

Cladocera (Crustacea: Branchiopoda) in Indian hot water springs

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ABSTRACT: We found two species of Cladocera (Crustacea: Branchiopoda), namely *Latonopsis* cf. *australis* Sars, 1888 (family Sididae) and *Alona cambouei* Guerne et Richard, 1893 (family Chydoridae), in the Unhere hot water springs near Pali, State of Maharashtra, India at temperatures of 34.5–36.7 °C. Our finding is the first record of cladocerans with exact species determination in hot springs of the Oriental zone.

KEY WORDS: Anomopoda, fauna, India, abiotic factors, temperature.

Cladocera (Crustacea: Branchiopoda) в индийских горячих источниках

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РЕЗЮМЕ: Мы нашли, что два вида Cladocera (Crustacea: Branchiopoda), а именно, *Latonopsis* cf. *australis* Sars, 1888 (семейство Sididae) и *Alona cambouei* Guerne et Richard, 1893 (семейство Chydoridae), весьма обычны в горячих источниках Унхере около города Пали, Штат Махараштра, Индия при температурах 34,5–36,7 °C. Это первое сообщение о находке кладоцер, определенных до вида, в горячих источниках Ориентальной биогеографической зоны.

КЛЮЧЕВЫЕ СЛОВА: Аноморпода, фауна, Индия, абиотические факторы, температура.

Table 1. Physico-chemical properties of Pali hot springs.
Таблица 1. Физико-химические характеристики горячих источников Пали.

Physico-chemical properties	April 2009	June 2009	February 2010	May 2010
Temperature, °C	35.7	36.7	34.5	35.0
pH	7.38	7.5	7.0	7.15
Conductivity, $\mu\text{S cm}^{-1}$	4.2	4.5	4.86	4.85
T.D.S., mg l^{-1}	3.1	3.18	3.3	3.43
Salinity, ‰	2.4	2.52	2.6	2.61

Introduction

The literature about flora and fauna of hot springs in the Oriental zone is fragmentary (Kirtikar, 1968; Thomas, Gonzalves, 1968; Jana, 1971). There is only a single previous record of Cladocera in hot springs (Jana, 1971) without illustrations and with generic determinations only, viz. *Daphnia* and *Diaphanosoma* in a hot spring in West Bengal at 37–51 °C, together with the rotifer genera *Lecane*, *Monostyla*, and *Euchlanis*, and some ostracods. But any findings of the cladocerans in such extreme conditions are important, because they improve our knowledge on cladoceran diversity (Forró et al., 2008). This short communication is aimed to describe our finding of cladocerans in hot springs at Pali, India.

Material and methods

The hot springs of Pali are located in the village of Unhere Budruk near the town of Pali, Kolaba District, State of Maharashtra, India (18°33'25.20"N, 73°13'05.34"E). They erupt into three tanks of about 2 × 2 × 2 m, from where the water overflows to form neighboring puddles of tepid water (Kirtikar, 1968).

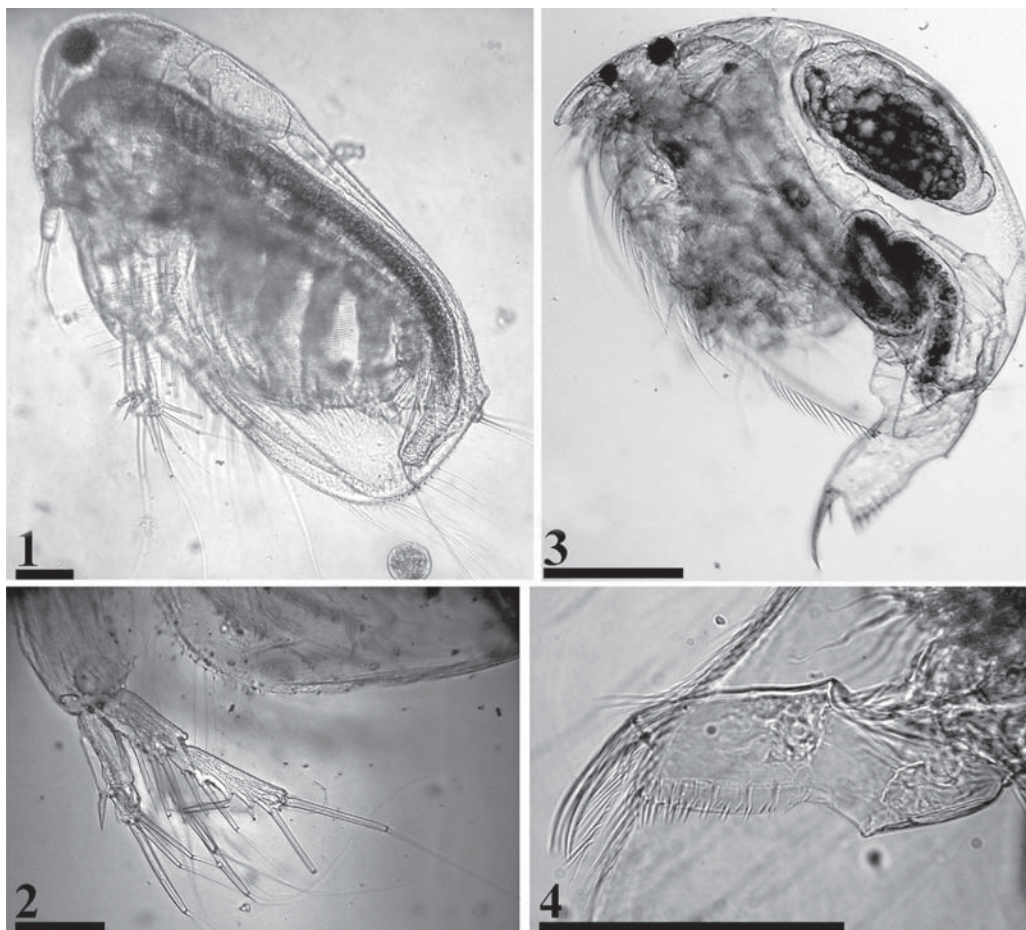
The qualitative samples were collected in February, April, and June of 2009, February and May of 2010 from one of the tanks by plankton net. The temperature, pH, conductivity, total dissolved solids and salinity were recorded using a Multi-Parameter Probe (Eutech Instru-

ments) during each sampling (Table 1). The samples were preserved in formalin, sorted under an Olympus Magnus (MS-24) dissecting binocular microscope, and finally studied under an Olympus binocular microscope (CH 20i). Photos were made using a digital camera Sony DSC-W35 attached to the latter. For identification of the species 10 parthenogenetic females of each species were used. The samples are saved in the personal collections of the authors.

Results and discussion

Two species of cladocerans were found: *Latonopsis* cf. *australis* Sars, 1888 (family Sididae) and *Alona cambouei* Guerne et Richard, 1893 (family Chydoridae) (Figs 1–4). Our samples were not quantitative, but total number of both species in all series of 2009 was quite high, and each time *Latonopsis* was more abundant. Both species were absent in two 2010 collections.

Among the species of *Latonopsis* Sars, 1888, the *L. australis* group is diagnosed by: (1) three long naked setae on the postero ventral corner of valve with length of about 70% of body length, (2) postabdomen relatively small, with 7–9 small teeth closer to distal end, (3) postabdominal claws with two basal spines; (4) not more than 12 setae on two-segmented antennal exopod; (5) length of female not more than 1.8 mm (Korovchinsky, 2004). *Latonopsis* cf. *australis* was never recorded before from hot springs, although it was found in various freshwater habitats in India (Korovchinsky, 2004).



Figs. 1–4. Cladocerans of the hot springs of Pali, State of Maharashtra, India.

1–2 — *Latonopsis* cf. *australis*, general view and antenna II; 3–4 — *Alona cambouei*, general view and postabdomen. Scale bars 0.1 mm.

Рис. 1–4. Ветвистоусые ракообразные горячих источников Пали, Штат Махараштра, Индия.

1–2 — *Latonopsis* cf. *australis*, общий вид и антенна II; 3–4 — *Alona cambouei*, общий вид и постабдомен. Масштаб 0,1 мм.

Alona cambouei Sars, 1888 is a member of *A. puchella*-species group; among members of these groups, it is diagnosed by: (1) number of notches on posterior margin of head shield uneven; (2) three major head pores without connection between them; (3) only about 30–35 setae, significantly differentiated in size, at ventral margin of carapace; (4) prominent preanal angle of postabdomen; (5) postabdominal claw of moderate length, subequal to preanal portion of postabdomen; (6) basal spine ca. 0.25–0.3 of the claw length; (7) size of female

not more than 0.45 mm (Sinev, 2001). Michael and Sharma (1987) did not report *Alona cambouei* from India. Although this taxon is common in tropics of Old World including the Oriental zone (Sinev, 2001), it was never recorded from hot springs.

Diatoms and cyanobacteria, a possible food for the cladocerans, are quite numerous in Pali hot water springs (Kirtikar, 1968). So, not food, but, probably, temperature is a limiting factor for establishment of the populations of other cladocerans there. The upper limit of

temperature was determined as 30°C for *Daphnia* and *Ceriodaphnia* (Mallin, Partin, 1989) and 32°C for chydorids (Bogatova, 1962), while temperatures of 42–44 °C caused their immediate death (Brown, 1929). But *Latonopsis* is a tropical-subtropical taxon which normally occurs at 34–38 °C (Korovchinsky, 2004); only 46 °C is lethal for it (Brown, 1929). So, *Latonopsis* would occur in hot springs under temperature conditions normal for this animal. There are cladocerans which survive even under higher temperatures: for *Macrothrix* cf. *rosea* the lethal temperature is 50 °C (Brown, 1929)!

Probably, the population of *Alona cambouei* in Pali hot springs is also adapted to high temperature conditions, although thermal preferences of the chydoridae are inadequately studied (Bogatova, 1962). Such adaptations probably include biochemical adaptations which could be specially investigated.

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References

- Bogatova I.B. 1962. [Lethal concentrations of oxygen, water temperature and pH for some representatives of the family Chydoridae] // Zool. Zh. Vol.41. P.58–62 [in Russian].
- Brown L.A. 1929. The natural history of Cladocerans in relation to temperature // Amer. Nat. Vol.63. P.248–264, 346–352, 443–454.
- Forró L., Korovchinsky N.M., Kotov A.A., Petrussek A. 2008. Global diversity of cladocerans (Cladocera; Crustacea) in freshwater // Hydrobiologia. Vol.595. P.177–184.
- Jana B.B. 1978. The plankton ecology of some thermal springs in West Bengal, India // Hydrobiologia. Vol.61. P.135–143.
- Kirtikar K.R. 1968. Algae of the hot springs at Palli // Hydrobiologia. Vol.25. P.340–351.
- Korovchinsky N.M. 2004. [Cladocerans of the order Ctenopoda of the world fauna (morphology, systematics, ecology, biogeography)]. Moscow: KMK Scientific Press Ltd. 410 p. [in Russian].
- Mallin M.A., Partin W.E. 1989. Thermal tolerances of common Cladocera // J. Fresh. Ecol. Vol.5. P.45–51.
- Michael R.G., Sharma B.K. 1988. Fauna of India and adjacent countries. Indian Cladocera (Crustacea: Branchiopoda: Cladocera). Calcutta: Zoological Survey of India. 262 p.
- Sinev A.Yu. 2001. Separation of *Alona cambouei* Guerne & Richard, 1893 from *Alona pulchella* King, 1853 (Branchiopoda: Anomopoda: Chydoridae) // Arthropoda Selecta. Vol.10. No.1. P.5–18.
- Thomas J., Gonzalves E.A. 1968. Thermal algae of western India // Hydrobiologia. Vol.25. P.330–340.

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