Rotifer News

A newsletter for rotiferologists throughout the world

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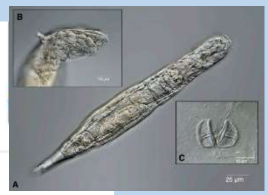
Correspondence

A living bdelloid rotifer from 24,000-year-old Arctic permafrost

Lyubov Shmakova [1, 6], Stas Malavin [1, 6], Nataliia Iakovenko [2], Tatiana Vishnivetskaya [1, 3], Daniel Shain [4], Michael Plewka [5], Elizaveta Rivkina [1]



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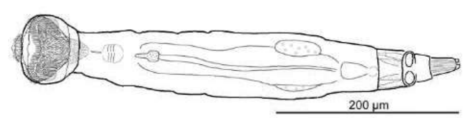

An extraordinary new fluvial bdelloid rotifer, *Coronistomus impossibilis* gen. nov., sp. nov., with adaptations for turbulent flow (Rotifera: Bdelloidea: Coronistomidae fam. nov.)

AYDIN ÖRSTAN

Issue 34: October 2021

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In this issue:

- International …
- Recovery …
- New …
- Sexual …
- Research …
- Key …
- Virtual …
- Obituaries …
- Many other topics

Produced at the

National Autonomous University of Mexico (UNAM)-Faculty of Higher Studies (FES) Iztacala, Mexico

Editorial.........

Since the last issue of Rotifer News (RN 33), there was an enormous delay in the release of the present number due to many factors. However, it is important to release the issues and keep the tradition of RN continuing for the benefit of rotifer workers around the world. The present issue contains some historical photos of previous rotifer meetings including the one organized by the National Autonomous University of Mexico, Campus Iztacala (Rotifera XI), information about the next International Rotifer Symposium (Rotifera XVI) and miscellaneous contributions from rotifer workers to enrich the younger generation of researchers in many different fields of zooplankton and limnology. The different workshops and courses held in various institutions, particularly on rotifers, cladocerans and copepods will be included in the future issues of RN. Many of these courses have influenced Mexican workers more than others, if one considers the percentage of participation by the Mexican students in different international rotifer symposia. For example, Wallace et al. (2015) have shown that Mexico represented the largest number of participants in the IRS (see *SILnews* no. 67).

Digital presentation of all previous Rotifer News numbers has already begun, and these are being added to the RN website.

As mentioned in the RN website, the practice of providing full rotifer literature is discontinued with this issue. However, selective works are covered in each issue. For complete bibliographic works on rotifers, most journals provide such information on their web pages. Tremendous increase in the Open Access mode is also helpful to get full text articles. In this issue, highlights of works on rotifer diversity available in the public domain have been added.

The improved website of RN has other features that would help rapid communication among the rotifer workers. To begin with, RN has advisory board consisting of all previous editors of RN, organizers of IRS and some invited workers who have powerful influence on the future rotifer research. Sadly, giants of rotifer research are gradually stepping out of active role due to age. Still their recorded works are available for future research. The RN website has a section on species images where anyone may use the identified rotifers for teaching, power point presentations etc., with appropriate credit to the source. The biographic section offers full recognition of the contributions made by the global community of rotifer researchers to the body of science. Another important unit of the RN website is the collection of historical letters. These can be of great relevance to stimulate younger generations, especially through classroom teaching.

The RN issue 34 covers some interesting works on bdelloids. Additional news on the International Rotifer symposium (IRS XVI, 2022) is included. Other interesting topics such as Rotifera in Bibliometry, Research Progress, Notes and News have been included.

SSS Sarma, Editor
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XVI INTERNATIONAL ROTIFER SYMPOSIUM
SEPTEMBER 5-9, 2022
ZAGREB, CROATIA
Diverse rotifers in diverse ecosystems

The XVI International Rotifer Symposium, 5 to 9 September 2022 in Zagreb, Croatia

Introduction
The International Rotifer Symposium has taken place every three years since the inaugural meeting in 1976, at Lunz am See (Austria). It is a unique opportunity for rotiferologists, i.e., "rotifer family", to share up-to-date perspectives on all topics related to rotifer biology, as well as renew friendships. These meetings provide lifetime inspiration to study of these remarkable small metazoans.

Event Venue
Zagreb is the capital city of Croatia. It is a central European city (UTC/GMT +1 hour) situated in the middle of the triangle Vienna – Budapest – Venice. The city with a tradition of almost one thousand years celebrated its 900th birthday in 1994. Zagreb lives a rich cultural life, with more than 20 theatres, 3 concert halls, around 60 museums and art galleries, and also is a known centre of congress tourism. The temperature in September is around 25-28°C and there is a chance of occasional rain.

Conference Venue will be Hotel Dubrovnik located in the city centre, on the main Ban Jelačić Square. Conference hall for 200 persons is well equipped for oral and poster presentations, perfectly isolated from outside noise, with large lobby area allowing to for coffee breaks and refreshments. The most important cultural landmarks and institutions, as well as the town's main pedestrian zone with many shops, restaurants, cafes and the famous outdoor market are only a few steps from the hotel.

Session Topics

Biodiversity and biogeography patterns
Autecology to Synecology
Experimental biology and toxicology
Molecular biology, genetics and genomics
Aquaculture and applied research

Special Sessions
Rotifers in karst ecosystems and the Mediterranean region.

Invited Speakers
Details will be added in 2021.

Workshops
Details will be added in 2021.

Proceedings
The proceedings of the symposium will be published as a special issue of Hydrobiologia.

Oral and Poster presentations
Details will be added in 2021

Poster Flash Talks
Posters will be introduced at the beginning of each poster session by a max 2 minutes flash talk consisting of 2 slides.

Rotifer Image Contest
One participant can add at most five images. The participants will elect the best image during the symposium. Voting will be online.

Symposium venue

The venue will be placed in Hotel Dubrovnik located in the city centre, on the main Ban Jelačić Square. The four-star Hotel Dubrovnik has been welcoming guests since 1929 and has won a number of awards for its facilities and services. The most important cultural landmarks and institutions, as well as the town's main pedestrian zone with many shops, restaurants, cafes and the famous outdoor market are only a few steps from the hotel.

The Main Train Station is 900 m away. The Main Bus Station can be reached within 1.9 km, while Zagreb Airport is at a distance of 18 km.

Organizing Committee at University of Zagreb

Maria Špoljar
Tvrtko Dražina
Ivančica Ternjej
Tea Tomljanović
Sanja Gottstein

Scientific Committee

Jorge Ciros-Pérez
Steven Declerck
Diego Fontaneto
Holger Herlyn
Natalia Kuczynska-Kippen
Evangelia Michaloudi
Maria Špoljar
Elizabeth Walsh
David Mark Welch
Yufeng Yang

Honored Members of the Scientific Committee

Jolanta Ejsmont-Karabin
John Gilbert
Alois Herzig
Linda May
S.S.S. Sarma
Terry Snell
Robert Wallace

For further details about Registration, Abstracts, Accommodation, Excursions etc., consult: http://www.rotiferaxvi.biol.pmf.hr/

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Symposium news from the organizer

Dear all

You are invited to participate in symposium activities.

Scientific and Organizing Committees of Rotifera XVI

Applications for Special Sessions, Workshops, and pre- or post-conference courses:

Please send us the required information for each activity by November 15, 2021:

Title, leader, max 200 words of description, specify the equipment and facilities.

The Scientific Committee will consider each application in the frame of the program and conference schedule and inform you about the decision by December 1, 2021.

Maria Špoljar

Some interesting contributions

Aydin Örstan's (2021) contribution in Zootaxa: An extraordinary new fluvial bdelloid rotifer, Coronistomus impossibilis gen. nov., sp. nov., with adaptations for turbulent flow (Rotifera: Bdelloidea: Coronistomidae fam. nov.). doi.org/10.11646/zootaxa.4966.1.2
The new species lives in microhabitats with turbulent flowing waters. The author considered many features of the species and compared with all relevant bdelloid literature before naming the new family.

Shmakova et al. (2021). A living bdelloid rotifer from 24,000-year-old Arctic permafrost. Current Biology 31. https://doi.org/10.1016/j.cub.2021.04.077.
Researchers revived the bdelloid rotifer (Adineta vaga) from the Alayeza River in the Russian Arctic.

Laine et al. 2020 Sexual reproduction in bdelloid rotifers. bioRxiv. doi: https://doi.org/10.1101/2020.08.06.239590
The authors, based on genomic evidence, show that the bdelloid, Macrotrachella quadricornifera, is facultatively sexual.

Rotifer diversity studies (Recent works)

Ardura, A., Martinez, J.L., Zaiko, A., Garcia-Vazquez, E. 2021 Poorer diversity but tougher species in old ballast water: Biosecurity challenges explored from visual and molecular techniques. Marine Pollution Bulletin 168: 112465. DOI: 10.1016/j.marpolbul.2021.112465

Asriansyah, A., Wildan, D.M., Pratiwi, N.T.M., Simanjuntak, C.P.H., Sulistiono, Hestirianoto, T., Shafrudin, D., Nugroho, T. 2021 Study on zooplankton diversity aquatic ecobiology of Batang Toru River, North Sumatera, Indonesia. IOP Conference Series: Earth and Environmental Science, 744 (1), art. no. 012003. DOI: 10.1088/1755-1315/744/1/012003

Cakil, Z.V., Garlasché, G., Iakovenko, N., Di Cesare, A., Eckert, E.M., Guidetti, R., Hamdan, L., Janko, K., Lukashanets, D., Rebecchi, L., Schiaparelli, S., Sforzi, T., Kašparová, E.Š., Velasco-Castrillón, A., Walsh, E.J., Fontaneto, D. 2021 Comparative phylogeography reveals consistently shallow genetic diversity in a mitochondrial marker in Antarctic bdelloid rotifers. Journal of Biogeography 48: 1797-1809. DOI: 10.1111/jbi.14116

Chaparro, G., Mariani, M., Hein, T. 2021. Diversity of dormant and active zooplankton stages: Spatial patterns across scales in temperate riverine floodplains. Journal of Plankton Research, 43: 61-71. DOI: 10.1093/plankt/fbaa063

da Silva, N.J., Lansac-Tôha, F.M., Lansac-Tôha, F.A., Sales, P.C.L., de Sousa Rocha, J.D.R. 2021. Beta diversity patterns in zooplankton assemblages from a semiarid river ecosystem. International Review of Hydrobiology 106: 29-40. DOI: 10.1002/iroh.201902018

Divya, K.R., Zhao, S., Chen, Y., Cheng, F., Zhang, L., Qin, J., Arunjith, T.S., Schmidt, V.B., Xie, S. 2021 A comparison of zooplankton assemblages in Nansi Lake and Hongze Lake, potential influences of the East Route of the South-to-North Water Transfer Project, China. Journal of Oceanology and Limnology 39: 623-636. DOI: 10.1007/s00343-020-9288-1

Dorak, Z. 2020. The story of the cute ghosts in a shallow lake: Zooplankton. Fresenius Environmental Bulletin 29: 10869-10880.

dos Santos, E.F., Abra, J., Castilho-Noll, M.S.M. 2021 Does land use influence the local and regional structure of the rotifer assemblage? Hydrobiologia 848: 1059-1072. DOI: 10.1007/s10750-020-04513-6

Ejsmont-Karabin, J., Karpowicz, M. 2021. Rotifera in lake subhabitats. Aquatic Ecology. DOI: 10.1007/s10452-020-09818-1

Espinosa-Rodríguez, C.A., Sarma, S.S.S., Nandini, S. 2021. Zooplankton community changes in relation to different macrophyte species: Effects of *Egeria densa* removal. Ecohydrology and Hydrobiology 21: 153-163. DOI: 10.1016/j.ecohyd.2020.08.007

Freiry, R.F., Pires, M.M., Gouvea, A., Hoffman, P.H.O., Stenert, C., Maltchik, L. 2021. Ecological correlates of the alpha and beta diversity of zooplankton hatchling communities in seasonal subtropical ponds. Ecological Research 36(3): 464-477. DOI: 10.1111/1440-1703.12213

Gu, Y., Cai, Q., Tan, L., Li, B., Ju, S., Ye, L. 2021 Taxonomic and functional diversity of planktonic rotifers along a phosphorus gradient in the three gorges reservoir, China. Fresenius Environmental Bulletin 30 (2A): 1687-1695.

Jaime, S., Cervantes-Martínez, A., Gutiérrez-Aguirre, M.A., Suárez-Morales, E., Juárez-Pernillo, J.R., Reyes-Solares, E.M., Delgado-Blas, V.H. 2021 Historical zooplankton composition indicates eutrophication stages in a neotropical aquatic system: The case of Lake Amatitlán, central America. Diversity 13: 432. DOI: 10.3390/d13090432

Karpowicz, M., Ejsmont-Karabin, J. 2021 Diversity and structure of pelagic zooplankton (Crustacea, Rotifera) in NE Poland. Water

(Switzerland) 13: 456 DOI: 10.3390/w13040456

Karuthapandi, M., Jaiswal, D. 2021. Littoral zooplankton diversity in Himayat Sagar Reservoir, Telangana, India. Lakes and Reservoirs: Research and Management 26: 42-51. DOI: 10.1111/lre.12349

Kuczyńska-Kippen, N., Špoljar, M., Mleczek, M., Zhang, C. 2021. Elodeids, but not helophytes, increase community diversity and reduce trophic state: Case study with rotifer indices in field ponds. Ecological Indicators 128: 107829. DOI: 10.1016/j.ecolind.2021.107829

Martin, G.K., Beisner, B.E., Chain, F.J.J., Cristescu, M.E., del Giorgio, P.A., Derry, A.M. 2021. Freshwater zooplankton metapopulations and metacommunities respond differently to environmental and spatial variation. Ecology 102: e03224. DOI: 10.1002/ecy.3224

Ochocka, A. 2021 ZIPLAS: Zooplankton Index for Polish Lakes' Assessment: a new method to assess the ecological status of stratified lakes. Environmental Monitoring and Assessment, 193: 664. DOI: 10.1007/s10661-021-09390-7

Onandia, G., Maassen, S., Musseau, C.L., Berger, S.A., Olmo, C., Jeschke, J.M., Lischeid, G. 2021 Key drivers structuring rotifer communities in ponds: Insights into an agricultural landscape. Journal of Plankton Research, 43 (3): 396-412. DOI: 10.1093/plankt/fbab033

Phan, N.-T., Duong, Q.H., Tran-Nguyen, Q.A., Trinh-Dang, M. 2021 The species diversity of tropical freshwater rotifers (Rotifera: Monogononta) in relation to environmental factors. Water (Switzerland), 13 (9), art. no. 1156. DOI: 10.3390/w13091156

Sarma, S.S.S., Jiménez-Santos, M.A., Nandini, S. 2021 Rotifer species diversity in Mexico: An updated checklist. Diversity 13: 291. DOI: 10.3390/d13070291

Shen, J., Qin, G., Yu, R., Zhao, Y., Yang, J., An, S., Liu, R., Leng, X., Wan, Y. 2021 Urbanization has changed the distribution pattern of zooplankton species diversity and the structure of functional groups. Ecological Indicators 120: 106944. DOI: 10.1016/j.ecolind.2020.106944

Souley Adamou, H., Alhou, B., Tackx, M., Azémar, F. 2021. Rotifers in the Niger River, Niger: diversity and abundance in relation to environmental parameters. African Journal of Aquatic Science. DOI: 10.2989/16085914.2021.1892577

Toruan, R.L. 2021 Zooplankton diversity in Lake Tondano, Indonesia. IOP Conference Series: Earth and Environmental Science, 744 (1), art. no. 012092. DOI: 10.1088/1755-1315/744/1/012092

Wallace, R.L., Walsh, E.J., Nandini, S., Sarma, S.S.S. 2021. A meta-analysis of benthic rotifer community structure as a function of lake trophic state. Aquatic Ecology. DOI: 10.1007/s10452-020-09825-2

Wang, W.-B., Wang, Q., Li, Y., Zeng, Y., Yang, Y.-F. 2021. Species diversity of bdelloid rotifers in leaf litter and four new records in China. Acta Hydrobiologica Sinica 45: 436-445. DOI: 10.7541/2021.2019.275

Zhang, Y.-N., Xu, S.-L., Huang, Q., Liu, P., Han, B.-P. 2021 Application of COI primers 30F/885R in rotifers to regional species diversity in

(Sub)tropical China. Diversity 13: 390. DOI: 10.3390/d13080390

Zhao, L., Zhang, X., Xu, M., Mao, Y., Huang, Y. 2021. DNA metabarcoding of zooplankton communities: Species diversity and seasonal variation revealed by 18S rRNA and COI. PeerJ, 9. DOI: 10.7717/peerj.11057

Zsuga, K., Inelova, Z., Boros, E. 2021. Zooplankton community structure in Shallow Saline steppe inland waters. Water (Switzerland), 13(9): art. no. 1164. DOI: 10.3390/w13091164

Rotifera in Bibliometry

According to Web of Science the Top 5 most cited articles mentioning rotifers in the text:

Yang ZH & Rannala B 2010 Bayesian species delimitation using multilocus sequence data. Proceedings of the National Academy of Sciences of The United States of America 107 (20): 9264-9269 (Times cited: 862)

Dumont Hj, Van de Velde I & Dumont S 1975. Dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from plankton, periphyton and benthos of continental waters. Oecologia 19: 75-97 (Times cited: 837)

Thompson FL, Iida T & Swings J 2004 Biodiversity of vibrios. Microbiology and Molecular Biology Reviews 68: 403–431 (Times cited: 787)

Comments: This is not directly related to rotifers. It mentions the density of Vibrio *in rotifer cultures*.

Cavalier-Smith T 1998 A revised six-kingdom system of life. Biological Reviews 73: 203-266 (Times cited: 756).

Relevant part: The author proposed new phylum Acanthognatha (rotifers, acanthocephalans, gastrotrichs, gnathostomulids)

Yoshida T, Jones LE, Ellner SP, Fussmann GF & Hairston NG 2003 Rapid evolution drives ecological dynamics in a predator-prey system. Nature 424 (6946): 303-306 (Times cited: 697)

According to Scopus, top 5 articles most cited

Harman D 1981 The aging process. Proceedings of the National Academy of Sciences of the United States of America. 78: 7124-7128 (Times cited 1519)

Relevant part: dietary antioxidants increase the life span of rotifers.

Dumont HJ, Van de Velde I & Dumont S 1975 The dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from the plankton, periphyton and benthos of continental waters. Oecologia 19: 75-97 (Times cited 882).

Yang Z & Rannala B 2010 Bayesian species delimitation using multilocus sequence data. Proceedings of the National Academy of Sciences of the United States of America 107: 9264-9269 (times cited 876).

Thompson FL, Iida T & Swings J 2004 Biodiversity of vibrios. Microbiology and Molecular Biology Reviews 68: 403-431 (Times cited 829).

Cavalier-Smith T 1998 A revised six-kingdom system of life. Biological Reviews 73: 203-266 (Times cited 797).

World catalogue of Rotifera
http://rotifera.hausdernatur.at/

Research in Progress

The research work in progress in different laboratories is included here with the hope that it facilitates interaction among the world rotiferologists.

RL Wallace

Current research projects underway

With grant support from the USA National Science Foundation, as well as their respective institutions, Rick Hochberg (University of Massachusetts – Lowell), Elizabeth J. Walsh (University of Texas – El Paso), and Robert L. Wallace (Ripon College) are currently working on a long-term, collaborative research project entitled "Life cycle evolution in Rotifera: The influence of sexual reproduction on contemporary systematics of Monogononta." [NSF grants — RH DEB- 2051684; EJW DEB- 2051704; RLW DEB-2051710.]

Phylum Rotifera comprises the largest lineage of bisexual, microscopic animals in the monophyletic clade Gnathifera. However, unlike other gnathiferans, rotifers play important ecological roles as grazers and predators in the microbial loop and classical planktonic food webs of freshwater environments. Their life history displays a complex interplay among abiotic and biotic factors that favor some characteristics over others, thus benefiting reproduction of particular species in certain habitats. They also show extraordinary variability in morphology and modes of reproduction. However, evolutionary paths may have constrained reproductive form and function, thereby restricting reproductive flexibility within specific lineages and inhibiting character evolution. Unlike other members of the Gnathifera, modes of rotifer reproduction include strictly sexual, strictly asexual, and cyclical parthenogenetic. Cyclical parthenogenesis is found only in subclass Monogononta, the largest clade of free-living rotifers. This clade also shows the greatest reproductive variability, including haplodiploidy, amphoterism, matrotrophy, and male dwarfism. Ultimately, the goals of these researchers are to (1) increase phylogenetic knowledge of Monogononta, (2) advance systematics above the level of genus, and (3) provide a framework for testing how lineage diversification is related to reproductive divergence.

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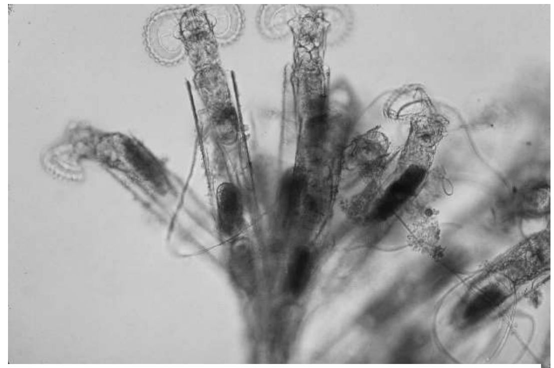
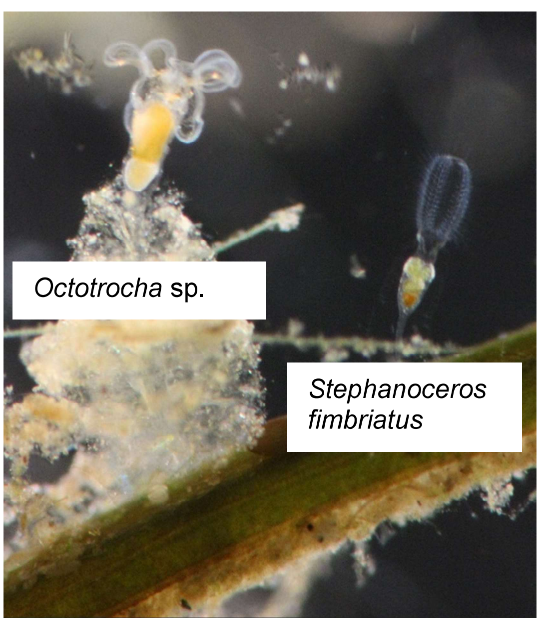
Collotheca ornata



Limnias melicerta colony

Collotheca tenuilobata

Sinantherina socialis larval colony



Octotrocha sp.

Stephanoceros fimbriatus

Epiphanes brachionus

Hexarthra sp.

All photos original of RLW

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TW Snell
Current research projects underway

Two of my last publications before my retirement in May 2019 focused on using rotifers in aquaculture. One was presented at the XV International Rotifer Symposium in El Paso, Texas and was published in Hydrobiologia (Snell et al. 2018). A second was a book chapter on the Genetic Resources of Rotifers in the Genus *Brachionus* and published in 2019. Like most scientists, I spent my career thinking that after I published the results of my scientific investigations, the implementation of these findings was the responsibility of aquaculture practitioners. When I was drawn into a collaboration with owners of a commercial marine finfish hatchery, I quickly discovered that this is not the case. They were keen on optimizing their rotifer use for the larviculture of marine fishes but were experiencing frequent and unpredictable crashes of their rotifer mass cultures that were negatively impacting their operations. We started changing their protocols to make their rotifer cultures more reliable and resilient to operator mistakes.

The hatchery is Sustainable Aquatics (https://sustainableaquatics.com/) in Tennessee (USA). Their major product is marine ornamental fish (clownfish, tangs, angels, etc) sold to the aquarium market, but recently they have ventured into rearing salmon indoors in closed recirculating systems. Our first challenge was to stabilize their rotifer production. We accomplished this by simplifying their protocols to batch cultures on 10-day cycles. Their main production unit is 1000 liter plastic bags where they first grow the green alga *Tetraselmis suecica* for about 5 days and then inoculate with the rotifer *Brachionus manjavacas* at a density of about 1/10 ml. They harvest rotifers on day ten and then repeat the cycle. They manage about forty 1000 liter bags to meet the rotifer needs of the hatchery. A key to maintaining good rotifer growth and purity of their intended strain is to return to resting eggs once every 3 months for their rotifer inoculant. This eliminates any contaminants accumulated in the rotifer mass cultures and limits genetic changes in their cultivated rotifer populations through evolution. This system has been in operation for the past 5 years with stable production, no crashes, and through several changes in rotifer culture technicians.

A key to consistently producing rotifers well suited for larval predators in commercial hatcheries is to properly manage the rotifer strain in culture. Rotifer body size is paramount because fish larval predators are limited in their ability to ingest rotifer prey by their mouth gape. One of the great benefits of the intense research into the biodiversity of the *Brachionus plicatilis* species complex is the discovery of more than 15 species with a wide range of body sizes (Mills et al. 2017). Aquaculturists can now choose to culture *Brachionus rotundiformis* as small as 136 µM in length or *Brachionus plicatilis* as large as 305 µM (Figure 1). Even larger strains (365 µM) have been produced using heavy-ion-beam irradiation (Tsuneizumi et al. 2021). An even smaller rotifer, *Proales similis* (88 µm long), has been added to the toolbox of aquaculturists (Wullur et al. 2009). With these biological resources, the commercial larviculture of many new marine fish species should become possible.

An example of the application of rotifer biodiversity in the larviculture of new fish species can be seen with yellow tangs, *Zebrasoma flavescens* (Figure 2). Tangs are in high demand in the aquarium industry. To fill that demand, Hawaii traditionally issued commercial permits to capture wild tangs, putting increasing pressure on natural populations. This practice, however, has led to depleted tang stocks, threatening reefs ecosystems and possibly harming Hawaii's tourist trade. In 2020, Hawaii decided that tang collection permits would no longer be renewed. That decision has led to a rapid increase in tang prices creating incentives for black market trade.

Tangs have not yet been successfully farmed commercially. Part of the reason is that the larviculture of tangs has proven difficult, requiring a combination of copepod nauplii, rotifers and *Artemia*. Mass production of copepod nauplii is not yet reliable for commercial aquaculture, so a small rotifer like *Proales similis* looks attractive as an alternative. Sustainable Aquatics is experimenting with *P. similis* as a replacement for copepod nauplii in tang larviculture, along with new products for enriching the nutritional quality of rotifers before feeding them to fish larvae, improving broodstock nutrition, and strengthening of fish immune systems. We believe that together these improvements in fish husbandry will make the commercial aquaculture of yellow tangs feasible. This will relieve some of the collection pressure on natural populations that is driving some to local extinction. We further expect that this pattern of closing down wild collection will expand globally in the coming decade, requiring most marine ornamental fish to be aquacultured rather than collected from the wild.

Selected works

Mills S. et al. 2017. Fifteen species in one: deciphering the *Brachionus*

	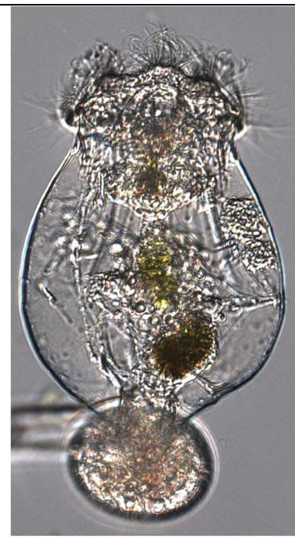	
Brachionus manjavacas “Russian strain”– mean adult length = 254 µm	*Brachionus rotundiformis* “Italy strain” – mean adult length = 136 µM	*Proales similis* “Mexican strain” – mean adult length = 88 µM

Figure 1

	
Yellow tangs schooling on a coral reef.	The yellow tang, *Zebrasoma flavescens.*

Figure 2.

plicatilis species complex (Rotifera, Monogononta) through DNA taxonomy. Hydrobiologia 796:39-58.

Snell TW, RK Johnston, AB Matthews. 2018. Utilizing *Brachionus* biodiversity in marine finfish larviculture. Hydrobiologia DOI 10.1007/s10750-018-3776-8.

Tsuneizumi K. et al. 2021. Application of heavy-ion-beam irradiation to breeding large rotifer. *Bioscience, Biotechnology, and Biochemistry* 85: 703–713 doi: 10.1093/bbb/zbaa094.

Wullur, S., Sakakura, Y., and Hagiwara, A. 2009. The minute monogonont rotifer *Proales similis* de Beauchamp: Culture and feeding to small mouth marine fish larvae. Aquaculture 293: 62-67.

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Obituary

Professor Anna Hillbricht-Ilkowska (December 12, 1932 – July 28, 2021)

I regret to inform you that Professor Anna Hillbricht-Ilkowska passed away on July 28, 2021.

She was born on December 12, 1932 in Warsaw. She studied biology at the University of Warsaw, where in 1963 she obtained her Ph.D. In 1981 she was awarded the title of professor. In the years 1975 - 2002 she was a head of the Department of Hydrobiology at the Institute of Ecology of the Polish Academy of Sciences. Since 1987 she was the editor-in-chief of Ekologia Polska (Polish Journal of Ecology). She has published over 220 scientific publications and 11 books, becoming one of the most famous Polish hydrobiologists. She was the supervisor of 10 doctoral dissertations.

Some of us met with her at two rotifer symposiums: the one in Uppsala in 1982 and then in Mikolajki in 1994, where she was one of the organizers of the symposium. On the latter, she presented a lecture on history of Polish rotiferology (Hillbricht-Ilkowska 1995).

She was the author of several works devoted to rotifers. There were among them methodological ones on sampling frequency (Hillbricht-Ilkowska 1965), and methods for the calculation of numbers, biomass and production (Hillbricht-Ilkowska & Weglenska 1970). The lakes and ponds she studied were of different trophy and morphometry, having a different response to anthropopression (Hillbricht-Ilkowska 1964, Hillbricht-Ilkowska 1983, Hillbricht-Ilkowska et al. 1975, 1988). She used estimates of rotifer productivity based on number of eggs, birth rates, and generation time (Hillbricht-Ilkowska & Weglenska 1970; Hillbricht-Ilkowska et al. 1972) to assess the productivity and energy flow in the lakes and ponds (Hillbricht-Ilkowska 1977; Hillbricht-Ilkowska et al. 1972, 1975, 1988). She cooperated with R. Pourriot, studying the effect of simulated predation (removing individuals at different rate) on fecundity and production of survivors in a culture of *Brachionus calyciflorus* (Hillbricht-Ilkowska & Pourriot 1970). Her death is an irreparable loss for our "rotifer family"

Some of the publications by prof. Anna Hillbricht-Ilkowska devoted to Rotifer research.

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Obituaries

Professor Maria Rosa Miracle
(2 June 1945 - 28 May 2017)

For full details
Camacho et al., 2019 Preface. A tribute to Maria Rosa Miracle. Limnetica 38(1): i-ix

Dr. Ramesh D. Gulati
(28 Sept 1935–23 Dec 2019)

For full details: Gopal et al., 2020. Fifty years of research on plankton ecology, biomanipulation and restoration of shallow lakes in the Netherlands: a tribute to Dr. Ramesh Datt Gulati (1935–2019). Hydrobiologia (2020) 847:3511–3517 doi.org/10.1007/s10750-020-04366-z

A call for more research on subclass Bdelloidea: a revised key to genera

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Introduction

Based solely on the number of recognized species (<500), bdelloid rotifers are a small taxon, yet they are a curious group for many reasons (Ricci 2017, Wallace et al. 2015, 2021). (1) Unlike monogonont rotifers many bdelloids move across surfaces using a leech like locomotory process. This imagery provides the etymon for the group (*bdell-*, Greek, leech + *-oid*, Greek, like). (2) Unlike monogononts, the trophi of bdelloids lack a fulcrum: i.e., ramate type. Moreover, there is relatively little variation in its general structure (Fontaneto et al. 2004, Melone & Fontaneto 2005, Melone et al. 1998). (3) Not all bdelloids feed on small particles (e.g., algae, bacteria, bits of detritus): at least one species is carnivorous (Ricci et al. 2001). (4) We do not understand their genetic organization. Unlike other members of the phylum, male bdelloids have never been reported (Birky 2010, Fontaneto & Barraclough 2015). Thus, they are reputed to have been evolving for millions of years without males and sexual recombination (Van Doninck et al. 2009). Bdelloids are degenerate tetraploids (Cariou et al. 2017, Mark Welch et al. 2008) and appear to have a unique mode of genetic exchange (Eyres et al. 2015). But while recombination in bdelloids remains unclear (Vakhrusheva et al. 2020), we do know that they are capable of horizontal gene transfer (Boschetti et al. 2011, Debortoli et al. 2016, Gladyshev et al. 2008). With the apparent lack of sexual recombination, bdelloids have been called an ‘evolutionary scandal’ (Debortoli et al. 2016, Flot et al. 2013, Mark Welch et al. 2009, Maynard Smith 1986). However, Lainea et al. (2020) have recently questioned the assertion of the absence of sexual reproduction. They posit that bdelloids possess meiosis-associated genes — thus can, and do, reproduce sexually (but very rarely) — and that at least one species has undergone recent, sexual genetic exchange. [At the time of this writing we cannot adequately evaluate these statements.] (5) Like the monogonont rotifers, bdelloids appear to be replete with hidden or cryptic diversity (Fontaneto et al. 2011); thus, there are probably many more species than we currently recognize. In addition, we doubt that all habitats have been thoroughly explored. (6) Bdelloids are incredibly tough animals for reasons that are probably related. They survive desiccation by entering an anhydrobiotic state, both as adults (xerosomes or tuns) and embryos (xerova) (Wallace et al. 2015). In the process of desiccation, bdelloids lose volume and produce protective molecules (Boschetti et al. 2011, Ricci 2017, Tunnacliffe 2005). They can survive for years in the anhydrobiotic state (Ricci 2017) — for example on mosses and other very ephemeral habitats — and can disperse in the wind over long distances (Rivas et al. 2018, 2019). Bdelloids also survive freezing (De Smet & Van Rompu 1994, Murray 1910, Shackleton 1909). Indeed, specimens recently isolated from the permafrost in northeastern Siberia dated to about 24 000 years BP have been reanimated (Newsham et al. 2006, Shmakova et al. 2021). Some bdelloids are able to survive intense ionizing radiation: i.e., they are radioresistant (Gladyshev & Meselson 2008). (7) Research on the distribution of rotifers (both bdelloids and monogononts), offers evidence that challenges the ubiquity hypothesis, that is, the 'everything is everywhere, *but* nature selects' hypothesis (Fontaneto et al. 2008, Iakovenko et al. 2015). This concept argues small organisms of about 1 mm in size or smaller are capable of dispersing by wind (anemochory), water (hydrochory), and/or on or in animals (zoochory) (Rivas et al. 2018), but that their survival and reproduction will depend on the local conditions (De Meester et al. 2002, de Wit & Bouvier 2006). (8) Although bdelloids, as well as monogononts, are found in saline waters (Walsh et al. 2008), they are not commonly found in marine habitats (Fontaneto et al. 2006, 2008). Actually, this presentation of interesting features could be expanded, along with the list of supporting references. Indeed, the references that we cite here should not be considered to be exhaustive.

Unfortunately, far too many investigations of rotifer biology, biogeography, and the structure of rotifer communities ignore bdelloids. This is understandable for at least three reasons. First, as Fontaneto et al. (2012) have emphasized "… the distribution of rotifers seems to reflect the distribution of rotifer scientists more than that of rotifers themselves" — this observational bias is known as the rotiferologist effect. That is, researchers concentrate their efforts in studying rotifers in places close to their laboratories or places that they have visited to make collections. There is a second aspect to the rotiferologist effect: for more than a decade there has been limited opportunities for new workers to receive adequate training in rotifer identification (Wallace et al. 2015: p230). The third reason for a lack of research effort has to do with the animals themselves. Like many illoricate rotifers, when preserved without adequate anesthetization bdelloids will contract into an unidentifiable mass of tissue, making it difficult, if not impossible, to identify (Wallace et al. 2015: p268). Thus, exploration of these fascinating animals requires live specimens. Moreover, they are not the easiest rotifers to identify even when relatively calm on the microscope slide. All of this results an incomplete study of the taxa leading to a continuation of the knowledge gap in our understanding of bdelloids. What the rotifer community needs is a strategy to rectify this situation. We believe that a good start to close this knowledge gap would be encourage readers of *Rotifer News* with this short contribution that provides a key to bdelloid genera[1].

Several workers have published keys that cover the bdelloids, chief among these are the following: Bartoš (1951, 1959), Donner (1965), Edmondson (1959), Fontaneto & De Smet (2015), Fontaneto et al. (2008), Koste & Shiel (1986), Kutikova (2005), Ricci & Melone (2000), Rudescu 1960, Wallace et al. (2006, 2010, 2015). Some of these are somewhat limited in their use as they go only to the level of genus, are regional in scope, difficult to obtain, or are written in a language with which many are unfamiliar. While we are not completely satisfied with any of these keys, at least as they pertain to the bdelloids, the key by Ricci & Melone (2000) to the level of genus offers one of the simplest and easiest (i.e., user-friendly) keys to begin the study of bdelloids. Here we offer readers of *Rotifer News* an updated version of a key to bdelloids based on some of the works cited above. It is our hope that it will stimulate the study of this small but fascinating group. We do not assert that our effort is a definitive review of the taxa; its intent is simply to kindle interest. Additionally, we recognize that controversies involving bdelloid taxonomy exist, but we chose not to specify them.

We encourage critiques of these keys and look forward to seeing better ones published in the scientific literature[1]. Thus, besides comments on, and corrections to, our dichotomous key, we are especially interested in the usefulness of developing a circular key to the bdelloid genera. In Figure 1, we offer an example of one that is based on the dichotomous key of Ricci & Melone (2000).

Key to identify bdelloid families and genera *

1 Stomach with easily recognized lumen, not resembling a frothy mass of food vacuoles…… 2
– Stomach without easily recognized lumen, gut resembles a frothy mass of food vacuoles (sometimes termed "pellets"); usually several teeth; Oviparous…….. Family **Habrotrochidae**
[Presence of oil droplets, often found in both bdelloids and monogononts, and symbiotic algae in the stomach wall of Family Ituridae (monogonont) may make this judgment difficult.]

2(1) Corona with 2 distinct trochal disks on raised pedicels ………………… Family **Philodinidae**
– Corona otherwise ……………………………………………………………………………. 3

3 (2) Corona as small, ciliated, slightly raised regions near mouth; pharynx, trophi protrusible; spurs present or replaced by medial caudal appendage; major teeth of trophi placed in the anterior half ……………………………………………………………………………… Family **Philodinavidae**
– Corona a ventral ciliated field; major teeth of trophi placed medially ……………………………. 4

[1]We remind readers of *Rotifer News* that this contribution should not be cited as a formal publication. Also, we request that it not be copied and used in a publication without the express permission of the authors. Please see the comment about licensing under the Creative Commons.

4 (3) Corona as a ventral pair of flat, posterior edge may possess a rake-like structure used to collect food; browsing the substratum; spurs present, 3 toes; oviparous or ovoviviparous§ ………………………………………………………………………………………………… Family **Adinetidae**
– Corona not as above, weakly bilobed; trophi nonprotrusible; spurs absent; 2 toes; 1 medial caudal appendage with short, terminal attachment structures (nibs) Family **Coronistomidae**

* – Once a diagnosis to the level of genus has been made, workers should consult publications that provide additional descriptions of the species (Bartoš 1951, Ricci & Melone 2000, Edmondson 1959, Donner 1965, Fontaneto & De Smet 2015, Wallace et al. 2006, 2010, 2016, 2019), as well as updates on their taxonomy: https://www.quekett.org/starting/microscopic-life/bdelloid-rotifers; Örstan & Plewka (2017, Örstan 2021). Images are available from the Rotifer World Catalog — URL = http://www.rotifera.hausdernatur.at/ — (Jersabek & Leitner 2013). For a detailed taxonomic treatment of all rotifers consult the List of Available Names for rotifers (Jersabek et al. 2018).

§ – In this key we use the term oviparous to mean that embryos, still within their egg shell, are released from their parent before they hatch and that ovoviviparous means that the young hatch from their egg shell within the parent and then are released as a functional offspring. Some authors refer to the latter as viviparity. Strictly speaking, there is no egg shell in the viviparity.

Family Habrotrochidae Harring, 1913

1 Corona with shelf-like ring present on pedicels (trochi)[1] running parallel to trochus; 6-10 teeth. … ………………………………………………………………………… *Otostephanos* Milne, 1916
– Corona without shelf-like ring. …………………………………………………………………. 2

2(1) Hood partially covering corona; 3–9 teeth. ……………………. *Scepanotrocha* Bryce, 1910

– Hood absent; trophi with numerous teeth; many species live in cases or nests (may be covered loosely with detritus). ……………………………………… *Habrotrocha* Bryce, 1910

[1] – Ricci & Melone (2000) use the term “trochi” when referring to the pedicels.

Family Philodinidae Ehrenberg, 1838)

1 Toes absent, attachment disk may be present ………………………………………………… 2
– Toes present: 2, 3, or 4 ……………………………………………………………………………… 4

2 Foot short (≤ ½ trunk length) ……………………………………………………………………… 3
– Foot long (≥ ½ trunk length); trophi with 2 teeth; epizoic within branchial chambers of fresh- and brackish water crabs. …………………………………………… *Anomopus* Piovanelli, 1903

3 Trophi with 2 teeth; epizoic on marine annelids and holothurians; ovoviviparous. …………… ……………………………………………………………………………… *Zelinkiella*[1] Harring, 1913
– Trophi usually ≥ 3 teeth; lacking toes, but possessing an attachment disk; some species epizoic; oviparous. ………………………………………………………… *Mniobia* Bryce, 1910

4 Foot with more than 2 toes ……………………………………………………………………………. 5
– Foot with 2 toes; trophi with 4 teeth.………………………………… *Didymodactylos* Milne, 1916

5 Foot with 3 toes ………………………………………………………………………………………. 6
– Foot with 4 toes ………………………………………………………………………………………. 7

6 Corona with large, lateral, elongate, conical projections (wing-like); 2–3 teeth.……………… ………………………………………………………………………………. *Ceratotrocha*[2] Bryce, 1910
– Corona not as above ……………………………………………………………………………………. 8

7 Integument stiff and armor-like ………… 9
– Integument not as above ………… 10

8 When present eyespots on rostrum; toes and spurs prominent; 2-3 teeth; ovoviviparous. ………… *Rotaria* Scopoli, 1777
– Body not as above; body wall possessing spines; oviparous. ……… *Macrotrachela* Milne, 1886

9 Integument sculptured possessing short spines; spurs long; many species possess eyespots; 2–3 teeth; ovoviviparous. ………… *Dissotrocha* Bryce, 1910
– Integument stiff and armor-like (sculptured); foot short with 4 toes, spurs short; usually 2 teeth; oviparous. ………… *Pleuretra* Bryce, 1910

10 Spurs long, flat and wide; foot ≥ ½ animal length; often epizoic on gills of gammarids; oviparous (cerebral eyespots absent) or ovoviviparous (cerebral eyespots present).. *Embata*[3] Bryce, 1910
– Spurs short or if long not flat and wide; foot ≤ ½ animal length; spurs short………… ………… *Philodina* Ehrenberg, 1830

[1] – To our knowledge no adequate illustration is available for this monospecific genus. This is a species in need of much study.
[2] – The keys of Bartoš (1951) and Edmondson (1959) position genus *Ceratotrocha* within the family Habrotrochidae.
[3] – *Pseudoembata acutipoda* Wycliffe & Michael, 1968 *species inquirenda*: oviparous with cerebral eyespots; epizoic on freshwater shrimps (*Caridina* sp.) warrants some additional examination: see Örstan & Plewka 2017.

Family Philodinavidae Harring, 1913

1 Corona poorly developed, pedicels short. ………… *Abrochtha* Bryce, 1910
– Pedicels of corona reduced or absent ………… 2

2 (1) Corona greatly reduced (not wheel-like) with cilia restricted to mouth region; foot with 2 short spurs. ………… *Philodinavus* Harring, 1913
– Corona comprising 2 small ciliated disks; spurs absent, caudal appendages present. ………… ………… *Henoceros* Milne, 1916

Family Adinetidae Hudson & Gosse, 1886

1 Body elongate, trunk widest (fusiform); corona with rake-like structure anterior to mouth used to help obtain food; foot distinct with 3 toes and 2 spurs; most species oviparous. ………… ………… *Adineta* Hudson, 1886
– Body short (stocky), head not wider than body; foot indistinct, lacking spurs, but terminating with numerous extensions (papillae). ………… *Bradyscela* Bryce, 1910

Family Coronistomidae Örstan, 2021

Non-protrusible trophi; monospecific. ………… *Coronistomus impossibilis* Örstan, 2021

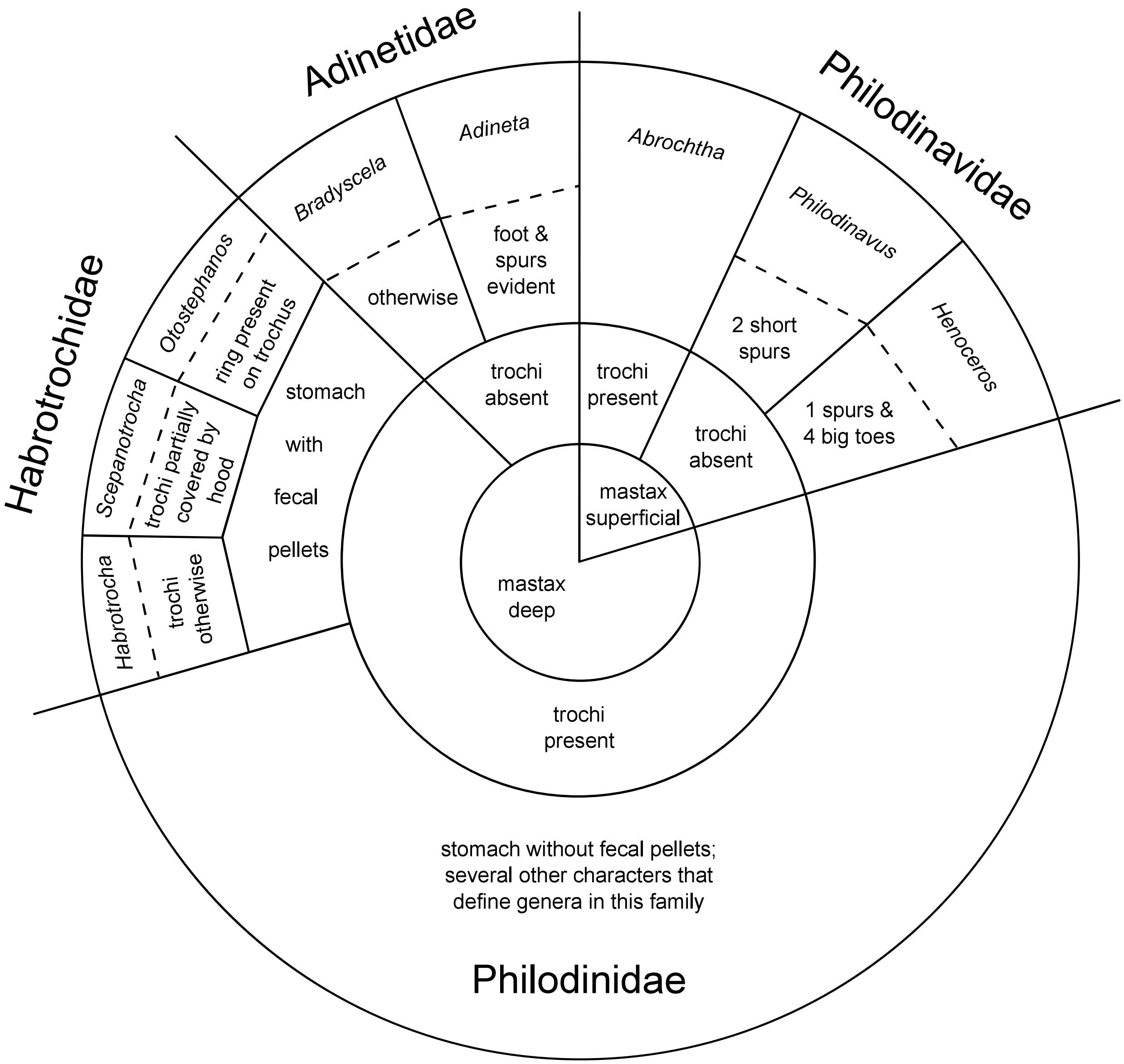

Fig. 1. A partial circular key to the genera of bdelloids based criteria employed by Ricci & Melone (2000).

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Notes and News

Two new records of interesting rotifers found in urban ponds in Aguascalientes State

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The Rotifera group has been studied in Aguascalientes State since 1987 with more than a thousand localities from different reservoirs, ponds and pools. These studies have reported 96 species belonging to 33 different genera. However, the rotifers of urban ponds in Aguascalientes have not been studied well.

Few studies have reported rotifer species from urban water bodies, despite being in contact with urban settlements. Some species of rotifers survive in these conditions. Two species in particular, *Heterolepadella ehrenbergii* (Fig. 1) and *Proalides tentaculatus* (Fig. 2), have been found in this type of environment. Such species have never been found in the locations mentioned in the previous lines, especially because such locations are of natural water bodies in most of the cases. It is interesting to observe that these two species appeared in these ponds within urban parks. These urban environments are significant because they serve as a refuge for species in the face of the loss of natural environments. Recent research has shown that they can contribute to the conservation of species at the regional level, these waterbodies act as "stepping stones" that facilitate the movement of some species through the landscape.

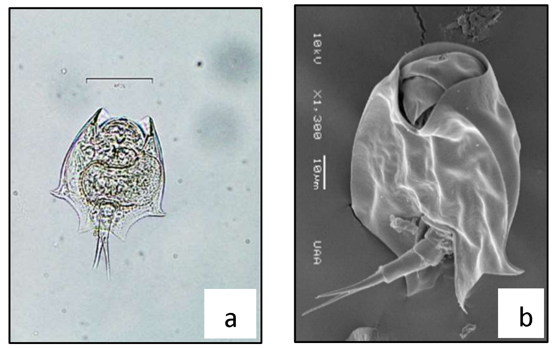

Figure 1. a) Digital micrography. b) SEM micrography. *Heterolepadella ehrenbergii* (Perty, 1850) showing its peculiar shape of the lorica, its prominent anterior and posterior aperture. Pseudo-segmented foot with two long asymmetric toes. Collected in Rodolfo Landeros Gallegos Park, Aguascalientes State. Source 1b: Araceli Adabache Ortíz.

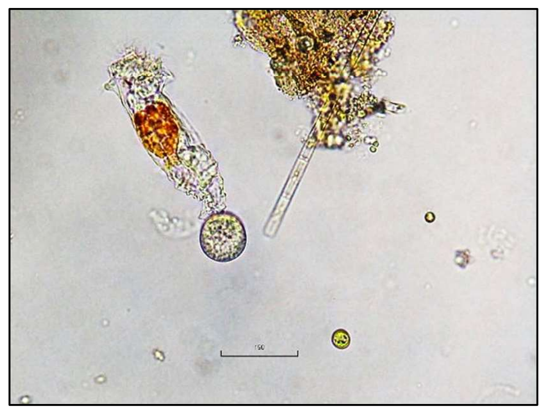

Figure 2. Digital micrography. *Proalides tentaculatus* de Beauchamp, 1907. No-loricated rotifer, showing the lateral antennae and an egg. Collected in Hidalgo Park, Aguascalientes States.

Other new records of rotifers are: *Collotheca ornata* (Ehrenberg, 1832) (Isla San Marcos Park), *Lecane decipiens* (Murray, 1913) (UAA pond), *Lecane arcula* Harring, 1914 (UAA pond) and *Lophocharis salpina* (Ehrenberg, 1834) (Rodolfo Landeros Park).

There are other urban ponds in the state that have not yet been studied well. On the basis of these recent results, there could be many other interesting rotifer species in this region.

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Unseen photos from the International Rotifer Symposia

Virtual Rotifer Collaboratorium (VRC)

CoVid-19 has made the past couple of years difficult, requiring quarantining or at least social distancing and wearing face masks; some have had to endure much worse. Many of us have had to teach our classes, attend conferences, and conduct meetings using online platforms such as Zoom. While they worked, seeing someone eye-to-eye is always better. Yet some thinking 'outside of the box' has helped keep us motivated and enthused. One such idea (suggested last year by LM), was to 'get together virtually' to discuss our recent research findings on rotifers. After discussing this with other colleagues, we got together for our first meeting in December 2020. It was great to see our friends and have a long overdue chat. The name for these sessions (suggested by RLW), Virtual Rotifer Collaboratorium: An online Rotifer Forum (VRC) and suggested a few topics that could be discussed during the VRCs. The zoom platform was hosted by UNAM – FES Iztacala (Mexico). We invited a few colleagues from all over the globe for a test of the VRC and, despite significant differences in time zones, all participants were enthusiastic about the trial run.

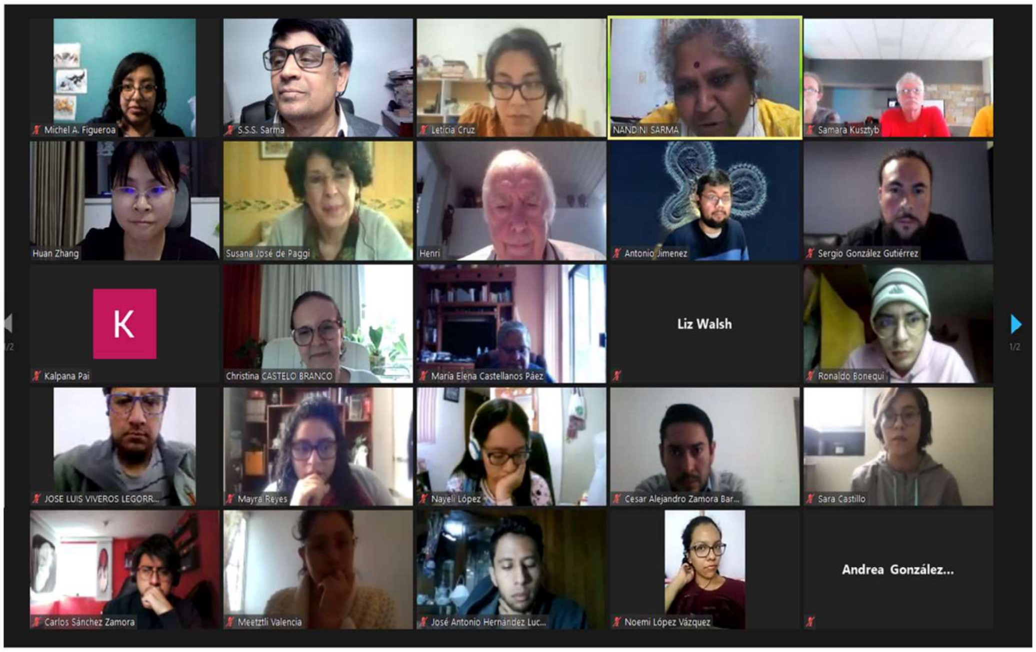
After the first couple of sessions, wherein we enjoyed 'meeting' and conversing with our friends, we began to invite speakers. A short presentation (~15–20 mins.) by an invitee was followed by a general discussion. The first talk, by Lars-Anders Hansson from Sweden, was on the morphology and population dynamics of rotifers in a fluctuating environment. At the next meeting, Christina Branco presented a talk on the Rotifers in Brazil. In the last session, we had back-to-back talks by Aydin Örstan and Natalia Iakovenko. Aydin spoke on "Working with bdelloids: morphological diversity and taxonomical adversity." Natalia spoke on "Another Sleeping Beauty: living bdelloid rotifer *Adineta* recovered from 24,000 years old permafrost."

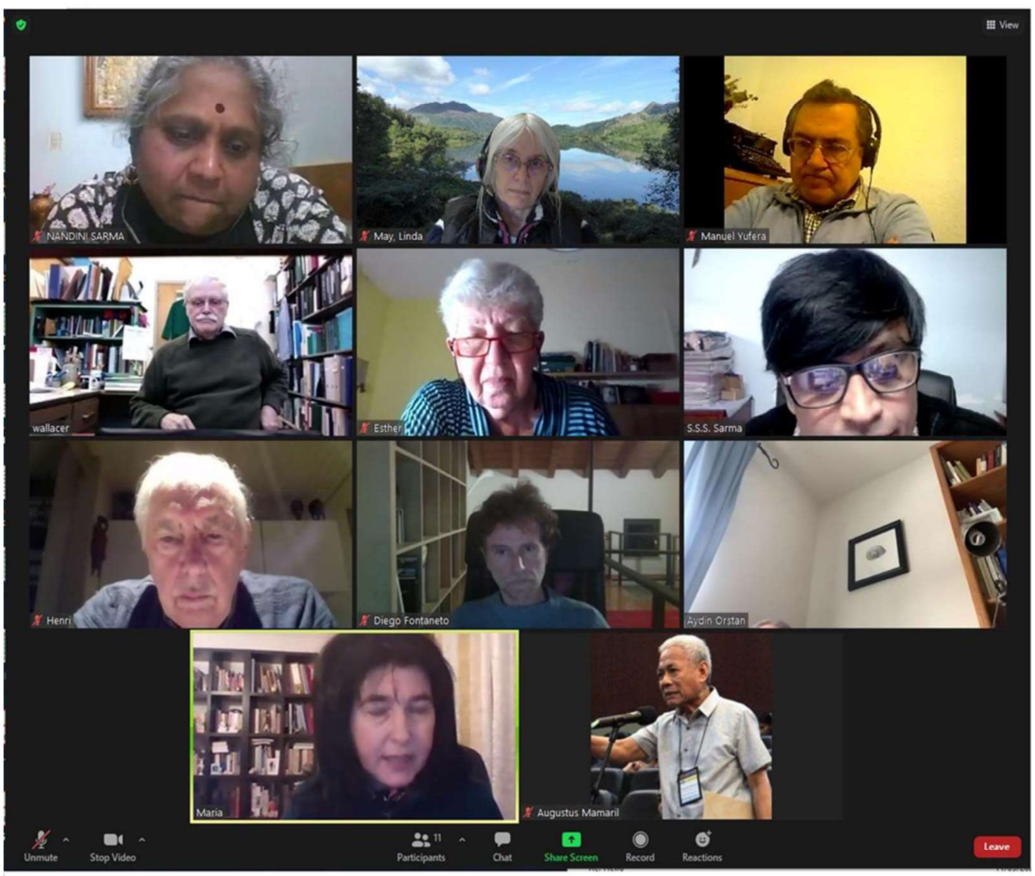
The VRC is a wonderful, informal forum to discuss rotifers. Through them old friendships are renewed and new ones established. Also, it has the potential for new collaborations to be formed. We do not intend the VRC to be a replacement for the International Rotifer Symposia, but its venue allows the participants to learn about exciting new results and then to extend that enthusiasm until the Rotifer Family meets again in Zagreb (Croatia) in the early fall of 2022. Until now the VRC meetings have been open by invitation only. This was not to be elitist; we did this to establish a procedure for the VRC and to work out the pitfalls of running an online meeting without much logistical support from Instructional Technology departments. Now that the network has become established we wish to open the meetings to all rotifer enthusiasts. If you would like to join us, please email *nandini@unam.mx* to request a Zoom link. Please think about offering to share some of your findings with the group on a date that is convenient to you.

We look forward to meeting you!

S. Nandini, Linda May & RL Wallace

VRC Zoom sessions in progress





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