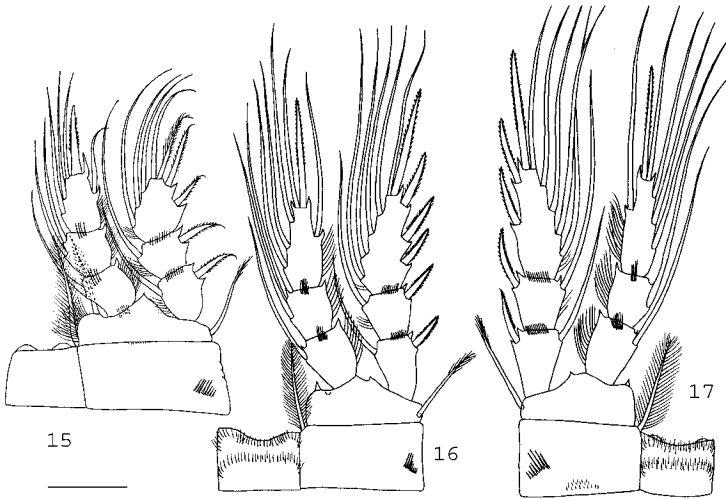
	Pamirs				Tibet (Kiefer, 1939)	
	Lake Karakul		Lake Shorkul		Six localities in Ladakh	
	x	min-max	x	min-max	x	min-max
<i>Female:</i>	N=10		N=10		N=16	
Body length, μm	1722	1625-1850	1810	1625-2000	1626	1110-2280
Caudal rami L/W	6.52	6.20-7.15	6.11	5.55-6.85	5.85	5.00-6.66
Ti/caudal rami L	0.90	0.78-1.00	0.97	0.84-1.00	-	(0.94)
Ti/Te	1.80	1.68-2.00	1.66	1.50-1.80	1.60	1.36-1.82
Ti/Sd	1.58	1.35-1.74	1.90	1.73-2.00	-	(2.00)
P4enp3 L/W	3.73	3.30-4.20	2.76	2.66-2.90	3.56	2.77-3.65
P4enp3 inner spine/L P4enp3	0.79	0.75-0.86	0.69	0.62-0.75	0.70	0.60-0.88
P4enp3 inner spine/outer spine	1.78	1.60-2.00	1.54	1.42-1.73	1.77	1.43-2.14
<i>Male:</i>	N=5		N=5		N=5	
Body length, μm	1555	1525-1600	1535	1375-1650	1324	1320-1620
Caudal rami L/W	6.18	6.00-6.40	5.67	5.20-6.15	5.52	5.26-5.90
P4enp3 L/W	4.02	3.92-4.09	2.95	2.80-3.10	3.10	2.64-3.55
P4enp3 inner spine/L P4enp3	1.00	0.94-1.04	1.02	0.97-1.10	0.99	0.88-1.04
P4enp3 inner spine/outer spine	1.67	1.53-1.85	1.47	1.41-1.60	1.56	1.50-1.66
P6 dorsal seta/middle seta	1.50	1.30-1.67	1.53	1.36-1.66	1.69	1.45-1.80
P6 middle seta/ventral spine	1.91	1.80-2.00	1.49	1.36-1.57	1.45	1.34-1.61



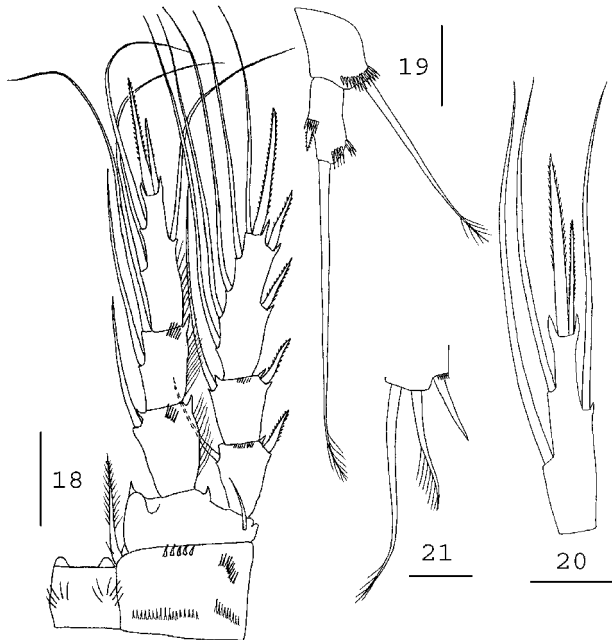
Figs. 1-6. *Cyclops ladakanus* Kiefer, 1936, female. 1. habitus; 2. pediger 5 and genital somite; 3. furcal ramus ventrally; 4. furcal ramus dorsally; 5. labrum; 6. antennule. Scales: (1) 250 μm ; (2, 6) 100 μm ; (3-5) 50 μm .



Figs. 7-14. *Cyclops ladakanus* Kiefer, 1936, female. 7. antenna, frontal side; 8. basipodite of antenna, caudal side; 9. basipodite of antenna, frontal side; 10. mandible; 11. maxillula; 12. palp of maxillula; 13. maxilla; 14. maxilliped. Scales: (7) 100 μm ; (8, 9, 11, 13) 50 μm ; (10, 12) 25 μm .



Figs. 15-17. *Cyclops ladakanus* Kiefer, 1936, female. 15. P1; 16. P2; 17. P3. Scale: 50 μ m.



Figs. 18-21. *Cyclops ladakanus* Kiefer, 1936. 18. P4 of female; 19. P5 of female; 20. endopodite 3 of P4 of male; 21. P6 of male. Scales: (18, 21) 50 μ m, (19, 20) 25 μ m.