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GENETIC CHARACTERISTIC OF THE AFRO-ASIATIC SPECIES *EUCYCLOPS (EUCYCLOPS) AGILOIDES ROSEUS* (CRUSTACEA: COPEPODA) IN CONNECTION WITH ITS FIRST FINDINGS IN NORTH AMERICA: HUMAN MEDIATED DISPERSAL OR HISTORICAL ROOTS

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The mitochondrial l CO1, 12SrRNA and nuclear genes nITS, 18SrRNA of the species *Eucyclops (Eucyclops) agiloides roseus* have been studied. It has been shown that according to mitochondrial genes, the species splits into 3 clades, differing by 10.8–12.7%. *E. (E.) a. roseus*, is usually widespread within Eurasia and Africa and was also found in North America (California) and Taiwan, when compared with the material from GenBank and Bold. The discovery of the species in these regions is recorded for the first time, which is especially important for North America, where a large number of alien species of aquatic invertebrates have been identified in recent years. The *Eucyclops* found in North America (California) and Taiwan are similar to each other and are as close as possible to the Kazakh populations. The article examines the two most likely reasons for the discovery of a species new to the fauna of America: human settlement or the habitation of historically long-existing populations related to Asian ones, as noted for a number of other invertebrate species.

Keywords: biogeography, *Eucyclops*, bioinvasions, molecular genetics, Paratethys
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Referens

Alekseev V.R., Sukhikh N.M. On time and place of origin of continental calanoid families: a hypothesis // Crustaceana. 2020. Vol. 93. P. 245–260.

Alekseev V. The modern distribution of two *Eucyclops* (*Eucyclops*) Claus, 1893 species (Cyclopoida: Copepoda) as a reflection of the Tethys Sea evolution // Hydrobiologia. 2023. Vol. 850. P. 4801–4814.

Alekseev V.R., Chaban O.A. New records of continental cyclopids (Crustacea: Copepoda: Cyclopiformes) from Eastern Siberia and Russian Far East // Arthropoda Selecta. 2021. Vol. 30. P. 503–520.

Alekseev V.R., Monchenko V.I. Species diversity of the cyclopid basin of the Caspian Sea // In the collection: Biological diversity of buffer invertebrates in continental water bodies. SPb.: Zool. In-t RAS, 2011. P. 157–164.

Anufriieva E.V., Holynska M., Shadrin N. Current invasions of asian cyclopid species (Copepoda: Cyclopidae) in Crimea, with taxonomical and zoogeographical remarks on the hypersaline and freshwater fauna // Annales Zoologici. 2014. Vol. 64. P. 109–130.

Bouckaert R., Vaughan T.G., Barido-Sottani J., Duchêne S., Fourment M., Gavryushkina A., Heled J., Jones G., Kühnert D., De Maio N., Matschiner M. BEAST 2.5: An advanced software platform for Bayesian evolutionary analysis // PLoS computational biology. 2019. Vol. 15, e1006650. [https://doi.org/10.1371/journal.pcbi.1006650] (Accessed on 25.08.2024)

Eyun Si. Phylogenomic analysis of Copepoda (Arthropoda, Crustacea) reveals unexpected similarities with earlier proposed morphological phylogenies // BMC Evol Biol 2017. Vol. 17, P. 23 [https://doi.org/10.1186/s12862-017-0883-5]

Gaponova L., Hołyńska M. New data on the Western Palearctic distribution of *Eucyclops roseus* (Copepoda: Cyclopidae), with notes on its taxonomic relationships // North-Western Journal of Zoology. 2022. Vol. 18. P. 135–142.

GenBank. Available online: https://www.ncbi.nlm.nih.gov/nuccore/KJ020567 (Accessed on 25.08.2024)

Hall T.A. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT // Nucleic acids symposium series. 1999. Vol. 41. P. 95–98.

Hamrova E.V., Krajicek M., Karanovic T., Cerny M., Petrusek A. Congruent patterns of lineage diversity in two species complexes of planktonic crustaceans, *Daphnia longispina* (Cladocera) and *Eucyclops serrulatus* (Copepoda), in East European mountain lakes // Zoological Journal of the Linnean Society. 2012. Vol. 166. P. 754–767.

Ishida T. 1997. *Eucyclops roseus*, a new Eurasian copepod, and the *E. serrulatus-speratus* problem in Japan // Japanese Journal of Limnology. 1997. Vol. 58. P. 349–358.

Ishida T. Illustrated fauna of the freshwater cyclopoid copepods of Japan // Bulletin of the Biogeographical Society of Japan. 2002. Vol. 57. P. 37–106.

Kan K., Sasaki A., Itoh E., Matsumasa M. New record of *Eucyclops roseus* Ishida, 1997 (Copepoda: Cyclopoida: Cyclopidae) from Takamatsunoike Pond, Iwate Prefecture, Japan, with discussions of its intraspecific genetic and morphological variation // Annual Report of Iwate Medical University Center for Liberal Arts and Sciences. 2023. Vol. 58. P. 15–26.

Kazmin V.G., Natapov L.M. The Paleogeographic Atlas of Northern Eurasia. Institute of Tectonics of Lithospheric Plates: Moscow, Russia, 1998. 26 p.

Ketmaier V., Marrone F., Alfonso G., Paulus K., Wiemann A., Tiedemann R., Mura G. Mitochondrial DNA regionalism and historical demography in the extant populations of *Chirocephalus kerkyrensis* (Branchiopoda: Anostraca) // PLoS ONE. 2012. Vol. 7, e30082. [https://doi.org/10.1371/journal.pone.0030082] (Accessed on 25.08.2024)

Kiefer F. Crustacea. Contribution a la faune du Cameroun // In: Faune Colonies francaises 1. Monod: Th. 1928. P. 535–570.

Kiefer F. Die freilebenden Copepoden der Binnengewässer von Insulinde // Archiv für Hydrobiologie, Supplementband 4(3), Tropische Binnengewässer. suppl. 1933. Vol. 12. P. 519–621.

Kiefer F. Freilebende Ruderfusskrebse (Crustacea Copepoda) aus Nordwest und Südindien (Pandschab, Kaschmir, Ladak, Nilgirigebirge) // Scientific Results of the Yale North India Expedition, Biological report no. 19. Memoirs of the Indian Museum, Calcutta. 1939. Vol. 13. P. 83–203.

Knowlton N., Weigt L.A. New dates and new rates for divergence across the Isthmus of Panama // Proceedings of the Royal Society of London. Series B: Biological Sciences. 1998. Vol. 265. P. 2257–2263.

Korovchinsky N.M., Kotov A.A., Sinev A.Yu., Boykova O.S., Smirnov N.N. Cladocera (Crustacea: Cladocera) of Northern Eurasia. Volume 1. Moscow: KMK Partnership of Scientific Publications, 2021. 481 p.

Kotov A.A., Taylor D.J. Mesozoic fossils (> 145 Mya) suggest the antiquity of the subgenera of *Daphnia* and their coevolution with chaoborid predators // BMC evolutionary biology. 2011. Vol. 11. P. 1–9.

Lee J.M., Min G.S., Chang C.Y. *Eucyclops serrulatus* species group (Copepoda: Cyclopoida: Cyclopidae) from Korea. // Korean Journal of Systematic Zoology. 2005. Vol. 21. P. 137–156.

Marino I.A., Pujolar J.M., Zane L. Reconciling deep calibration and demographic history: Bayesian inference of post glacial colonization patterns in *Carcinus aestuarii* (Nardo, 1847) and *C. maenas* (Linnaeus, 1758) // PLoS One. 2011. Vol. 6, e28567. [https://doi.org/10.1371/journal.pone.0028567] (Accessed on 25.08.2024)

Novikov A., Abramova E., Novichkova A., Chertoprud E. Unveiling copepod diversity and faunal patterns in Middle Siberia: insights from Tiksi settlement vicinity // Acta Biologica Sibirica. 2023. Vol. 27. P. 683–708.

Posada D. jModelTest: phylogenetic model averaging // Molecular biology and evolution. 2008. Vol. 25. P. 1253–1256.

Schwentner M., Clavier S., Fritsch M., Olesen J., Padhye S., Timms B.V., Richter S. *Cyclestheria hislopi* (Crustacea: Branchiopoda): a group of morphologically cryptic species with origins in the Cretaceous // Molecular phylogenetics and evolution. 2012. Vol. 66. P. 800–810.

Scotese C.R. Atlas of Jurassic Paleogeographic Maps, PALEOMAP Atlas for ArcGIS, volume 3, The Jurassic and Triassic, Maps 32-42, Mollweide Projection, PALEOMAP Project, Evanston: IL. 2014a. [https://doi.org/10.13140/2.1.4850.4321] (Accessed on 20.04.2024)

Scotese C.R. Atlas of Paleogene Paleogeographic Maps (Mollweide Projection), Maps 8-15, Volume 1, The Cenozoic. PALEOMAP Atlas for ArcGIS, PALEOMAP Project, Evanston: IL. 2014b. [https://doi.org/10.13140/2.1.4151.3922] (Accessed on 20.04.2024)

Sukhikh N., Zavarzin D., Alekseev V. Origin and taxonomic position of Far Eastern island populations of *Eurytemora caspica tethysiana* subsp. nov. // Zoologischer Anzeiger. 2023. Vol. 306. P. 119–137.

Sworobowicz L, Mamos T, Grabowski M, Wysocka A. Lasting through the ice age: The role of the proglacial refugia in the maintenance of genetic diversity, population growth, and high dispersal rate in a widespread freshwater crustacean // Freshwater Biology. 2020. Vol. 65. P. 1028–1046.

Tamura K., Stecher G., Kumar S. MEGA 11: Molecular Evolutionary Genetics Analysis Version 11 // Molecular Biology and Evolution. 2021. Vol. 38. P. 3022–3027.

Thompson J.D., Higgins D.J., Gibson T.J. CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice // Nucleic Acids Research. 1994. Vol. 22. P. 4673–4680.

Wolfe J.M., Daley A.C., Legg D.A., Edgecombe G.D. Fossil calibrations for the arthropod Tree of Life // Earth-Science Reviews. 2016. Vol. 160. P. 43–110.

Zofkova M., Timms B.V. A conflict of morphological and genetic patterns in the australian anostracan *Branchinella longirostris* // Hydrobiologia. 2009. Vol. 635. P. 67–80.