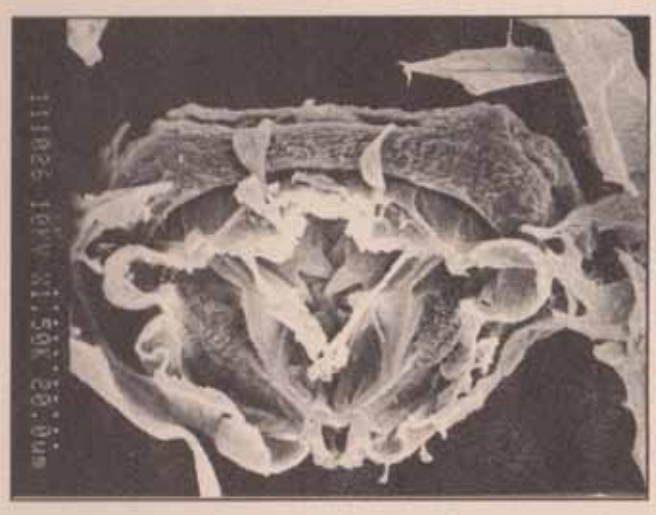
ROTIFER NEWS

A newsletter for rotiferologists throughout the world



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Rotifer News is a newsletter for professional and amateur investigators of the Rotifera. The newsletter is not part of the refereed scientific literature (e.g. *Limnol. Oceanogr., Freshw. Biol., Oecologia* etc) and should not be so cited. It is a means of informal communication between widely dispersed workers with a common interest, where news, abstracts, work in progress, requests, recent publications and so on can be advertised or circulated.

Rotifer News is produced at The Murray Darling Freshwater Research Centre once or twice a year, depending on contributions from readers and regional editors. Regional editors are listed below. Back issues of the newsletter are available from Bob Wallace or Russ Shiel on request. Assistance with production and mailing cost is always appreciated!

If you know of anyone who may wish to receive *Rotifer News* who is not presently on the mailing list, please pass on their address to the nearest regional editor

* * * * * *

Rotifer News contact addresses:

Production Editor: Russ Shiel, MDFRC, PO Box 921, Albury, NSW 2640 Australia. Ph: 61-60-431002; Fax 61-60-431626; e-mail: shielr@mdfrc.canberra.edu.au

Regional Editors:
Australasia: as above;

Europe, eastern: Jolanta Ejsmont-Karabin, Inst. Ecology, Ul Lesna 13, 11730 Mikolajki, Poland. Ph: 16051;

Europe, western & U.K.: Linda May, Inst. Freshw. Ecol., Inst. Terr. Ecol., Bush Estate, Penicuik, Midlothian EH26 0QB, Scotland. Ph: 031-445-4343; FAX 031 445 3943;
OR
Ros Pontin, 26 Hermitage Woods Cres., St Johns, Woking, GU21 1UE U.K. Ph: 04867-81564;

North America: Bob Wallace, Dept Biology, Ripon College, 300 Seward St, Ripon WI 59471-0248 USA. Ph: 414-748-8122; FAX 414-748-7306; e-mail WALLACER@ACAD.RIPON.EDU

Scandinavia: Peter Andersen, Zoologisk Museum, 2 Dep., Universitetsparken 15, DK2100 Copenhagen, Denmark. Ph: 313-541-11262; FAX 0045-313-98155;

South Africa: Bob Brain, Transvaal Museum, P.O. Box 413, Pretoria, Sth Africa 0001. Ph: 322-7632; FAX 27-12-322-7939;

South America: David Kuczinski, Univ. de Moron, Fac. Ciencias, Cabildo 134, Moron 1708, Buenos Aires, Argentina. Ph: 629-2404 y 6127;
OR
Susana Jose de Paggi, Inst. Nac. de Limnologia, Macia 1933, 3106 Santo Tome, Santa Fe, Argentina. Ph: 70152-70723.

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The cover: **Transverse section of *Brachionus plicatilis*.**
SEM micrograph from Walter Kleinow
Zool. Inst., Univ. Köln

Editorial

This issue of *Rotifer News* includes the list of participants and abstracts submitted for the VIIIth Rotifer Symposium, Collegeville Minnesota, USA, June 22-27 1997. The combined abstracts booklet/newsletter will be mailed out to non-attendees after the Minnesota meeting. Non-attendees are reminded that subscriptions for the continuation of *Rotifer News* will be collected at the meeting. If you are able to support the newsletter as a global means of informal communication between workers on the Rotifera, please forward your subscription to one of the regional editors, or to me, the production editor, at the address shown opposite. The requested subscription of $US10/yr covers 2 issues airmailed. The newsletter will continue to be produced in hard-copy while there is a perceived need for it. The possiblity of an electronic copy via the WWW will be discussed at the Minnesota meeting. News on that in issue #30. Finally, apologies for any errors/omissions in the list of participants/abstracts, which arrived via e-mail courtesy of Liz Wurdak. Mistakes therein are mine! Some editorial licence has been taken to reduce or re-format lengthy abstracts to a more appropriate size for this booklet. *Rotifer News* content is a little truncated for this issue, but hopefully the mass of incoming contributions from you, the readership, will bring Issue 30, Dec. 1997, back up to strength. Cheers to all for a successful Minnesota meeting!

Russ Shiel

Rotifer VIII - Minnesota, June 22-27 1997

PARTICIPANTS

The following list of participants was complete at the time of writing. The number(s) in parentheses refers to the abstracts with which they are involved.

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ABSTRACTS

Abstracts for oral and poster presentations are listed alphabetically by senior author. If titles or author addresses are not given they were not supplied with the abstract.

1. The role of male-producing mictic females in rotifer sexual reproduction

Eduardo Aparici, Maria Jose Carmona and Manuel Serra
Departament de Microbiologia i Ecologia. Universitat de Valencia, E46100-Burjassot. Spain

A better knowledge of the demography of the period between mixis induction and resting-egg production is needed in order to improve our understanding of optimal patterns of mixis and optimal allocation of resources to sexual reproduction in rotifers. Here we briefly review several theoretical and

empirical studies focused on the role of male-producing mictic females. Our main conclusions are:
(1) Mate-competition may modify the optimal timing of mixis causing an early mixis than expected in absence of such a competition. In blooms of mixis, early mictic females may produce males with high chances of copulation despite that early mixis would decrease resting egg production in the whole population.
(2) Frequency of male-producing mictic females, relative tototal mictic females, is dependent on the density of total mictic females, but this dependence is lower at high mictic female density.
(3) Sex allocation problem in rotifers is the problem of how frequently the fertilization of mictic females should be, since non-fertilized mictic females produce males. Theoretical analysis predicts an equal number of male-producing mictic females and resting egg producing mictic females, a result which can be interpreted as an even allocation to male and female function. The empirical data support the prediction for an even sex allocation.

2. Rotifer assemblages in relation to morphometry and trophic status in small doline lakes

X. Armengol, E. Vicente & M.R. Miracle
Departament de Microbiologia i Ecologia, Universitat de Valencia, 46100 Burjassot, (Valencia, Spain)

The planktonic rotifer community of 27 small doline lakes in different substrates (dolomites and gypsum rich marls) on the karstic area near Cuenca (Spain) were compared. Samples were taken in two periods, spring and late summer-early autumn of 1992, using transparent Van Dorn bottles at different depths of the vertical profile.

A total of 52 species were identified in these samples, in which a small proportion of littoral species was also found specially in shallower lakes. Some of the most frequent species were *Anuraeopsis fissa, Keratella quadrata, Polyarthra dolichoptera, Hexarthra* spp., *Synchaeta* spp. and *Asplanchna girodi*.

Several ecological descriptors such as rotifer density, relative density with respect to the total zooplankton, presence of littoral rotifers and diversity, as well as species composition, have been related to lake morphometry, degree of stratification, turbidity and trophic level.

3. Competition Between *Bosmina longirostris* and *Keratella cochlearis*

Baio, C. & M. J. Boavida, Dept. Zoologia, Fac. Ciencias Univ. Lisboa, Campo Grande, C2, 3BAPiso, 1700 Lisboa, Portugal

Previous work has showed some evidence of possible competition interactions between *Bosmina longirostris* and *Keratella cochlearis* in Meimoa Reservoir (Portugal). In this work we tested the hypothesis of possible competition interactions between these two species. Laboratory experiments were conducted at 20BAC with individuals collected at the same time in Meimoa Reservoir. As food we used a suspension of *Chlorella* sp. in different concentrations. For each concentration of food we tested several densities of *Bosmina longirostris* and *Keratella cochlearis* that were estimated from different samples collected in different seasons of the year.

4. New records of sessile Rotifera from freshwater fish ponds of Tripura, India with notes on ecological niche

Sukanta Banik
Freshwater Aquaculture Research Unit, Department of Life Sciences, Tripura University, Agartala 799 004, Tripura, India.

This presentation provides information on the ecological niche characteristics of the studied species. The niche conditions are found to be very specific. Further, this study adds 13 rotifer species to the known sessile rotifer fauna of India: *Beauchampia crucigera* (Dutrochet), *Limnias melicerta* (Weisse), *Octotrocha speciosa* (Thorpe), *Ptygura longicornis* (Davis), *P. crystallina* (Ehrenberg), *P. beauchampi* (Edmondson), *P. pilula* (Cubitt), *Sinantherina ariprepes* (Edmondson), *S. socialis* (Linn.), *Conochilus hippocrepis* (Schrank), *Stephanoceros fimbriatus* (Goldfusz), *Cupelopagis vorax* (Leidy) and *Acyclus inquietus* (Leidy).

5. Size-structure dynamics of the rotifer chemostat: some experimental observations

Martin Boraas[1], Dianne Seale[1], Joseph Boxhorn[1] and James McNair[2]
1. Department of Biological Sciences University of Wisconsin at Milwaukee P.O. Box 413 Milwaukee, WI 53201
2. Patrick Center for Environmental Research The Academy of Natural Sciences of Philadelphia 1900 Benjamin Franklin Parkway Philadelphia PA 19103

Understanding mechanisms regulating population growth is facilitated by conducting experimental studied under known conditions in a controlled environment. Studies of unicells have shown that step changes in the environment of a steady-state continuous culture result in very revealing transient dynamics in the population as it approaches a new steady state, particularly with respect to size and age structure. Comparable animal studies are rare. Due to their short generation time, rotifers are ideal for this type of study. In a continuous culture, the dilution rate (medium flow rate/culture volume) equals the steady-state specific growth rate and a constant size structure of the cultured population. Data in this paper show that step shifts in the dilution rate are followed by predictable changes in the size distribution of the rotifer population as a new steady state is approached. In a companion paper (McNair, *et al.*, this symposium), a minimum structured model is presented that appears to account for these observations.

6. Investigation of the toxicity of the chrysophyte flagellate *Poterioochromonas malhamensis* to the rotifer *Brachionus angularis*

Joseph E. Boxhorn[1], Dale A. Holen[2] and Martin E. Boraas[1]
1. Department of Biological Sciences, University of Wisconsin -- Milwaukee
2. Department of Biology, Pennsylvania State University -- Worthington-Scranton

The toxicity of the chrysophyte flagellate *Poterioochromonas malhamensis* to the rotifer *Brachionus angularis* was investigated. Fed rotifers exposed to the flagellate experienced a mortality rate indistinguishable from starvation. Unfed rotifers exposed to the flagellate experienced a higher mortality rate. The mortality rate appears to depend on the flagellate concentration. Higher doses of flagellates resulted in quicker rotifer death. These laboratory results

are consistent with the hypothesis that the occurrence of *B. angularis* in the field may be negatively related to the presence of *P. malhamensis* and related flagellates.

7. Animal size and survival after desiccation.

Manuela Caprioli, Simona Orsenigo, Claudia Ricci
Dept. Biology, State University of Milan, Milan, Italy

Most belloid rotifers are adapted to survive desiccation of their habitats by entering anhydrobiosis, but the recovery ability changes with the species, with the strain and with the animal's condition. In particular the age of the rotifer influences its recovery, and this may be related to either physiological situation (i.e. reproductive activity) or size. Actually it has been found that the recovery capacity is generally lower for the young than for the mature; then the pre-reproductive phase could represent a critical time period and the rotifer should "hurry through" it. To do so, the volume of the egg could play a key role: from a bigger egg a bigger newborn can hatch that requires less resources and/or shorter time to reach the reproductive phase. To test this hypothesis, the volumes of the egg and of the adult of 7 belloid species are related to their capacity to recover successfully after 7-d-anhydrobiosis.

8. The feeding behavior of *Brachionus calyciflorus* (Rotifer) under toxic stress. I. effects of the experimental conditions.

Charoy C.[1], P. Lanterf[2] and C. Janssen[3]
1. Laboratoire de Trajectomtrie, Comportements et Connaissances - Bt. 403 University of Lyon 1 - 43, Bd. du 11 Novembre 1918 - 69 622 Villeurbanne Cedex (France)
2. Laboratoire de Chimiomtrie - Bt. 308 C.P.E. - University of Lyon 1 - 43, Bd. du 11 Novembre 1918 - 69 622 Villeurbanne Cedex (France)
3. Laboratory for Biological Research in Aquatic Pollution - University of Ghent, J. Plateaustraat, 22 - 9000 Ghent (Belgium)

Changes in feeding behavior of *Brachionus calyciflorus* (Rotifera) exposed to sublethal concentrations of copper were examined according to different experimental conditions. Filtration (F) and ingestion (I) rates were measured in different combinations of 6 experimental variables (age of rotifer, temperature, food-availability, mode of toxic supply: waterborne-Cu vs dietary-Cu, exposure time and concentration of copper) according to a factorial pattern associated with a multiple regression analysis.

The mode of copper supply causes the main average changes in toxicity (23% and 15% of the whole variation for F and I criteria respectively). Moreover, only waterborne-Cu affects the feeding behavior of the rotifers. Temperature is the 2nd source of toxicity variation. Toxic stress increases with the temperature (5,5% and 8,7% of the whole variation for F and I criteria respectively). Although the direct effects of the other environmental variables on the copper toxicity are less pronounced, they can contribute through interactions.

This study emphasizes the necessity of considering not only the direct effect of each environmental variable on the variations of toxicity, but also the interactions between them in order to make relevant extrapolations of short-term laboratory test responses to real world situations.

9. Distribution, population dynamics, and functional role of *Habrotrocha rosa* in *Sarracenia purpurea* pitcher communities.

Liane Cochran-Stafira
Department of Ecology and Evolution,
University of Chicago, Chicago, IL 60637, USA

While unidentified rotifers have frequently been observed living as inquilines in the leaves of the northern pitcher plant *Sarracenia purpurea*, the bdelloid species *Habrotrocha rosa* has previously been confirmed only from Newfoundland and a single site in the United States. In an effort to determine whether this species functions as an endemic mutualist in the pitcher food web, I sampled pitchers throughout much of the range of *S. purpurea* in the US and Canada. *H. rosa* was isolated from approximately 30% to more than 80% of pitchers sampled at each site. Field and laboratory studies indicate that populations of *H. rosa* are regulated by larvae of the mosquito Wyeomyia smithii via competition and intraguild predation, and possibly through predation by larvae of the midge *Metriocnemus knabi*. In laboratory reconstructions of the pitcher food web, H. rosa fed primarily on bacteria and fine detritus particles. Observations of freshly collected rotifers from natural pitchers indicates that they also feed on very small mixotrophic chrysophytes when present, but in laboratory studies *H. rosa* did not have a significant impact on the protozoan community. Bacterial community structure was significantly affected directly by rotifer grazing and indirectly through higher interactions among all food web components. These observations suggest that *H. rosa* is an important component of the pitcher food web.

10. Spatial patterns in birth rates of two coexisting rotifers: vertical differences

Jose M. Conde-Porcuna and R. Morales-Baquero
Departamento de Biologia Animal y Ecologia, Facultad de Ciencias, Universidad de Granada, E18071 Granada, Spain.

The vertical distribution of two rotifer populations (*Keratella cochlearis* and *Anuraeopsis fissa*) and their birth rates were studied in a mesotrophic reservoir (Bermejales, South of Spain) during an annual cycle and, after that, in a high frequency sampling performed during spring. Birth rates of both species were analyzed in relation to food availability, temperature and water transparency. Birth rates of *A. fissa* were higher at surface waters than under the photic zone regardless of food conditions, although-h there were no differences of density with depth. Birth rates and densities of *K cochlearis* did not show differences with depth. The results seem to show different strategies of rotifers depending of the characteristics of the system.

11. Diel variation in egg-ratio of *Hexarthra Bulgarica* in the high mountain lake La Caldera (Spain)

L. Cruz-Pizarro[1], J.M. Conde-Porcuna and P. Carrillo
1. Instituto del Agua. Universidad de Granada. 18071 Granada. Spain; Dpto. Biologia Animal y Ecologia. Universidad de Granada. 18071 Granada, Spain.

Hexarthra bulgarica is the dominant species in the lake La Caldera (South of Spain) both in number of individual and in biomass. This species shows a nocturnal vertical migration and a simultaneous diel horizontal movement.

In the present study, a detailed 24 hour sampling program was carried out at 4 depths in 6 stations located along two main transacts of lake La Caldera. The results show the existence of rhythmicity in oviposition of amictic and mictic eggs by H. bulgarica. Time of the day has a significant influence on the oviposition of amictic eggs and resting eggs of this rotifer. The number of resting eggs per female increases during night. We try to go deeply into the relationship between these diel variations and the migratory movements of the animals suggested by Gophen (1978). In addition to this, diel variation in egg-ratio of *H. bulgarica* was also analyzed in relation with vertical migration of the copepod *Mixodiaptomus laciniatis*.

12. Rotifers from Victoria Island (Northwest Territories, Canadian Arctic)

Willem H. De Smet and L. Beyens
Department of Biology, University of Antwerp, R.U.C.A.-campus, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium

Analysis of 15 samples collected from 13 freshwater bodies in the region of Cambridge Bay, Victoria Island, NWT, Canada (69 degrees 070N, 105 degrees 030W), yielded 112 taxa (4 Bdelloidea, 107 Monogononta) of rotifer, providing new occurrence records for Canada and the American Continent. Overall, the majority of the fauna consists of cosmopolitan, cold-stenothermal species, together with four arctic endemics. Some rare and new species are described and illustrated. Comments are presented on the history of the rotifer community composition in the N. American Arctic.

13. Influence of environmental variables on rotifer assemblage in a man-made lake.

Miloslav Devetter
Faculty of Biology, University of South Bohemia, Branisovska 31, Ceske Budejovice 370 05, Czech Republic

Seasonal changes of planktonic rotifer community were evaluated in a Czech eutrophic reservoir in relation to 17 environmental variables. Three year time courses of rotifers during vegetative periods 1993-1995 were analyzed. The seasonal dynamics of rotifers in all three studied years was characteristic by two distinctive seasonal aspects. The spring peak, with maximum year densities and species diversity, was dominated by *Keratella cochlearis, K. hiemalis, K. quadrata* and *Polyarthra dolichoptera*. The later summer-autumnal peak, or several smaller peaks of about half density than the spring one, was formed mainly by *Keratella cochlearis, Trichocerca similis* and *Polyarthra vulgaris*. The separation between these two peaks coincided with the decline of phytoplankton and development of clear-water phase in this reservoir. Using unconstrained principal component analysis of all rotifer data two associations of species was possible to identify. These corresponded to above mentioned seasonal aspects, where grouping of spring species was better pronounced. In a more sophisticated standardized redundancy data analyze all measured environmental variables were constrained with repect to the rotifer variables. This method identified biomass of Copepoda, biomass of phytoplankton <20 μm, surface temperature, total nitrogen, density of heterotrophic nanoflagellates and BOD5 (<40 μm) as a dominant gradients. The first two ordination axis explaining 85.2% of cumulative percentage

variance of species - environment relationship and 38.9% of species data. High correlation with total rotifer density has Copepoda biomass and BOD5.

14. Colony size in *Conochilus hippocrepis*: defensive adaptation to predator stage sizes.

Maria Dieguez & Esteban Balseiro
Centro Regional Universitario Bariloche. Universidad Nacional del Comahue, Unidad Postal Universidad. 8400, Bariloche, Argentina

The zooplankton of the shallow temporary pond Laguna Fantasma is an interesting assemblage of large species that contrasts with the zooplankton size spectrum of the deep Andean lakes.

During the hydroperiod of 1994, we studied the development of colonies of Conochilus hippocrepis in relation to the life cycle of the predaceous calanoid *Parabroteas sarsi*. We analyzed the changes of individuals per colony, colony diameter and density of *C. hippocrepis* in relation to body size, mouthpiece size and density of the predaceous copedod Psarsi.

P. sarsi has an univoltine cycle in the pond, and during the study Conochilus coexisted with calanoid copepodites and adults. Colony size had a positive correlation with predator body size. Colonies adjusted their size to the coexistent stage of Parabroteas and particularly to maxilliped size. These results are consistent with the fact that Parabroteas increases the capacity of capture and eat larger preys during its development. Coloniality is an effective adaptation for *Conochilus* against *Parabroteas* and colony size has a great plasticity as a defensive character against changes in predator size and feeding abilities.

15. Influence of food resources on body size of *Keratella cochlearis* (Gosse) in a small Andean lake

Maria Dieguez, Beatriz Modenutti and Claudia Queimalinos
Centro Regional Universitario Bariloche. Universidad Nacional del Comahue. Unidad Postal Universidad. 8400. Bariloche, Argentina.

Morphometry of *Keratella cochlearis* was analyzed in Laguna Ezquerra, a small lake of South Andes, in relation with food availability. Phytoplankton and zooplankton samples were taken every week during a spring-summer period (October 1988-March 1989). *K. cochlearis* was present over the entire study, but it was most important in spring (99% of total rotifer density). Three morphs were distinguished: *cochlearis, tecta* and *micracantha*. Phytoplankton was largely (>90%) made up of flagellates, *mainly Rhodomonas lacustris* and *Chrysochromulina parva*, except in November *when Stichogloea doederleinii* and in March when *Asterionella formosa* were observed. The biovolume of the algal cells less than 20 pm GALD was taken as a measure of the food resources. Significant relationships between temperature and the morphometric parameters: loriga vadth (LW), loriga length (LL) and total length (LT), were obtained. The maximum variations of the loriga parameters were observed during November-December, in coincidence with the greatest changes in the phytoplankton community. We also found a significant correlation between LL, LW and nanoplankton biovolume. The observed variation of LL and LW was fitted to an exponential model. The obtained model parameters would indicate that nanoplankton biovolume fluctuations

have a similar effect on LL and LW. On the contrary, the posterior spine length was independent from changes in temperature and food resources.

16. Structural analysis of a mate recognition glycoprotein (gp29) in rotifers

Brian J. Dingmann and Terry W. Snell
Georgia Institute of Technology, Atlanta, GA 30332, USA

Sexual communication in rotifers is mediated by random contact chemoreception. Male rotifers identify conspecific females by means of a pheromone localized on the corona of the females. A glycoprotein (gp29) involved in conspecific mate recognition in rotifers has been isolated from *Brachionus plicatilis* O.F. Muller and characterized. The protein portion has been shown to be essential for mate recognition. Removal of the protein portion of gp29 by Proteinase K depressed mating activity of males with conspecific enzyme-treated females. Amino acid compositional analysis has revealed that methionine and glycine compose roughly 30 percent of the protein. The N-terminal domain sequence of the protein will now be presented and the design of PCR primers for the gp29 gene will be described. N-terminal amino acid sequence homologies with published amino acid sequences will be examined. This information will contribute to understanding how the chemical structure of the mate recognition pheromone of rotifers is used by males to discriminate conspecific females.

17. Rotifers in relation to littoral ecotone structure in Lake Rotomanuka, New Zealand.

I. C. Duggan[1], J. D. Green[1], K. Thompson[1] and R. J. Shiel[2]
1. School of Science, University of Waikato, Private Bag, Hamilton, New Zealand; 2 Murray- Darling Freshwater Research Centre, P.O. Box 921, Albury, N.S.W. 2640, Australia.

The spatial and temporal dynamics of rotifers from the littoral ecotone of Lake Rotomanuka were studied over a period of 10 months from February to November 1994. Rotifer samples were taken at two weekly or three weekly intervals by use of artificial substrates from eight predetemined sites, chosen with respect to macrophyte species distribution from shallow to deep water. 61 species of rotifer were found, a value which is high in comparison with those from New Zealand limnetic communities. Predominant rotifer species were *L. bulla*, and *T. parva*. Total rotifer peak abundances were found in summer within emergent and submerged vegetation (when shallow regions were dry). The various rotifer species showed differing spatial and temporal dynamics within the littoral, though 3 major groupings, based on temporal occurrence, were distinguished by cluster analysis and correspondence analysis: summer-autumn (e.g. *L. bulla, L. hornemanni*), winter-spring (e.g. M. mucronata, *T. porcellus*), and another group abundant from late autumn to mid spring (e.g. *T. parva, P. vulgaris*). Temporal variability of abundant rotifer species was found to be far greater than spatial variability. Canonical correspondence analysis indicated that temperature change was the factor most strongly associated with the temporal distribution of rotifer species, while macrophyte species composition appeared to play the major role in determining spatial distribution. Macrophytes influenced spatial rotifer distribution both directly and indirectly: directly through the physical structure of the macrophyte species present and indirectly by producing

variations in physico chemical conditions (e.g. oxygen and pH) and by preventing mixing between shallow and deep water.

18. Feeding preference and population growth of *Asplanchna brightwelli* (Rotifera) offered two non-evasive prey rotifers

H.J. Dumont, S.S.S. Sarma & S. Nandini**
*Laboratory of Animal Ecology, University of Gent, K. L. Ledeganckstraat 35, B-9000, Gent, Belgium. *(Present address) Lab. de Zoologia, UNAM Campus Iztacala, Los Reyes, AP 314, CP54090 Tlalnepantla, Edo. de Mexico, Mexico.*

Population growth rates of the predatory rotifer *Asplanchna brightwelli* were determined at 25 °C using a large (*Brachionus calyciflorus*) and a small (*Anuraeopsis fissa*) rotifer prey species in three concentrations (0.5, 0.1 and 2.0 (g dry weight per ml) and in five combinations. The prey ingestion time by the predator was also measured. For B. Calyciflorus the ingestion time (22.97(8.95 s) was more than six times that of *A. fissa* (3.68(0.93 s). Regardless of prey type, the population growth of *Asplanchna* increased with increasing food density. The maximum rate of population growth (1.01(0.10 per day) was higher at high density of *A. fissa* prey than that at the same density of *B. calyciflorus*. Gut content analysis of *A. brightwelli* revealed that the number of prey ingested increased with increasing prey densities:

19. Effects of contrasting land Use on rotifer communities of streams in Masurian Lakeland, Poland.

Jolanta Ejsmont-Karabin [1], Marek Kruk[2],
1 Institute of Ecology, Polish Academy of Sciences, Hydrobiological Station, Lesna str. 13, 11-730 Mikolajki, Poland
2 Academy of Agriculture and Technology, Department of Water Protection and Inland Fisheries, Oczapowskiego 5, 10-957 Olsztyn, Poland

The influence of land-use patterns on rotifer communities of streams in Masurian Lakeland, Poland, was examined. Six streams in forest area and two streams in agricultural area were sampled monthly from March 1995 to October 1996. In all 41 genera and 139 species (I.e. ca. 30% of all records of all rotifer species in Poland) were collected and identified. Of these four species were new for Poland. Rotifer numbers in the forest streams were 10 times higher than in the streams in agricultural area. The forest streams were also more abundant in species, both their total number recorded in particular streams (67 in forest and 27 in agricultural ones), as well as the mean number of species recorded in one sample (14 and 4 species, respectively). As a result the values of ShannonUs diversity index were markedly higher (2.45 in average) in the forest streams than streams from agricultural areas (1.49). The streams differed also in their list of dominants. The forest stations were dominated by planktonic rotifers like *Keratella cochlearis, Polyarthra dolichoptera, Anuraeopsis fissa, Keratella testudo, Polyarthra vulgaris, P. remata*, whereas littoral species dominated in streams in agricultural area. *(Lecane closterocerca, Colurella adriatica, C. colurus, C. obtusa, C. uncinata*). The studied communities were characterized by persistence in time of composition and diversity characteristic for particular streams.

20. Rotifer communities and pH conditions: a comparison of long-term patterns in a whole-lake acidification experiment and several unmanipulated lakes in Wisconsin, USA.

Thomas M. Frost, P.K. Montz, B.L. Sanderson, S.E. Arnott
Center for Limnology, University of Wisconsin-Madison
and M.J. Gonzalez
Wright State University, Dayton, Ohio, USA.

Rotifer communities can thrive in acidic conditions. Little Rock Lake (LRL) in northern Wisconsin has been the site of a large-scale experiment that began in 1984 and continues at the present time. It was divided into a reference basin and a treatment basin that was acidified in three, two-year stages to pH 5.6, 5.2, and 4.7. Acid additions were completed in 1990 and recovery has been monitored since that time. LRL's treatment basin has undergone substantial shifts in its rotifer community over the course of the experiment. The relative biomass of rotifers in the zooplankton community increased markedly with acidification. *Keratella taurocephala* became the dominant species during the pH 4.7 phase and occasionally made up more than 80% of total rotifer biomass. Recovery has been marked by a decrease of *K. taurocephala* and the proportional biomass of rotifers but the treatment basins zooplankton community is still distinctly different from that in the reference basin. Here we contrast the LRL rotifer community with that in nearby lakes to test the hypothesis that acidification shifted it from a composition characteristic of dilute, clear-water lakes to that of naturally acidic bog lakes and determine the type of community that is developing with recovery.

21. Morphotypical diversity and morphometric characteristics of *Keratella cochlearis* (Gosse, 1851) in lakes of Belarus

Galina A. Galkovskaya , Institute of Zoology ASB

The instantaneous morphotypic structure and morphometric characteristics of *Keratella cochlearis* in lakes of Belarus are investigated. The number of morphotypes in the populations decreased with the increase of the trophic degree of lakes. The curves of lorica length frequencies of *K. cochlearis cochlearis* had the polymodal form in different strata of stratified lakes. Polymodal curves are examined as a mixture of separate generations. The morphotypical diversity and morphometric characteristics of *K. cochlearis* are discussed in connection with the functional resistance and stability of populations

22. Molecular analyses of the relationship between rotifers and acanthocephalans.

James R. Garey[1], Thomas J. Near[2], Michael R. Nonnemacher[1], Ryan D. Landefeld[1] and Steven A. Nadler [3]
1Department of Biology, Duquesne University, Pittsburgh Pa 15282, 2Center for Biodiversity, Illinois Natural History Survey, Champaign, IL 61820, 3 Department of Nematology, University of California, Davis, Davis, CA 95616.

Rotifers are free-living animals that are usually less than 1 mm and possess a characteristic wheel organ. Acanthocephalans are larger endoparasitic animals that use vertebrates and arthropods to complete their life cycle.

Lorenzen (1985) suggested that acanthocephalans share most recent common ancestry with rotifers of the class Bdelloidea based on cuticular structure and the presence of lemnisci found in some bdelloid rotifers and all acanthocephalans. Winnepenninckx *et al.* (1995) found evidence for a close association of rotifers and acanthocephalans based on nuclear 18S rRNA gene sequence information, and Garey *et al.* (1996) demonstrated with a more complete 18S rRNA gene sequence data set that representatives of all three acanthocephalan classes appear to share an immediate common ancestor with bdelloid rotifers. We now present additional evidence from the mitochondrially encoded 16S rRNA gene that acanthocephalans share an immediate common ancestor with bdelloid rotifers. Therefore, both morphological and molecular data from a variety of characters and genes supports the placement of the acanthocephalans as a sister class to Bdelloidea under the superclass Lemniscea within the phylum Rotifera.

23. Differential sensitivity of *Synchaeta* and *Daphnia* to nucleoside analogs from the cyanobacterium *Anabaena affinis* .

John J. Gilbert
Department of Biological Sciences, Dartmouth College, Hanover, New Hampshire 03755, USA.

Toxic cyanobacteria may influence the species structure of freshwaterzooplankton communities by differentially affecting the various species present. Different zooplankton species may vary in their ability to ingest the cyanobacteria and become exposed to the toxins, and they may vary in their susceptibility to assimilated toxins. The cyanobacterium *Anabaena affinis* contains two pyrrolo [3,2 d] pyrimidine derivatives that are toxic to the cladoceran *Daphnia pulex* but not to the *rotifer Synchaeta pectinata*. Three-day LC50 values for compound 1 (9 deazaadenosine 5U-a -D-glucopyranoside) and compound 2 (9-deazaadenosine) were 1.33 and 0.56 ug ml-1) for one clone of *D. pulex* and 0.79 and 0.54 µg ml-1 for a second clone of this species. Much higher concentrations of compounds 1 (3.6 ug ml-1) and 2 (2.2 µg-1) had no effect on the survival or reproduction of *S. pectina* over a three day period. The striking insensitivity of this rotifer to A. affinis endotoxins is curious, because the rotifer is very unlikely to ingest A. affinis filaments and hence to have evolved resistance to the toxins. This study suggests that blooms of some cyanobacteria may inhibit cladocerans without affecting rotifers, and thereby increase the ability of rotifers to coexist with competitively dominant cladocerans.

24. Mate choice in male *Brachionus plicatilis* rotifers

Africa Gomez and Manuel Serra
Departament de Microbiologia i Ecologia, Universitat de Valencia, E46100, Burjassot (Spain)

Some proximate mechanisms that increase the probability of successful male copulation are examined in *Brachionus plicatilis* (Rotifera). Using behavioral tests, we analyzed first whether male choice exists concerning female age. Second, we examined male direct discrimination of sexual (mictic) and parthenogenetic (amictic) females on the basis of male behavior after encountering both kinds of females. Results showed that the probability of male mating initiation decreases with the age of female, and that males

copulate almost exclusively with females less than 24 h old. Preference for sexual females was also found in the probability of mating initiation, but no preference for copulating sexual females was found. As only young, sexual females are fertilizable, these mechanisms would enhance the likelihood of a male copulating with a sexually receptive female, and, thus, male fitness. A theoretical model shows that the surprisingly low degree of male preference for sexual females can be adoptively explained on the basis of relative frequency of young females and mictic females in the population when the sexual phase occurs.

25. Spatial segregation between rotifers and cladocerans mediated by *Chaoborus*

M. J. Gonzalez
Wright State University, Dayton OH, 45435.

I analyzed the diel vertical migration of three rotifer species (*Kellicottia longispina, Keratella cochlearis* and *Polyarthra* sp.) in the presence and absence of *Chaoborus* using field enclosures (10 m deep). I calculated abundance, mean depth and spatial overlap of each rotifer with three *Daphnia* (*D. pulicaria, D. rosea* and *D. retrocurva*). Rotifer abundance was higher in the presence of *Chaoborus*, while *Daphnia* abundance was higher in the absence of *Chaoborus*. All rotifer species show similar mean depth in the presence and absence of *Chaoborus*. However *K. Longispina* and *K. cochlearis* daytime mean depths were significantly deeper than their mean depths at night. *Chaoborus* remained in the bottom of the enclosures during the day and migrated up in the water column at night. Therefore, all rotifer species showed minimum daytime overlap with *Chaoborus* and uniform distribution with respect to *Chaoborus* during the night. *Kellicottia longispina* was evenly distributed with respect to *Daphnia* in both predator treatments. *Keratella cochlearis* overlap with D. pulicaria was significantly lower in the absence of *Chaoborus* during day and night. This rotifer overlap with *D. rosea* was significantly higher in the presence of Chaoborus, but only at night. *Polyarthra* sp. overlap with *D. pulicaria* during the day was minimum in the absence of *Chaoborus*, and maximum in the present of *Chaoborus*. This results suggest that spatial overlap between rotifer and *Daphnia* is affected by *Chaoborus* presence.

26. Infestation of rotifers in the Volga Delta

Alexander K. Gorbunov, Anna A. Kosova
Astrakhanskiy Biosphere Reserve Naberezhnaya Reki Tsarev 119, Astrakhan 414021, Russia

Investigations were carried out in the water bodies of the Volga delta in 1986 1996. From preserved quantitative samples population density and percentage of infestation of rotifers were determined. From time to time the living material checked up and photographed. The investigations have shown that many species of rotifers inhabiting the water bodies of the Volga delta are subjected to infestation. For most species only single cases of infesting are typical. For some abundant species of rotifers infestation takes place every year and as a rule in the periods of their intensive development. Most frequently the parasites attack *Brachionus calyciflorus* Pallas *and Asplanchna priodonta* Gosse. More often *B. calyciflorus* was infested *by Microsporidium*

asperospora (Fritsch, 1895). *A. priodonta* was infested by *Pythium* sp. and bacteria. The main stages of the development of this parasites were examined on the live stock. Sometimes the infestation of the rotifers in the water bodies of the delta was 20 - 40%. For such species infestation is likely to be a factor of quantity regulation.

27. A typical summer biotic control of riverine phytoplankton communities through zooplankton grazing

Gosselain, V.[1], C. Joaquim-Justo[2], L. Viroux [1], J.P. Descy[1] & J.P.Thom[2]
(1) Laboratory of Freshwater Ecology (LFE-URBO), FUNDP, rue de Bruxelles, 61 - B-5000 Namur, Belgium ;
(2) Laboratory of Animal Ecology and Ecotoxicology, Institut de Zoologie, ULg, Quai Van Beneden, 22 - B-4020 Liége, Belgium..

The zooplankton community of the eutrophic large lowland river Meuse is largely dominated by rotifers and phytoplankton community by centric diatoms. We hypothesize that, even though river phytoplankton composition and dynamics are mainly determined by the physical properties of the fluvial system, some significant biotic control can be exerted by a community of small grazers, especially in low-flow conditions. Grazing measurements have been carried out for 3 years using the HANEY's method and a 6.5 litre grazing chamber. We measured total zooplankton filtration rates as well as individual filtration rates, so that contribution of different taxa could be estimated. We compared in situ individual filtration rates with published laboratory values. Total community grazing were then confronted to calculated grazing from zooplankton numbers. Total community filtration rates higher than 20% of the water volume cleared per day were observed several times in summer period. Rotifers were identified as major contributors to riverine zooplankton grazing and were able to induce changes in the phytoplankton community structure.

28. Strategic variation of egg size in *Keratella cochlearis*

Jim Green
17 King Edwards Grove, Teddington, Middx. TW11 9LY, England.

The volume of a single amictic egg of *Keratella cochlearis* can vary between 32,000 and 127,000 μm^3. Much of this variation is related to the size of the female laying the egg. Populations from Europe, Southern Africa, New Zealand and Japan conform to the same relationship between lorica length and egg volume. Seasonal variation in egg volume is related to seasonal variation in lorica length, but there are differences between lakes of differing trophic levels. In the Cumbrian Lakes, at any one time of year, the mean egg volumes in two lakes may differ by up to 30,000µm3. Oligotropic and high altitude lakes show less variation than lowland eutrophic lakes. The strategy of remaining large, and producing a large egg may be an adaptation to food shortage, but the relationship may also be influenced by the presence of predatory copepods.

29. Effects of eutrophication and lake restoration measures on rotifer population dynamics in Dutch lakes

Ramesh. D. Gulati, Klaas Siewertsen & Ellen van Donk[1]

Centre of Limnology, Nieuwersluis, The Netherlands;
1. Agricultural University of Wageningen, Wageningen, The Netherlands

Several shallow and eutrophic Dutch lakes were investigated for seasonal changes in their zooplankton. Many of these lakes were in the process of restoration by nutrient reduction or by biomanipulation (biomass reduction of planktivorous fish). The seasonal changes in the rotifer and crustacean densities, seston mass and crustacean feeding rates were measured. The lakes had much higher average rotifer densities (2,000-4,000 ind.l^{-1}) and diversity of species than the crustacean zooplankton. However, in both cases, the relatively small-sized species were more abundant. Among the 40 recorded rotifer genera twenty were the most common ones, with *Anuraeopsis fissa, Keratella cochlearis, Filinia*, and *Polyarthra* sp having the major share. In the biomanipulated lakes the rotifer numbers were often much lower. The rotifer numbers exhibited a significantly positive relationship ($P < 0.05$) with *Bosmina* densities and seston mass (<33 μm fraction) but negative relationship with the *Daphnia* densities and the crustacean body weight. Crustacean grazing and water clarity appeared to adversely affect the rotifer densities. The relationships between the two zooplankton groups are less clear in Lake Zwemlust, for which long-term data after its biomanipulation are available, than if pooled data are used for the lakes, for which such data are restricted to a few years.

30. *Brachionus plicatilis* Müller in Brackish-Water Lake Palaeostomi (Georgia)

Juta Haberman
Institute of Zoology and Botany, Vortsjarv Limnological Station, EE-2454, Rannu, Tartumaa, Estonia

Lake Palaeostomi is located on the shore of the Black Sea and is connected with latter by a 2-kilometre long and 140-160 metre wide canal. Before the formation (water breakthrough) of the canal in 1933, the lake was considered a freshwater lake with elevated salinity. Later, salinity increased and has been permanently rather high, in the surface layer up to 12%, at the bottom up to 13%, depending first of all on the direction and strength of wind. With strong western winds, a great amount of sea water flows into the lake, increasing salinity. In general, salinity of the water is extremely variable.

In July and August 1977 and in July 1996 *B. plicatilis* occurred at water salinity 2.65-6.62 and water temperature 25.2-27.2 °C. Its average abundance fluctuated from 5 to 2600 thous. Ind m^{-3}. A clear positive correlation was revealed between the occurrence of *B. plicatilis* and salinity. The species was more numerous in the pelagial, where salinity was higher (6.47-6.60%), than in the littoral (2.6-5.3%) whose water salinity was lowered by rivers. *B. plicatilis* accounts for 84% of the numbers of rotifers and 49% of the numbers of total zooplankton. Being obviously adapted to the variable salinity regime, *B. plicatilis* is the dominating (20% or more of total zooplankton abundance) zooplankton species in this lake.

31. Effect of water viscosity on the population growth of the rotifer *Brachionus plicatilis* Müller

Atsushi Hagiwara, Nozomu Yamamiya and Adriana Belem de Araujo
Faculty of Fisheries, Nagasaki University, Bunkyo, Nagasaki 852, Japan

Viscous forces predominate over inertial forces for micro-organisms with the small Reynold's number. The objective of this study was to examine how the change of water viscosity affects the swimming, feeding and population & growth of the marine rotifer *Brachionus plicatilis*.

Rotifers were cultured at 25oC by feeding Nannochloropsi oculata. By dissolving methyl cellulose, the relative viscosity (against natural sea water, salinity=22ppt) was regulated at I (control, no addition of methyl cellulose), 1.022, 1.031, 1.078 and 1.169. At higher viscosity, individually cultured rotifers showed slower swimming, lower ingestion rate and less fecundity. By increasing relative viscosity from I to 1. 169, the swimming activity index (Snell *et al.*, 1987) decreased from 28.3 to 4.9 (1mm2 square grids/30 sec.), ingestion rate from 1.13 to 0.34 cells/ind./hr), and a number of offsprings per amictic female from 20.8+3.0 to 8.1+3.7 (mean+SD).

These suggest that the measurement of water viscosity can be a mean to detect stress of rotifers from environment, where viscous substance is comparatively abundant, such as in mass culture tanks for aquacultural purpose.

The relative viscosity of water (from 500 ml rotifer batch culture) against natural sea water was monitored using a capillary type viscometer (Ostwald type). It varied from 1.054 to 1.148 during 30 days culture period and corresponded with the change of daily population growth rate.

32. Food niche differentiation among morphotypes of the polymorphic predator *Asplanchna silvestrii*.

S.E. Hampton
Department of Biological Sciences, Dartmouth College, Hanover NH 03755, USA.

The predatory rotifer *Asplanchna silvestrii* exhibits pronounced trimorphism that appears to be controlled by diet. These three morphotypes differ dramatically in body size and shape. The small saccate form seems to be the only morphotype that emerges from diapause embryos, and will produce the intermediate morphotype (cruciform) when fed algivorous prey. The largest morphotype (campanulate) is produced, in addition to cruciform offspring, by cruciforms that are fed congeneric or crustacean prey. Dominant available prey types likely change over time; thus it is probable that proportions of the three morphotypes present in a natural environment fluctuate correspondingly. It has been proposed that *Asplanchna* polymorphism has evolved to allow this predator to exploit a wider range of prey, since larger morphotypes should be better able to ingest larger prey. However, the distinction between the food niches of cruciforms and campanulates is still unclear. Here I present experimental evidence that campanulates can exploit crustacean prey more effectively than cruciforms. Additionally, I test the hypothesis that cruciform mothers produce a higher proportion of campanulate offspring when fed crustacean prey than congeneric prey. This research lends support to the hypothesis that Asplanchna polymorphism is an adaptation that allows exploitation of a wide range of resources in a variable environment.

33. (Title not received) [A study on dietary enrichment of *Brachionus plicatilis* used as food for marine fish larvae]

Aynur Hindioglu, Sukran Cakli, Serpil Serdar, & H. Duyar

Rotifera (*Brachionus plicatilis* O.F.Müller 1758) are very important for feeding of marine fish larvae as gilthead seabream, seabass, red seabream and turbot and crustacean larvae as shrimp, lobster and crab. Larvae take Rotifera as first feed after yolk absorption. These Rotifera must have high nutritional value because it is very important for better growth and higher survival value is enriched before feeding larvae. In this study, Rotifera were enriched using three species of phytoplankton (*Chlorella* sp, *Tetraselmis suecica*, *Dunaliella tertiolect*), selco and mixed diet with 2 h, 4 h, 6 h, 24 h and 48 h and their fatty acid compositions were determined end of the time. Especially, EPA and DHA levels were given to enriched Rotifera and compared with each other.

34. Probiotic Culture of Rotifer *Brachionus plicatilis*

H. Hirata, M. Wachi, S. Yamada, O. Murata & T. Nasu
Faculty of Agriculture and Fisheries Res. Laboratory of Kinki University, 3327-204 Nakamachi, Nara, 631, Japan

Recently, a probiotic culture system for the fish has been developed in the sea farms. The present experiment was conducted to apply the system for the rotifer culture. The probiotic materials were made by the fermentation of head of yellowtail (Seriola quiqueradiata), green alga (*Ulva pertusa*), and lees of bean curd with "Uchishiro microorganisms". The microorganisms were consist of about 40 species of bacteria such as *Bacillus subtilis, B. licheniformis, B. ereus, B. macerans*, so on. The culture medium were prepared by the re-fermentation with 50 g of the probiotic materials in one liter of 50% sea water. The strong aeration was supplied for 3 or 4 days. The water temperture was kept at about 25 C. The medium were used as food for the rotifer.

In order to know the optimum volume of medium as food for rotifer, 4 tanks were prepared; Tank I: 100 ml medium for 1 liter rotifer,Tank 2: 20 ml medium for 1 liter rotifer, Tank 3: 10 ml medium for1 liter rotifer, and Tank 4: no probiotic medium for the rotifer as control. Initial population densities of rotifer in all the tanks wereregulated to about 100 individuals per ml.

The higher population density, 351 ind/ml, of the rotifer was found inTank 2 which were fed on 20 ml medium for 1 litter rotifer. The second higherdensity, >288 ind/ml, was observed in Tank 3 which were fed on 10 ml medium for therotifer. On the contraly, the population densities in Tank 1 and 4 decreased day byday due to too much or too less meduim supplied. From those experiments, it is understood that the probiotic medium are useful to serve as food for rotifer if it is supplied in satisfactory volume.

35. Comparison of Processes Regulating Zooplankton Assemblages in New Freshwater Pools.

Holland, T.A. and D.G. Jenkins
Biology Dept., University of Illinois at Springfield, Springfield, IL 62794, USA.

The importance of colonization history in the determination of community structure has recently recieved attention, often as studies of known species

introductions or under controlled laboratory conditions. How does colonization history affect zooplankton assemblages during natural colonization, especially in the presence of other known regulators (i.e., habitat duration and nutrient enrichment)? We examined this question during a 6-month experiment in 16 small (1.5 m), new freshwater pools. Pools were experimentally manipulated for permanence (permanent vs. temporary) and nutrient level (+/- N & P). Nutrients were added to maintain concentrations typical of eutrophic waters. Water levels in permanent pools were maintained with added water and temporary pools dried out naturally for 1 month.

Permanence and nutrient enrichment significantly ($p<0.05$) affected zooplankton species richness, TN, TP, and pH. However, the distribution and abundance of species varied considerably among pools, regardless of permanence or nutrient enrichment. Colonization history was important for community composition. Also, colonization was limited to 10 rotifers (species of *Brachionus, Cephalodella, Lecane, Lepadella, Rotaria*, and *Trichocerca*), and 2 crustacean species. Our results indicate that zooplankton assemblages were strongly regulated by colonization history, as well as habitat duration and nutrient enrichment in the new pools. Colonization history may have lasting effects on zooplankton community composition in natural, older systems as well.

36. Dicranophoridae (Rotifera) from the Alps, with description of new species and a new genus

Christian D. Jersabek
University of Salzburg, Institute of Zoology, Hellbrunnerstr. 34, A-5020Salzburg, Austria

The dicranophorid Rotifera recorded from mountainous altitudes of the Austrian Alps are described and figured. Of the .. Dicranophoridae identified, two species in a new genus and *Encentrum* respectively are new to science, several are new records for the Alps. All representatives of the family so far known from the Alps are listed and available information on distribution and ecology is given.

37. Comparison of direct contamination by PCBs in rotifers and cladocerans.

C. Joaquim-Justo and J.-P. Thom
University of Liege, Laboratory of Animal Ecology and Ecotoxicology Quai Van Beneden 22, B-4020 Liege, Belgium.

The rotifer *Brachionus calyciflorus* and the cladocerans *Daphnia magna* and *Bosmina coregoni* were contaminated by addition of Aroclor 1260, a PCB mixture predominant in samples from the river Meuse (Belgium), to their culture medium. PCB concentrations in the culture medium varied from 0.05 =B5g/1 (PCB concentration measured in the water of the river Meuse) to 1 =B5g/1. The animals were not fed during the experiments so that the PCB contamination could only occur by the direct pathway. *B. calyciflorus* accumulated the same PCB concentration when contaminated either in enclosures or in a flow-through system and the maximum contamination was measured in rotifers after 8 to 24 hours of contact with the xenobiotic. PCB accumulation in rotifers and in cladocerans were compared. The presence of

humic acids in the experimental medium was found to decrease the PCB concentration accumulated by the animals. The estimation of the direct uptake of PCB by rotifers and cladocerans in the river Meuse was calculated on the basis of the in vitro measurements; it was 4 times lower than the PCB concentrations measured in zooplankton samples collected in the river Meuse. These results give evidence that the direct pathway is not predominant in the PCB contamination of the zooplankton of the river Meuse.

38. Does the evasive behavior of *Hexarthra* Influence its competition with cladocerans?

Anupama Kak and T. Ramakrishna Rao
Department of Zoology , University of Delhi, Delhi - 1 1 0 007 INDIA

Large-bodied cladocerans are known to be able to suppress rotifer populations through both exploitative and interference types of competition. We tested the hypothesis that the primarily predator-deterrent evasive movements of Hexarthra mira also help to reduce the adverse effects of interference competition with the cladocerans and allow it to coexist with them. We studied in the laboratory the population growth of the evasive *Hexarthra mira* and the non-evasive *Brachionus calyciflorus* and *B. angularis* in the presence of a cladoceran, either *Daphnia similoides* or *Ceriodaphnia cornuta* at three food (Chlorella) levels (0.5, 2, and 4 x 106 cells ml-1) at 250 C. The non-evasive, but larger-sized B. calyciflorus was suppressed by *D. similoides* at low and medium food levels, and by *C. cornuta* at low food levels only. The smaller *B. angularis* showed similar trends with *D. similoides*, but with *C. cornuta* it persisted and increased in population size regardless of food level. The evasive *Hexarthra* on the other hand, not only coexisted with either cladoceran, but its population size actually increased regardless of food level. We suggest that the evasive movements of *Hexarthra* help by reducing the frequency of its being drawn into the bronchial chamber of a large, feeding cladoceran.

39. Structural shanges and dynamics of periphytic rotifers along a pollution gradient in a sub-tropical river-a multivariate approach

Parminder Kaur and N.K.Mehra
Limnology Unit, Department of Zoology
University of Delhi, Delhi 110007, India

An extensive survey of periphytic rotifers on the Delhi segment of river Yamuna was carried out (Dec, 1991-Nov, 1993). Based on physical, chemical, and biological data, different zones on the river were differentiated. Significant changes in rotifer assemblages were evident at different zones. It is suggested that such changes are influenced by site-specific physico-chemical characteristics, in turn affected by quality and quantity of sewage and agro-industrial waste disposal.

40. Seasonal variation as a determinant of population structure in rotifers reproducing by cyclical parthenogenesis.

Charles E. King and Manuel Serra
Department of Zoology, Oregon State University, Corvallis, OR 97331, USA and Departament de Microbiologia i Ecologia, Universitat de Valencia, E-46100 Burjassot (Valencia), Spain

Monogonont rotifers live in habitats that display extensively variation in both biotic and abiotic components. Much of this variation is seasonal and therefore predictable for a given pond or lake. In 1972, King proposed one physiological and two genetic models presenting alternative modes of adaptation to this temporal variation. Our purpose in the present paper is to review and evaluate how our knowledge of the seasonal structure of rotifer populations has changed in the past twenty five years.

Seasonal changes in clone frequencies have been reported from three studies of natural populations using electrophoretic analysis of isozymes. In one of these studies there was evidence for substantial temporal overlap of multilocus genotypes suggesting that these clones were broad-niched generalists. By contrast, both the genetic and ecological analyses in the other two studies support a nonoverlap model in which clonal groups are composed of narrow-niched specialists that undergo seasonal succession. In both of these studies the clonal groups appear to have achieved the status of sibling species, a phenomenon that we conclude is probably common in monogonont rotifers.

Strong competition is required to maintain reproductive isolation between successive groups of seasonal specialists. The existence of this competition has been inferred from natural populations and demonstrated by studies in the laboratory. Also required, and also supported by field observations, is a temporal separation of periods of mictic (sexual) reproduction. A final requirement of the nonoverlap model is seasonal variation in the timing of resting egg hatching. That is, clones established from hatching of resting eggs must enter a physiologically appropriate habitat if they are to increase in number and achieve a competitive advantage. Unfortunately, we still have little information on this topic.

Finally, we present the results of a study analyzing the effects of variation in the mictic ratio (i.e., the relative frequency of mictic females) on the adaptive structure of rotifer populations. Mixis may shift the balance between costs and benefits of specialization thereby producing seasonally-specialized populations that overlap in space but not time. Life history patterns may therefore provide fundamental insights on the adaptation of rotifers to the extensive temporal variation in their environments.

41. Stereopictures of internal structures and of the trophi of rotifers

W. Kleinow
Zoologisches Institut der Universitut zu Köln, Weyertal 119,
D - 50923 Köln, Germany

We have developed approaches to obtain SEM pictures of the internal structure of rotifers and of intact rotifer trophi. In our paper we show how the interpretation of such SEM pictures is assisted by examining pairs of images which are obtained by tilting the object during SEM by certain angles. Observing the resulting photographs by means of a suitable stereoscope (or in certain cases even by still simpler techniques) enables a three dimensional perception of the objects. This aided, for example, in clarifying the orientation of the trophi within the mastax by comparing suitable 3-D-pictures of trophi with 3-D-pictures of sections of the mastax.

Our method used routinely for preparing trophi of Brachionus plicatilis for SEM requires large numbers of rotifers. In order to examine trophi of other

rotifers the method has been modified in order to obtain SEM pictures of trophi from small numbers of rotifers. With this technique, under favorable circumstances, it should be even feasible to take pictures from the same rotifer and its trophi at first through the light microscope and afterwards from its trophi in the SEM.

42. Mate recognition of the rotifer *Brachionus plicatilis* Müller at different temperatures

Tomonari Kotani[1], Atsushi Hagiwara[2], Terry W. Snell[3]
1. Graduate School of Marine Science & Engineering, Nagasaki University, Bunkyo, Nagasaki, Japan; 2. Faculty of Fisheries, Nagasaki University, Bunkyo, Nagasaki, Japan; 3. School of Biology, Georgia Institute of Technology, Atlanta, Georgia, USA

Recent studies on sexual isolation among euryhaline Brachionus species suggest that differences in the molecular structure of a mate recognition pheromone (MRP) are important in maintaining reproductive isolation. It has not been clarified whether MRP structure can be affected by the environment. The objective of this study was to examine the effect of temperature on mate recognition of the rotifer *B. plicatilis*. Three strains (Russian, German, and Tokyo strains) of *B. plicatilis* were cultured on *Nannochloropsis oculata* and a series of intrastrain matings were made using rotifers reared at three temperatures (15, 20, and 25 °C). Thus the matings were conducted for nine combinations of treatments (3 strains x 3 temperatures). Temperature affected the attempted matings (frequency of circling behavior per male/female contact) differently among strains and sexes. Culture temperature of females affected the frequency of mating attempts than that of males. Male recognition of females occurred best at 20 °C for the Russian strain. German strain males only recognized females when they were reared at 20 °C. For Tokyo strain, however, rearing temperature did not affect mate recognition. The degree of binding of anti-MRP antibody from Russian females will be compared to binding females of all three strains. Antibody binding will be discussed in relation to the above mating results.

43. Catecholaminergic neurons in the brain of rotifers

Elena A. Kotikova
Zoological Institute of the Russian Academy of Sciences, 199034, St. Petersburg, Russia

Arrangement of catecholaminergic (CA-ergic) neurons in the nervous system in 10 species of rotifers from the subclasses Archeorotatoria and Eurotatoria (according to Markevich, 1990) has been studied by histochemical GAIF method. All the species investigated are shown to have a common plan of the nervous system structure. A total number of neurons varies within 16-29 with size ranging from 2 to 10 μm. The shape of neurons usually is elongate or oval, or rarely boat- shaped. Main differences are observed in the arrangement of the brain neurons; their number varies within 6-11. Three successive stages of complication of geometric arrangement of CA-ergic neurons of the brain ganglion are distinguished: X-shaped, arched and circular. Brain neurons can be longitudinally extended in 3 or 4 levels, forming X-shaped structures with different degree of curvature (*Philodina* sp., *Manfredium eudactylotum*). Among the species with arched brain, a gentle

curve has been recorded in Platyias quadricornis, but the most steep one has been observed in *Asplancha herricki, A. priodonta* and *Euchlanis dilatata*. All 6-8 brain neurons in X-shaped and arched types are situated dorsally. Transformation from arched configuration to circular is realized in two stages. At the first stage a weak curve arises (in *Notommata* sp. with semicircular brain) followed by a further progressive rapproachment of the brain sides (in *Lecane arcuata*). The second stage leads to the appearance of an exclusive elliptic brain complex (in *Brachionus quadridentatus*) or a ring-shaped one (in Dicranophorus forcipatus). The two latter rotifers have 4-7 dorsal neurons and 2-4 ventral ones. The CA-ergic neurons constitute only 3-7% of total number of cells in the brain and they are situated at the brain periphery. The complication of geometric arrangement of brain neurons is not immediately connected with the systematic position of rotifers. It seems to be a result of parallel and independent development.

44. Phenotypical diversity of rotifers

L.A.Kutikova
Zoological Institute, RAS, St.Petersburg, 199034, Russia

Phenotypical diversity of rotifers is regarded as different forms of the morpho-functional variability. Data on onthogenetical, modificational and genotypical variability of rotifers are reviewed. The adaptive plasticity is pronounced in Eurotatoria having a multitude of interactions with the environment and a multitude of different pathways in the development. This group shows high morph-functional and species diversity. Protoramida (Floscullariina, Conochiliina) is characterized by a notable structural diversity although it includes small number of species. Paedotrocha and Seisonida possess a relatively standardized phenotypes and a small numbe of species. Bdelloida is also characterized by a fairly standardized phenotype, however itUs species diversity is great. (Markevich's system and classification of the rotifers (1991) are used in the discussion). Parallelisms and alternations of the phenotypical characters of the rotifers are considered in the context of the phylogenetical and evolutionary processes.

45. The species cadastre of rotifers of fresh water Bodies in north-west Russia

L.A.Kutikova
Zoological Institute, RAS, St.Petersburg, 199034, Russia

A taxonomical list of the rotifer species (about 400) was composed on the basis of a thorough review of literature beginning from the middle of the 19th century. The fresh water bodies studied situated from the Kaliningrad Region up to the Ural included approximately 100 lakes, more 70 rivers, several tens of reservoirs, and a large number of marshes and small water bodies.

The north planktonic lake complex (Gerd, 1946; Kutikova, 1975) is typical of the majority of these water bodies. During the warm time of the year in the heated biotopes some southern species can occur and even be drifted by the river streams into the high latitudes. The most widely distributed rotifers belong to cosmopolitans, north Palearctic and Nearctic species It is intended to include results of these studies into computer data bases.

46. Adaptation to low temperatures: differences between two sibling species *Brachionus plicatilis* and *Brachionus rotundiformis*

Esther Lubzens, Orna Gibson, Morad Khayat
National Institute of Oceanography, Israel Oceanographic and Limnological Research, Haifa, Israel.

The increased need for different size rotifers as food for raising small mouthed marine fish larval, led to the culture of different body size rotifers in mariculture facilities. While the culture of the relatively large *Brachionus plicatilis* can be performed at a wide range of temperatures (15-30 0C), dependable cultures of the small size *B. rotundiformis* are obtained at relatively high temperatures (25 38 °C). Recently, attempts are directed towards the culture of cold water marine fish that produce extremely small sized larvae. These larvae require small sized prey organisms during the first period after hatching from eggs. The introduction of small *B. rotundiformis* into these fish larvae culture systems has met with great difficulties, due to their sensitivity to low temperatures.

In the present study we addressed the following questions: 1. Is the survival of rotifers at low temperatures dependent on the accumulation of lipids and/or highly unsaturated fatty acids? 2. Is it dependent on the synthesis of a specific *shock protein*?

Previous work showed that relatively large amounts of lipids, including highly unsaturated fatty acids accumulate in *B. plicatilis* kept at 10 °C for at least 24 h. In addition, the *B. plicatilis* synthesized a ~90 kDa protein, that was not found in rotifers kept at 25 or 33 °C. Higher amounts of total fatty acids were found in *B. rotundiformis* kept at 15 °C for 48 h than those maintained at 10 °C and both groups show substantial amounts of HUFA. While the amount of lipids per rotifer were lower in *B. rotundiformis* , this corresponded to their smaller size. However, these rotifers did not survive at lower temperatures, although several gradual exposure regimes were tested. In another series of experiments we found that *B. plicatilis* that were exposed to 330 C and 37 °C and did not accumulate lipids or HUFA, survived at lower temperatures. Thus, the present results indicate that while lipids and HUFA accumulate in rotifers exposed to low temperatures, it may have resulted from their lower reproductive rates at these temperatures (Oie and Olsen, in press) that also lead to accumulation of lipids and HUFA. Nevertheless, this lipid accumulation does not assure their survival at low temperatures.

The possibility that the ~90 kDa protein serves as *a cold shock* is currently investigated.

47. Temporal and vertical distribution of planktonic rotifers and crustaceans in the Butgenbach Reservoir (Belgium) related to physical and chemical factors and impact on the Warche water quality.

Yves Marneffe & J.P. Thome
University of Liege, Laboratory of Animal Ecology and Ecotoxicology Quai Van Beneden 22, B-4020 Liege, Belgium.

Between March and October 1996, samples were collected in the Butgenbach reservoir and in the Warche and Holzwarche rivers which feed this lake. Planktonic rotifers and crustaceans (cladocerans and copepods) were identified and counted. Their population dynamics were related to physical and chemical factors (temperature, oxygen, nitrogen compound, phosphate and silicium concentrations) and to phytoplankton biomass. The zooplankton was dominated by rotifers thriving in spring and crustaceans (cladocerans and copepods) in summer and autumn. During summer, a temperature gradient took place and a drastic depletion of oxygen was observed below 7 meters that inducing an increase of ammonia concentrations at these depths. Moreover, the deterioration of the physical, chemical and biological quality of the reservoir water got worse due to the important touristic rush around the lake during this season. The water quality of the river Warche was compared upstream and downstream of the lake on the basis of in situ measurements and ecotoxicological tests assessing the influence of water samples on mortality and reproduction parameters of Brachionus calyciflorus. These results show that during the stratification period in the lake, the Warche water quality decrease markedly downstream of the lake.

48. A Study of rotifers in the River Thames, England, between April and October, 1996.

Linda May
Institute of Freshwater Ecology, Bush Estate, Penicuik, Midlothian EH26 0QB

More than 30 species of rotifer were recorded in the River Thames between April and October, 1996. Seven of these were relatively abundant, i.e. *Keratella cochlearis, Synchaeta oblonga, Polyarthra dolichoptera, Keratella quadrata, Brachionus angularis, Euchlanis dilatata and Brachionus calyciflorus.* In spring, there was little variation in rotifer abundance along the river, but a marked downstream increase in abundance developed later in the year. Mean rotifer density ranged from only 13 ind.l^{-1} at the upstream site to 1000 ind.l^{-1} at the most downstream site. Individual rotifer densities were very high on some occasions. The maximum total rotifer density recorded was 4,160 ind. l^{-1} on 29 July at the most downstream sampling site. In general, the overall increase in rotifer abundance downstream seemed to parallel increases in chlorophylla concentration in the river water. The impact of invertebrate predation on rotifer numbers was probably low, but fish gut analyses suggested that rotifers may be an important food source for larval fish.

Throughout the study, rotifers were collected by two different sampling methods. These methods were (1) the collection of whole water samples which were concentrated by a sedimentation technique in the laboratory and (2) collection with a 63 µm mesh plankton net. The results were compared. Method (1) often resulted in population density estimates which were more than double those determined using method (2). This suggested that an earlier study using a 125 µm mesh net (Bottrell 1977) had probably significantly underestimated rotifer densities in the river.

49. Size-structure dynamics of the rotifer chemostat: a simple physiologically structured model

James N. McNair[1], Martin Boraas[2], and Dianne Seale[2]
1. Patrick Center for Environmental Research, The Academy of Natural Sciences of Philadelphia, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, and 2. Department of Biological Sciences, University of Wisconsin at Milwaukee, P.O. Box 413, Milwaukee, WI 53201

The chemostat has proved to be a valuable tool in mechanistic studies of rotifer population dynamics. Most investigators have employed the classical Monod-Herbert model as the analytical framework for their studies. However, various lines of experimental evidence indicate that this unstructured model is inadequate for rotifers. In particular, it makes qualitatively wrong predictions regarding the transient dynamics of total population size when the dilution rate of a steady-state chemostat is suddenly shifted downward. We propose a simple alternative model that incorporates physiological structure in the rotifer population. This new model can account for the qualitative features of transients observed in total population size following a shift in dilution rate. It also predicts size-structure dynamics of the rotifer population, which can be compared against size structures measured with a particle analyzer (see the companion paper by Boraas et al., this symposium).

50. Phylogenetic relationships of phylum Rotifera

Melone, G.(1), Ricci, C.(1), Segers, H.(2), & Wallace, R.(3)
(1) Dipartimento di Biologia, Universita di Milano, Via Celoria 26, 20133 Milano, Italy (2) Lab. of Animal Ecology, Zoogeography and Nature Conservation, Dept M.S.E., University Ghent, K.L. Ledeganckstraat 35 B-9000 Gent, Belgium (3) Department of Biology, Ripon College, Ripon, Wisconsin 54971-0248, USA

This collaborative effort investigated the phylogenetic relationships of phylum Rotifera at two levels. (1) Our primary interest was to uncover possible evolutionary pathways followed within the phylum. Of the three classes of Rotifera two (Bdelloidea and Seisonidea) have been nominated as being most closely related to the ancestral form. Each of these views offers a different hypothesis regarding the evolutionary history within the phylum, including a distinct view of concordant synapomorphies. (2) A second interest was to examine the hypothesis that Acanthocephala are closely related to bdelloids. This hypothesis, first advanced by Lorenzen (1985), implies that Rotifera are polyphyletic and that acanthocephalans are highly modified bdelloids. Recently Garey et al. (1996), using 18S rRNA sequences, also argued for a sister-relationships between these taxa. To explore both of these interests, we investigated possible phylogenetic relationships among relevant taxa by using cladistic analysis to uncover all most-parsimonious trees from a data set comprising about 50 morphological and biochemical characters of 7 Rotifera taxa (Adinetida, Philodinavida, Philodinida, Collothecacea, Flosculariacea, Ploimida, Seison), plus the Acanthocephala and an acoelomate as an outgroup.

51. Rotifer vertical distributions in a karstic lake in relation to some limnological parameters

M.R. Miracle, X. Armengol, E. Vicente & A. Esparcia
Departament de Microbiologia i Ecologia, Universitat de Valencia, 46100 Burjassot, (Valencia, Spain)

The rotifer community in lake Arcas 2, a small karstic doline formed in marls rich in gypsum, has been described in relation to their vertical distribution, and several environmental parameters. Samples were taken from June until October of two consecutive years with a peristaltic pump along the vertical profile and at short depth intervals near the oxicline, during the stratification

periods. Van Dorn bottles were also used for epilimnetic samples and in mixing periods.

In the years studied the rotifer community was dominated by Anuraeopsis fissa and Filinia hofmanni , both reaching dense populations at the oxicline layers. Other rotifer species as *Polyarthra dolichoptera, Hexarthra mira, Keratella quadrata* and *Asplanchna girodi* were also present but with lower densities.

Principal components analyses were applied to study rotifer distributions. The results showed that vertical heterogeneity was the main source of variation for the rotifer community, although seasonal and interannual changes were also important. The relationships of rotifer distributions with several limnological parameters as chlorophyll, oxygen, temperature, pH, redox and conductivity, were also statistically analyzed.

52. Planktonic rotifers of Samborombon River Basin (Argentina)

Beatriz Modenutti
Centro Regional Universitario Bariloche, Universidad Nacional del Comahue, Unidad Postal Universidad, 8400 Bariloche, Argentina.

The Samborombon river is a plain river located in the depressed Pampa (Buenos Aires , Argentina). The basin lies NW-SE and drains 5090 km2 flowing into the Rio de La Plata estuary. Its gentle gradient (0.13 m km-1) produces flooded areas especially along the middle and lower courses. Ten sampling stations were established, five on the river Samborombon and five on its tributary streams (San Vicente, San Carlos, Manantiales, Saladillo and Dulce). Samples were taken seasonally during 1987. Chemical parameters (pH, conductivity, ion content) varied between the main course and its tributaries. Rotifers were the most important zooplanktonic group both in number of species and individuals. The rotifer fauna was composed by 47 species. The family Brachionidae was represented by the greatest number of species (22). Rotifer species were classified according to temperature as perennial, summer and winter species. Rotifer composition was related to conductivity and pH differences between the main course and its tributaries. *Brachionus plicatilis* and *Hexarthra fennica* constituted a clear association of the main course and seem to tolerate extreme conditions of water markedly alkaline and highly conductive. On the contrary, these species were not found in the tributaries.

53. Production of marine rotifer *Brachionus rotundiformis* feeding by the frozen cells of unicellular algae *Chlorella vulgaris* on a continuous culture system.

Takashi Nakao[1], Isao Maruyama[1], Ikuro Shigeno[1], Yotaro Ando[1] and Astushi Hagiwara[2]
1. Chlorella Industry Co. Ltd., No. 1 343, Chikugo, Fukuoka, 833, Japan; 2.Faculty of Fisheries, Nagasaki University, Bunkyo 1-14, Nagasaki, 852, Japan.

The condensed cell suspension of unicellular algae *Chlorella vulgaris* containing vitamin B12 in its cells has been widely used as a rotifer food in Japan. However *Chlorella* cells are available for rotifer culture no more than a month from the harvest although they keep in a refrigerator. We accordingly studied on the dietary value of the frozen cells of *C. vulgaris* for the rotifer *Brachionus rotundiformis* in order to lengthen the available period.

The frozen cells of *C. vulgaris* could not support the rotifer growth stably in a batch culture because of the death of *Chlorella* cells by the freezing. On the contrary it support the rotifer growth in a continues culture, although the dietary value was inferior than that of the living cells. The dilution rate achieved at 0.3 /day by the feeding of the frozen cells of *C. vulgaris* only (*Chlorella* density, 1.4 g dry weight/L diluted sea water; rotifer density, about 1200 ind./ml: culture volume, 30 L) . This result can be explained by the fact that the continues culture system reduced the elution of the content of *Chlorella* cells compared with batch culture, because *Chlorella* cells feeding into the culture were instantly fed by rotifer.

54. Influence of the food ration and the individual density on production efficiency of semi-continuous cultures of Brachionus fed microalgae dry powder.

N. Navarro (1) and M. Yufera (2)
(1) Cultivos Piscicolas Marinos S.A. Apartado 119, 11100 San Fernando, Cadiz, Spain.
(2) Instituto de Ciencias Marinas de Andalucia (CSIC), Apartado Oficial, I 1 5 1 0 Puerto Real, Cadiz. Spain.

In the present study we have examined the effect of the food ration and the individual density at the time of starting the harvesting stage in determining the population demographic parameters in semi-continuous culture of the rotifers *Brachionus plicatilis* and *Brachionus rotundiformis* fed freeze dried *Nannochloropsis oculata*. Three daily food rations (25, 50 and 100 mg l^{-1}) and three rotifer densities (250, 500 and 1000 rotifers ml^{-1}) has been tested trying to maintain constant the availability of microalgal cells at 100 ng per individual. Results showed that in steady-state the populations maintain similar rotifer density than pre-established. The production (rotifers l^{-1} d^{-1}) increased with the food ration but the system efficiency (mg-rotifers produced per mg-microalgae) was the same irrespective of the ration

55. Ecology versus taxonomy: is there a middle ground?

D.L. Nielsen, R.J. Shiel & F.J. Smith
Murray-Darling Freshwater Research Centre, Cooperative Research Centre for Freshwater Ecology, P.O. Box 921 Albury, 2640, NSW, Australia

In many long term, intensive experimental and field studies there often arises a need to trade off taxonomic resolution for ecological answers. Compounding this problem is the taxonomic impediment - a lack of taxonomists capable of processing large numbers of samples to species resolution, especially in major groups such as the Rotifera. In this paper we investigate the level of taxonomic resolution required to detect changes in rotifer assemblages arising from a flood event in artificial billabongs. Family and generic resolution may be adequate to interpret *population* responses to disturbance events, but species resolution is required to interpret *biodiversity* responses to such events.

56. Factors affecting long term survival of dry bdelloid rotifers

Aydin Orstan
13348 Cloverdale Place, Germantown, MD 20874, U.S.A.

Naturally dried lichens and mushrooms were stored at <1%, 23%, 44% and 75% humidities, at 21 °C, 5 °C and -20 °C and in either air or argon and the survival of bdelloids in these samples was determined as a function of time. Rotifers were extracted with 0.2 M sucrose, which was then diluted with water and the percentages of live rotifers were determined. The percentages of rotifers alive in lichen samples stored at 23% and 44% humidities over an 8-month period at 21 °C did not decline from the initial value (68% alive) obtained soon after the samples were collected. However, over the same period, 0% of rotifers survived at <1% humidity, and only 4% survived at 75% humidity. The lowering of temperature from 21 °C to 5 °C increased percent survival at both <1% and 75% humidity. And in a lichen sample which was first dried at 5 °C at <1% humidity and then stored at -21 °C at <1% humidity, the percentage of rotifers alive did not decline from the initial value over an 18-month period. At both <1% and 75% humidities at 21 °C, storage under argon increased percent survival of bdelloids in mushroom and lichen samples compared to survival in air at the same humidities. The comparison of these results with literature data suggests that lipid oxidation may contribute to the death of dry bdelloids. Since bdelloid specimens cannot be preserved using the conventional preservatives, it is recommended that samples containing new or rare species be stored at low humidities at temperatures below O °C in the absence of oxygen.

57.The history of rotifer research from Carl Linnaeus to present, focusing on Northern Europe

Birger Pejler
Limnological Institute, Norbyvagen 20, S-75236 Uppsala, Sweden

The research of rotifers in northern European countries is recorded and discussed, beginning with Carl Linnaeus and O.F. Müller, and finishing in recent times. The general development of rotifer research is reflected as well, ever since the first time, dominated by morphological taxonomy, and up till now, when also modern fields, like biochemistry, ecotoxicology and aquaculture, are included.

58. Effect of temperature and food concentration in two species of Littoral rotifers

Ignacio A. Perez-Legaspi & Roberto Rico-Martinez
Universidad Autonoma de Aguascalientes, Centro Basico, Departamento de Quimica, Avenida Universidad 940, C.P. 20100, Aguascalientes, Ags., Mexico

We performed life table experiments with two species of the littoral rotifers *Lecane luna* (O.F. Müller, 1776) and *Lecane quadridentata* (Ehrenberg, 1832). Three different temperatures (20, 25, and 30 °C) and food concentrations of *Nannochloris occulata* (1x107, 5x106, and 1x106 cel/ml) were investigated. We found important differences in all the treatments regarding offspring sizes, hatching percentages, life span and reproduction rates between both species. Our results represent an important contribution to determine population dynamics of littoral rotifers. This information can then be used to develop aquatic toxicology tests with littoral species, which are more susceptible than planktonic species to the accumulation of various toxic substances in the sediments.

59. Freshwater Rotifera of the genus Lecane from Songkhla Province, Southern Thailand

Pornsilp Pholpunthin and Supenya Chittapun
Department of Biology, Faculty of Science,
Prince of Songkla University, Hat-Yai, Songkhla 90112, Thailand.

Sixteen freshwater habitats in Songkhla Province, southern Thailand were investigated for rotifers of the genus *Lecane*. A total of twenty-three species were identified. The majority of species found were cosmopolitan (43%) or tropicopolitan (39%). The rest were oriental (9%) and palaeotropical (9%). The most common species was *L. bulla* (69% of the plankton samples taken), while *L. aculeata, L. arcula, L. blachei, L. rhenana, L. stenroosi and L. tenuiseta* were rare (6%). The greatest species diversity was found in Khlong-Hla reservoir (15 species).

60. Rotifer's consumption as factor modifying result of interspecies competition.

Roman Zurek and Agnieszka Pociecha
Institute of Freshwater Biology, Polish Academy of Sciences,
Ul.Slawkowska 17,31-016 Krakow,Poland

Growth rates of few alga species have been tested. There were chosen one small species of flagellate non.det.5 µm in diameter, larger green algae: *Eudorina* sp. 50-80 µm in diameter, *Pandorina morum* 40-50 µm in diameter and small diatom 33 µm. As consumer *Brachionus calyciflorus* was used. Concerning flagellate, it is able both to be autotroph, as well as to catch other microorganisms, especially diatoms. The results of competition in mixed two- or three species cultures of alga, and modifications of the above results caused by eating of some competitors via *Brachionus calciflorus* were estmated. *B. calyciflorus* can limit growth of the edible species and modify results of "beaker" succession.

61. Effect of turbidity and biotic factors on the rotifer community in an Ohio Reservoir

A.I. Pollard[1], M.J. Gonzalez[1], M.J. Vann[2] , and J.L Headworth[2]
1. Wright State University, Dayton, Ohio 45435
2. Miami University, Oxford, Ohio 45056

We examined spatial and temporal variability in rotifer abundance and population parameters from 1993-1996 along a turbidity gradient. Species composition and abundance was similar at low and high turbidity sites; however, rotifer abundance shows high year-to-year variability. Mean rotifer densities were similar from 1993-1995, but in 1996 they increased four-fold. We compared population parameters in years with contrasting Daphnia ambigua and fish (gizzard shad, *Dorosoma cepedianum*) abundance. The mean densities of *Daphnia* were 0.5 ind./L in 1994 and 54 ind./L in 1996. Fish abundance was higher in 1994 than 1996. Preliminary analysis indicate that rotifer birth and death rates were lower in 1996 than 1994. Our results support the following scenario: in 1994 high fish density resulted in high predation pressure on *Daphnia*. After the larval fish grew out of their zooplanktivorous feeding stage (switching to detritivores), the *Daphnia* population did not recover, and rotifer populations dominated the zooplankton community. In 1996 low fish density resulted in reduced

predation pressure on *Daphnia* , allowing their population to peak. During this window of time, rotifer populations were low, because of competition with *Daphnia*. Evidence of this competitive relationship is exacerbated by an increase in rotifer populations upon *Daphnia* decline. These results suggest that biotic factors, rather than abiotic factors, control rotifer population dynamics in this reservoir.

62. Periphytic rotifer communities of Australian artificial billabongs (ox-bow lakes) subjected to different inundation regimes.

Rosalind M. Pontin[1], D.L.Nielsen[2], & R.J.Shiel[2].
1. 26 Hermitage Woods Crescent, St. Johns, Woking, Surrey, GU21 IUE England, U.K. 2. Murray-Darling Freshwater Research Centre, Po. Box 921, Albury, N.S.W 2640, Australia.

Sixteen artificial billabongs (ox-bow lakes) on the floodplain of the River Murray, near Albury, New South Wales, Australia, were given one of four inundation regimes: 1) summer flooding, 2) winter/spring flooding, 3) permanent inundation, or 4) control treatmentin which water levels were allowed to vary naturally with rainfall or evaporation. Each billabong was divided into or deep sections, and fish or fish-less sections. All sections contained some macrophytes and most included *Myriophyllum* spp . 80Ml quantitative samples were taken with a syringe from the Myriophyllum beds of each section, or from open water where *Myriophullum* was absent. Samples were filtered through a 50 µm filter, fixed in 4% formalin and counted in entirety. Preliminary results of the effects of the different inundation regimes on the microfaunal communities, and particularly on the Rotifera, are presented.

63. Bacterivory in rotifers: implications for the biological control of microbial load in waste waters

T. Ramakrishna Rao
Department of Zoology, University of Delhi, Delhi- I 10 007 INDIA

The effluents released by local sewage treatment plants (STP) generally have undesirably high microbial load, which may be brought down by chemical (chlorination) or by physical (irradiation) methods. Considering the health hazards of the chemical and the high operating costs of the physical methods, there is a need to explore biological methods to effect reduction in microbial load of wastewaters. The frequent association of rotifers with activated sludge and their abundance in oxidation ponds provide the circumstantial evidence, and radiotracer demonstrations by many workers the experimental proof, that many rotifers are bacterivorous, and therefore good candidates for biological control. I screened, for their bacterivorous efficiency,different rotifer species including *Brachionus calyciflorus, B. angularis, Filinia longiseta, Keratella tropical, Rotaria neptunia* and *Philodina roseola*, collected from local oxidation ponds and STP effluents . Using demographic parameters as criteria, the performance of selected species on bacteria as food was then evaluated, with the unicellular alga Chlorella as a reference diet. Experiments were conducted with (i) filtered effluent water containing an assemblage of heterotrophic bacteria at high but variable concentrations, and (ii) laboratory-cultured E. coli (a strain originally isolated from wastewater). *B. calyciflorus* at high densities was able to effect a significant reduction in the microbial

load of the medium. However, in the field, additional factors such as retention time and flow rates also need to be considered.

64. Anhydrobiotic capabilities in bdelloids

Claudia Ricci
Dept. Biology, State University of Milan, Milan, Italy

The class Bdelloidea comprises several species that, living in unpredictable environments prone to dry out, are able to resist desiccation by entering a dormant state called anhydrobiosis. Several authors attribute this capacity to all members of the class, while others consider anhydrobiosis as a specialization that some species have acquired independently cued by a common environmental pressure. The capacity of entering into and recovering after anhydrobiosis has been tested by submitting 14 bdelloid species, representative of the four families, to 7-day-dryness. Eggs or embryos, prereproductive and reproductive animals were desiccated and kept dry for 7 days. For species belonging to order Philodinavida only general observations are given because of difficulties of rearing them. On the whole, all families comprise species with anhydrobiotic capabilities As already pointed out, the best recovery is obtained by rotifers that are reproductive in age. The eggs do not represent a resistant stage, but their viability increases with the embryo's age, as already known. Eggs of one species (*Otostephanos torquatus*) are found to be totally unable of surviving desiccation. Concerning the animals, out of the 14 species tested only two, *Rotaria neptunia* and *R. rotatoria*, do not survive 7-day-desiccation. As expected, best survival is exhibited by species that are used to live in "Terrestrial" habitats, but most bdelloids collected from permanently aquatic places, including other *Rotaria*, recover successfully, too. Therefore anhydrobiosis has to be considered a feature common to all bdelloids, that possibly has been lost by few species only.

65. The Philodinavidae (Rotifera, Bdelloidea): a special family-

Claudia Ricci and Giulio Melone
Department of Biology, State University of Milan, Italy

The family Philodinavidae includes three genera and four species: *Philodinavus paradoxus, Abrochtha intermedia, Henoceros falcatus* and *Henoceros caudatus*. *Philodinavus* and *Henoceros* live in freshwater environments, possibly with a high oxygen concentration, while *Abrochtha* is typical of unstable freshwater environments, like temporary puddles; but the three genera are able to survive desiccation. They all are browsers and their mastax is very close to the mouth opening, but have different rotatory apparatuses: the three genera are able to creep on the bottom, but only *Abrochtha* and *Henoceros* are also able to swim. We isolated and cultured rotifers belonging to the three genera, all present in Italy. Here we report observations on their morphology and behavior.

66. Phylogenetic relationships of Phylum Rotifera

C. Ricci1, G. Melone1, H. Segers2 & R. Wallace3.
1. Dipartimento di Biologia, Universita di Milano, Via Celoria 26, 20133 Milano, Italy; 2. Lab. of Animal Ecology, Zoogeography and Nature Conservation, Dept M.S.E., University Ghent, K.L. Ledeganckstraat 35 B-

9000 Gent, Belgium; 3. Department of Biology, Ripon College, Ripon, Wisconsin 54971-0248, USA

This collaborative effort investigated the phylogenetic relationships of phylum Rotifera at two levels. (1) Our primary interest was to uncover possible evolutionary pathways followed within the phylum. Of the three classes of Rotifera two (Bdelloidea and Seisonidea) have been nominated as being most closely related to the ancestral form. Each of these views offers a different hypothesis regarding the evolutionary history within the phylum, including a distinct view of concordant synapomorphies. (2) A second interest was to examine the hypothesis that Acanthocephala are closely related to bdelloids. This hypothesis, first advanced by Lorenzen (1985), implies that Rotifera are polyphyletic and that acanthocephalans are highly modified bdelloids. Recently Garey et al. (1996), using 18S rRNA sequences, also argued for a sister-relationship between these taxa. To explore both of these interests, we investigated possible phylogenetic relationships among relevant taxa by using cladistic analysis to uncover all most-parsimonious trees from a data set comprising about 50 morphological and biochemical characters of 7 Rotifera taxa (Adinetida, Philodinavida, Philodinida, Collothecacea, Floscullariacea, Ploimida, Seison), plus the Acanthocephala and an acoelomate as an outgroup.

67.Cross-mating tests re-discovered: a tool to assess species boundaries in rotifers

Roberto Rico-Martinez, Universidad Autonoma de Aguascalientes, Centro Basico, Departamento de Quimica, Avenida Universidad 940, Aguascalientes, Ags., C.P. 20100, Mexico.

The recent isolation of a mate recognition pheromone in the marine rotifer *Brachionus plicatilis* Müller has brought new light on the mate recognition systems of rotifers. We are presently understanding the importance of mating behavior as a highly efficient process used by rotifers to choose conspecifics. There are many differences in the main characteristics of mating behavior in members of five different families of rotifers. The present work proposes the use of these characteristics to assess a few cases where species boundaries between two or more species of rotifers are doubtful. The method proposed here can assess quantitatively the response of males of one species to a female of the doubtful taxa by measuring the percentage of mating attempts and the number of completed copulations. The data generated by this method can then be used together with molecular, cladistic, and evolutionary data to determine the species boundaries in these doubtful cases. This approach can help us distinguish between morphological differences between true evolutionary species and morphological differences induced by responses of rotifers to environmental or ecological factors.

68. Uptake of different sizes of latex beads by plankton rotifers.

Diethelm Ronneberger, Institut of Freshwater Ecology and Inland Fisheries Dept. Limnology of Stratified Lakes, Neuglobsow, Germany

The uptake of latex beads with different sizes as a model food by the plankton rotifers *Keratella cochlearis* and *Polyarthra dolichoptera* was investigated. Food investigations give a better understanding of the role of rotifers in the foodweb. Fluorescent latex beads were used as a model food for a better

understanding of the problems of the determination of food uptake. We assumed that plankton rotifers consume a higher part of bacteria as food. For an examination of this thesis Latex beads were used with mean diameters between 0,04 and 2 µm as model food for the representation of the sizes from bacteria to chlorococcal algae. We found increased ingestion rates (IR) from 77 to 600 beads animal-1 h^{-1}. Clearance rates (CR) of tracer food varied from 0,1 - 5,5 µl animal-1 h^{-1} with increasing sizes of food particles. The IR increased up to a food concentration of 10^6 and than equalised to a saturation curve.

69. Microplankton diversity and response to ecosystem perturbations in Alaskan Arctic LTER lakes

Parke A. Rublee, Biology Department, University of North Carolina at Greensboro, Greensboro, NC, USA 27412

Microplankton samples collected from reference and experimental lakes at the arctic LTER site in Alaska have been collected during summers since 1989. Abundance of microplankton is low (protozoan biomass, less than 0.5 ug C l^{-1}, rotifer biomass approx.2.0 mg C l^{-1}) in these highly oligotrophic lakes. Patterns of rotifer and protozoan abundance indicate temporal and spatial variation correlated with food resources and predators. Microplankton respond to the "bottom-up" stimulus of nutrient additions to lakes with increases in biomass and an accompanying reduction of diversity. This in turn leads to shifts in the pattern of carbon transfers among trophic levels in the food web. Reestablishment of "initial conditions" after cessation of lake fertilization is moderated by release of residual nutrients from lake sediments. The response to "top-down" perturbations of fish additions or removals is much less evident, since microplankton are at least two steps removed from top predators in these lakes, but only a single link away from bacteria and primary producers.

70. Rotifera of some freshwater habitats in the floodplain of the River Nan, North Thailand

La-orsri Sanoamuang
Department of Biology, Faculty of Science,
Khon Kaen University, Khon Kaen 40002, Thailand

A survey of 13 freshwater habitats in the floodplain of the River Nan, north Thailand was carried out during April and September 1996. The rotifer samples were collected qualitatively from rice fields, ponds, swamps, and roadside canals, using a 30 µm mesh net. One hundred and fifteen species were identified, 10 of which are new to Thailand. *Lecane superaculeata* n.sp. Is described and figured. The numbers of species found in two localities are relatively high, with 66 and 89 monogonont rotifers. Most of the species recorded are common, cosmopolitan or pantropical and warm-stenotherms. *Brachionus reductus* comb. nov. is considered as a distinct species rather than a subspecies of the Australian *B. dichotomus* Shepard. The occurrence of two more species previously considered endemic to Australia (*Macrochaetus danneeli* Koste & Shiel and *Notommata spinata* Koste and Shiel) illustrates a relation between the rotifer faunas of southeast Asia and Australia. Comments are presented on some insufficiently known taxa in particular the new records for Thailand.

71. +78 species of Rotifera in a single pond from Central Mexico

S.S.S. Sarma & Elias-Gutierrez Manuel
National Autonomous University of Mexico Campus Iztacala, AP 314 CP 54000 Los Reyes Iztacala, Tlalnepantla Edo. de Mixico, Mixico.

A survey on rotifers from a small pond (less than 2 ha in area and 3 m deep), located at Kilometer 28 in the federal highway Ixtlahuaca-Jilotepec (19 49'13" N, 99 42'22" W) at an altitude of 2503 m above sea level resulted in a total of 78 species. From these, 20 are new records for Mexico. These are: *Cephalodella exigua* (Gosse, 1886); *C. forficula* (Ehrenberg, 1832); *C. misgurunus* Wulfert, 1937; *C. stenroosi* Wulfert, 1937; *C. ventripes* Dixon-Nutall, 1901; *Dicranophorus caudatus* (Ehrenberg, 1834); *Itura aurita* (Ehrenberg, 1830); *I. myersi* Wulfert, 1937; *Lecane hornemanni* (Ehrenberg, 1834); *L. latissima* Yamamoto, 1955; *Lindia torulosa* Dujardin, 1841; *L. truncata* (Jennings, 1894); *Octotrocha speciosa* Thorpe, 1893; *Pleurotrocha petromyzon* Ehrenberg, 1830; *Proales fallaciosa* Wulfert, 1937; *Ptygura furcillata* (Kellicot, 1889); *Resticula melandocus* (Gosse, 1887); *Trichocerca cylindrica* (Imhoff, 1891); *T. tennior* (Gosse, 1886) and *T. vernalis* Hauer, 1936. This study confirms the presence of some of the rotifer species mentioned only as lists in earlier studies. Comments on some species are made from the zoogeographical point of view.

72. Interactions in an assemblage of rotifers and cladocerans: evidence of facilitation

Nandini Sarma and T. R. Rao
Department of Zoology, University of Delhi, Delhi II 0 007, India

Complex interactions among zooplankton include not only predation and competition but in some cases facilitation too. We investigated the consequences of such interactions in an assemblage of rotifer and cladoceran species. Of the test organisms, the rotifers *Lecane bulla* and *Philodina roseola*, and the cladocerans *Macrothrix triserialis* and *Alona guttata* are littoral / benthic while the rotifer Brachionus calyciflorus is planktonic. Interactions were studied by examining the population growth of the test animals individually (controls) and in different combinations of the test organisms, two species at a time. Experiments were conducted at 25 ' C using *Chlorella* at a density of 2x 10^6 cells ml^{-1} as food. The planktonic rotifer, *B. calyciflorus* was adversely affected by the littoral / benthic rotifers, *P. roseola* and *L. bulla*, more so by the former. It was also adversely affected more *by M. triserialis* than by *A. guttata*. The population growth of *L. bulla* was however suppressed to a greater degree by *A. guttata* than by M. triserialis. *While P. roseola* reduced the population growth of all the other four species tested, its own population increased in the presence of *L. bulla, B. calyciflorus and M. triserialis*, indicating the existence of facilitation. Our findings show that certain littoral benthic zooplankton may actually benefit in the presence of coexisting species.

73. Differences between the rotifer populations of sub-tidal and littoral pools in a marine lagoon

A.P.Saunders-Davies
8 Kingfisher Close, Walton on Thames, Surrey KT12 4LF, England

The differences between the rotifer populations of some sub-tidal and littoral pools of a large marine lagoon are described. Possible factors for such differences are discussed including water disturbance, sediment loading and species of algae present.

74. Predation on rotifers by tanypods (Chironomidae) in a gravel stream.

Peter. E. Schmid
School of Biological Sciences, Queen Mary & Westfield College
University of London, UK.

Does the observed feeding pattern of tanypods, even if it appears to implicate competitive interactions, differ significantly from a pattern that would arise in an assemblage in the absence of any interaction between species? Is there any trend for predator individuals and groups of predatory instars to feed mutually exclusive on particular rotifer species or are prey species non-selectively eaten by predators? How are benthic rotifers spatially structured and does this pattern compensate for predatory effects on rotifer community structure? In the gravel stream Oberer Seebach, larval tanypods preyed on diverse species assemblages, mainly consisting of rotifers and early instar chironomids. To evaluate the significance of observed dietary and spatial resource overlap values amongst tanypod instars, simulations were generated from random models on each possible instar pair-wise association of patches and individuals of predators. Tanypods instars fed randomly among rotifer prey patches and preyed non-selectively on any motile species smaller than their mouth opening. Prey choice was primarily governed by prey availability and tanypods fed on many species at rather even proportions independent of each other.

75. Rotifers in interstitial sediments.

J.M. Schmid-Araya
School of Biological Sciences, Queen Mary & Westfield College
Mile End Road, London E1 4NS, U.K.

Rotifers have long been known to inhabit interstitial sediments, mostly confirming the high species richness of the group in a variety of habitats. This paper reviews the ecological role of rotifers within the interstitial environment (e.g. hyporheos, psammon, bed sediments) in lakes, and running waters. Comparison of densities, assemblage structure, patterns of colonization and drift are examined within riverine ecosytems.

76. The importance of inundated flood plains for planktonic rotifers (Monogononta, Rotatoria): adaptation of life history traits to cyclic flooding and desiccation

Thomas Schroder
Institute of Zoology, Freie Universitat Berlin, Konigin-Luise-Str. 1-3, 14195 Berlin, Germany

The flood plains of the River Oder (Northern Germany) are quite regularly inundated in winter and spring and desiccated during summer. The plankton community developing towards the end of winter and in spring is dominated by rotifers. Some species, such as *Brachionus calyciflorus, Keratella quadrata* and *Keratella cochlearis* maintain populations on the flooded areas and, when the flood retreats, also in the remaining permanent waters of the flood plain.

Other species as *Notholca squamula, Notholca acuminata, Argonotholca foliacea, Rhinoglena frontalis* and *Brachionus leydigi rotundus* are found during the flooding period only, with high abundances on the inundated areas. These species either must have adapted their life cycles to desiccation and produce drought-resistant diapause stages or they must colonize the temporally inundated areas from the permanent waters of the floodplain each time again. Experiments showed that *Notholca squamula* is able to produce amictic resting eggs independent of population density. Other experiments were conducted to test if resting eggs of this and other species are able to remain viable in the desiccating soils of meadows and softwood forests of the flood plain. The results and phenology of species are discussed in respect of adaptation to cyclic flooding and desiccation.

77. Rotifer diversity in a subtropical reservoir: a case study, with notes on taxonomy.

Hendrik Segers
Laboratory of Animal Ecology, Zoogeography and Nature Conservation, University of Gent, K. L. Ledeganckstraat 35, B - 9000 Gent, Belgium.

The recent interest in biological diversity has increased the relevance of species censuses in the evaluation of natural environments.. However, complete inventories of the freshwater coenosis of a habitat are rarely available, especially when Rotifera are concerned. Our aim was to study what sampling effort is required to obtain a reasonable estimate of rotifer (Monongonont) diversity in a freshwater habitat, and to make a near-complete census of the Rotifera of a subtropical, artificial reservoir. For this, a total of 100 qualitative samples collected on two occasions together with live samples from Broa reservoir, Itirapira, São Paulo, Brazil were studied. A preliminary total of 210+ rotifer species is recorded for the reservoir (Dumont & Segers, 1997). Here, a full account of the census is given. Taxonomic notes on little known or previously undescribed species are added.

78. Ecological genetics of *Brachionus* sympatric sibling species

Manuel Serra, Africa Gomez and Maria Jose Carmona
Departamento de Microbiologia i Ecologia, Universitat de Valencia
E46100-Burjassot (Spain)

In this paper we review previous studies on sympatric *Brachionus* populations in Torreblanca Marsh as a model of evolutionary and ecological relationships between closely related species. The marsh is a wetland in the Mediterranean coast of Spain with high spatial and temporal heterogeneity. Allozyme and morphometric analysis showed that *Brachionus* group *plicatilis* (formerly, *Brachionus plicatilis* and currently split into *B. plicatilis and B. rotundiformis*) was composed by three groups of genotypes with no evidence of gene flow between them (*B. plicatilis, B. rotundiformis* SM and *B. rotundiformis* SS), so that they can be considered sibling species. Correlations between seasonal and spatial distributions, on one hand, and temperature and salinity, on the other, were consistent with the results of experimental studies of population dynamics. Accordingly, *B. plicatilis* is an eurihaline, low temperature group, *B. rotundiformis* SM is better adapted to high temperature and low salinity, and *B. rotundiformis* SS is adapted at high temperature and high salinity conditions. Mating experiments showed that

copulations were almost completely restricted to within group. *B. plicatilis* had a different mating recognition system to either B. rotundiformis SM and SS, whereas the two *B. rotundiformis* groups had partially differentiate mating preferences. Cross-mating experiments performed in the laboratory failed to produce hybrids. The groups had different mictic response to density, salinity and temperature, which can be explained to some extent as an adaptive escape response, given their different ecological preferences. These differences imply a partial ecological barrier for male-female encounter between groups.

79. Biodiversity of freshwater rotifers in India, with remarks on their distribution in North-Eastern India.

B. K. Sharma
Department of Zoology, North-Eastern Hill University,
Permanent Campus, Shillong - 793 022, INDIA

Freshwater rotifer biocoenosis of India includes 330 species belonging to 63 genera and 25 eurotatorian families. It reflects qualitative importance of Lecanidae > Brachionidae > Colurellidae > Notommatidae > Trichocercidae and depicts a general tropical character. This fauna shows abundance of cosmopolitan elements while tropical and pantropical species are also fairly well represented. Indian rotifera includes 29 endemic taxa, three Australasian elements, seven Oriental taxa and several other species of global and local biogeograhical interest. The status of systemic studies in India is examined. Comments are made on nature, composition and ecology of the reported rotifer biodiversity and on their occurrence in various aquatic biotopes.

The rotifer communities of soft and slightly acidic to circumneutral waters of North-Eastern India exhibit 132 species spread over 32 genera and 19 families. Further, these are characterized by various acidophilic elements, abundance of lecanids and relative paucity of Brachionus species. The rotifer fauna of this region registers greater affinity with faunas of South - East Asian countries and exhibits several rare and interesting elements.

80. Floodplain bodiversity: why are there so many species?

Russell J. Shiel[1], John D. Green[2] & D.L. Nielsen[1]
1. Murray-Darling Freshwater Research Centre, PO Box 921,
Albury, NSW 2640 Australia
2. Dept of Biological Sciences, University of Waikato,
Hamilton, New Zealand

A Spring survey of >100 temporary floodplain waters on River Murray tributaries demonstrated a heterogeneous habitat series, with >500 species of microfauna encountered. Rotifers comprised the most diverse group, with <10 - >100 species recorded from each site on any given date. Microfaunal communities were distinct from those of adjacent permanent billabongs. Temporal heterogeneity also was pronounced: weekly sampling of a flooded roadside pool from first inundation in June through to complete desiccation in January demonstrated species replacements in days (rotifers) or weeks (microcrustacea). High species diversity is possible by fine subdivision of the available resources - microhabitat partitioning. Specialization in diet was common in the study habitats, with some rotifer taxa consuming only one or a limited suite of food items. Other congeners were separated by size,

permitting co-occurrence by exploitation of different resource fractions. Rapid and continuous production of resting eggs is seen as a hedge against ephemerality of habitat. The significance of such species richness in ephemeral waters is considered in the context of age of the Murray-Darling Basin, which has persisted in its present location since the breakup of Gondwana.

81. Some aspects of the taxonomy, distribution, and ecology of *Keratella mexicana*

Marcello Silva-Briano
Institute of Animal Ecology, University of Ghent,
K.L.Ledeganckstraat 35 B-9000, Ghent, Belgium

Keratella mexicana is a rotifer species recently described by Kutikova & Silva-Briano (1995). The present study provides new information obtained with ultrastructural analyses (SEM) is describing the trophi, lorica, ventral-dorsal spines and ornamentation of this rotifer. In addition to this, and extensive survey of 258 water bodies on Central Mexico was conducted to evaluate the distribution pattern and Ecological aspects of *K. mexicana*. There is an evident preference of *K. mexicana* for the plain zone with respect to the mountain regions.

82. Chemical ecology of rotifers.

Terry W. Snell, School of Biology, Georgia
Institute of Technology, Atlanta, GA 30332-0230, USA

Many intra- and interspecific interactions among rotifers are based on the transmission, reception, and interpretation of chemical signals. Interactions with algae include tasting algal cells based on the chemical composition of their cell surface. Asplanchna uses contact chemoreception to discriminate prey types and can even distinguish clonemates from unrelated individuals. Rotifer interactions with cyanobacteria are mediated through the toxicity of specific chemicals. Rotifer defenses against predation are often dependent on detection of chemical signals from the predator. *Brachionus* and *Keratella* species respond to a chemical from *Asplanchna* by producing of long postero-lateral spines in the F1 generation. The warts of *Sinantherina* are noxious to fish and reduce predation. Aspects of the rotifer life history are regulated by chemical signals. Chemicals produced by certain species of bacteria increase mixis 4-10 fold. Addition of a water soluble extract from *Brachionus plicatilis* increases mixis. Mate recognition by male B. plicatilis is determined by the detection of a 29kD glycoprotein on the body surface of females. This same glycoprotein has been detected on the body surface of several other rotifer species at sites believed to be important in mating. Other rotifer behaviors such as larval settlement, swarming, and resting egg hatching are probably also mediated by chemical signals. Much of what rotifers sense about their environment comes from chemical signals. These signals probably play a major role in determining the outcome of competition, predation, life cycle timing, and therefore the structure of zooplankton assemblages. Rich opportunities exist for research in the chemical ecology of rotifers.

83. Preliminary investigations on the biotic structure of the psammic rotifers in the water bodies of southern-eastern Poland.

Stanislaw Radwan[1] & Irena Bielanska-Grajner[2]
1) Department of Hydrobiology and Ichthyobiology, University of Agriculture, ul.. Akademicka 13, 20-950 Lublin, Poland
2) Department of Ecology, Silesian University, ul. Bankowa 9, 40-007 Katowice, Poland

Studies were carried out in spring and autumn of 1996 in four lakes of the Polesie Lubelskie region (Eastern Poland) and two anthropogenic water bodies (sand pit) of the Upper Silesia (Southern Poland), which considered an area of ecological disaster. Qualitative and quantitative composition of the psammic rotifers depend on surface area of beach but not on water trophy. The number of species of rotifers and their densities were lower then of those observed in northern Poland. The most poor psammic rotifer was in antropogenic water bodies. The biotic structure of psammic rotifers in the examined lakes was similar to that in Wigry lake (Northern Poland). The majority of rotifers were in eupsammon. Both Polesie Lubelskie in lakes and in the Upper Silesia water bodies the most abundant were psammoxsenic rotifers. The dominant rotifers in each examined lakes were: Lecane psammophila, *Trichocerca taurocephala* and *Elosa worrallii*. There were many psammophilous species, too. The only dominant rotifers in the anthropogenic water bodies was *Lecane psammophila*. The great influence on growth of rotifers could have climatic conditions (very low temperatures in spring and autumn). According to many authors temperature has great influence on numbers and occurrence of psammic rotifers.

84. Population growth of planktonic rotifers: does temperature shift the competitive advantage for different species?

Claus-Peter Stelzer
Max-Planck-institut fur Limnologie
Postfach 165, 24302 Plön, Germany

The numerical response of populations to different food concentrations is an important parameter to be determined for a mechanistic approach to interspecific competition. Theory predicts that the species with the lowest threshold food level (TFL) should always be the superior competitor if only one food source is offered. However TFLs are not species specific constants but may change along environmental gradients such as food size or temperature. In laboratory experiments I tested the hypothesis that temperature may differentially change the threshold food level of the three planktonic rotifers *Asplanchna priodonta, Brachionus calyciflorus*, and *Synchaeta* sp.. Numerical responses were assessed for each species at five different temperatures ranging from 11 °C to 27 °C with *Cryptomonas erosa* as sole food algae. The results are discussed with regard to resource competition and restriction to certain habitats and seasons for the respective species.

85. Organic carbon content in freshwater rotifers

Irena Telesh[1], Minna Rahkola[2] & Markku Viljanen[2]
1. Zoological Institute, Russian Academy of Sciences Universitetskaya emb. 1, 199034 St. Petersburg, Russia
2. University of Joensuu, Karelian Institute, P.O. Box 111, FIN-80101 Joensuu, Finland

Organic carbon content was measured in rotifers of 14 species from different freshwater habitats: Lake Ladoga in Russia and 4 small lakes and ponds in Finland. Most samples were collected in May-August 1996. The number of measured individuals of each species varied between 40 and 320. Mean values and range of carbon content (in micrograms) were: *Keratella cochlearis* - 0.022 (0.019-0.027), *K.c.tecta* - 0.0064 (0.0036-0.0085), *K.c. hispida* - 0.015 (0.013-0.018), *K. ticinensis* - 0.017 (0.0098-0.022), *K. quadrata* - 0.058 (0.045-0.075), *Polyarthra remata* - 0.012 (0.011-0.012), *P. vulgaris* - 0.018 (0.015-0.021), *P. major* - 0.051 (0.041-0.064), *P. eurvptera* - 0.064 (0.052-0.080), *Synchaeta* sp. - 0.020 (0.012-0.027), *S. stylata* - 0.042 (0.030-0.057), *S. pectinata* - 0.133 (0.093-0.189), *Trichocerca capucina* - 0.057 (0.043-0.076), *Asplanchna priodonta* - 0.284 (0.018-0.685). Prior to carbon analysis, rotifers were measured and their body volume was calculated according to the standard formulae. Carbon content was positively correlated with the rotifers body length (r=0.84) and body volume (r=0.82). Data on *Asplanchna* did not fit into the general curves. The measured variation in carbon content was lowest in *K. cochlearis, P. remata* and *P. vulgaris*, due to low variation in the individual body sizes of these rotifers. The general regressions between organic carbon content and body length (volume) in rotifers were calculated. These correlations can be used for the more precise estimation of the rotifers biomass and thus promote adequate evaluation of the carbon flow through pelagic communities.

86. Rotifers new to Florida, U.S.A.

Paul N. Turner (1) and Howard L. Taylor (2)
1. Department of Biological Sciences, #26, Wichita State University, Wichita, KS 67260 U.S.A.
2. 1812 Wood Hollow Court, Sarasota, FL 34235, U.S.A.

Of the 230 rotifers identified over an 11 year period from 30 sites in the southern and south-western parts of Florida, 89 are newly recorded from the state, bringing the total number of rotifers now known from Florida to 412. Five rotifers never recorded from North America prior to this study are discussed with respect to their geographical distribution and specific status: *Cephalodella pentaplax* Wulfert 1943 (recorded from Germany), *Cephalodella pachydactyla* Wulfert 1937 (recorded from Germany, Finland, and Sweden), *Lecane gwileti* (Tarnogradski 1930) (recorded from Germany, Poland, Spain, and Belgium), *Lecane schraederi* Wulfert 1966 (recorded from India) and *Lepadella tenella* Wulfert 1942 (recorded from Germany, and Belgium). *Notommata prodota* Myers 1933 was found for the first time outside its original description area in Maine, USA, and *Lecane curvicornis* is shown to be an endemic form from southeastern, North America.

87. Wind, rain, and waterfowl feces as passive dispersal vectors of zooplankton.

Underwood, M.O. and D.G. Jenkins
Biology Dept., University of Illinois at Springfield, Springfield, IL, 62794, USA.

Zooplankton, especially rotifers, are often thought to disperse readily, based on their wide geographic distributions and diapaused life stages (resting eggs,

cysts, etc.). If so, local communities should be saturated with regional species, and local community composition should be regulated by local abiotic and biotic factors (e.g., tolerance ranges, competition, etc.).

We collected particulate matter carried by wind and rain over a period of 14 months and cultured it under several conditions. Duck feces were also collected and cultured. As a test of culturing technique, sediment samples from 2 ponds were cultured under the same conditions. Only four rotifer species were cultured from wind and rain samples: no zooplankton were cultured from fecal samples. In contrast, 10 rotifer, 4 cladoceran, 3 ostracod, and 1 copepod species were cultured from pond sediments.Our results suggest that zooplankton dispersal occurs by discrete, infrequent introductions, rather than by frequent wind or rain events. Bdelloid rotifers may disperse by wind and rain, but infrequently and at low density. Regional processes (dispersal) and local processes both regulate zooplankton community composition: relative comparisons of regional / local processes may help understand zooplankton biogeography.

88. Female polymorphism in *Polyarthra remata* Skorikov in Lake Peipsi

Taavi Virro
Department of Zoology and Hydrobiology
University of Tartu, 46 Vanemuise St,
EE-2400 Tartu, Estonia

Polyarthra remata Skorikov is one of the dominating rotifers in Lake Peipsi (Estonia). It is often the most abundant *Polyarthra* species in the summer rotifer community. *P. remata* occurs from June to October, at 6.0-21.90C, with maxima in August or September, reaching population densities up to 300 ind I-1. The polymorphism of the females makes this species particularly interesting, Two coexisting forms, differing in body outline, were found in Lake Peipsi: a rounded form, with rounded posterior end of the body, and a rectangular form, with almost rectangular posterior part. Besides the normal rectangular forms, proloba forms were encountered. Moreover, analyzing the seasonal dynamics of *P. remata*, it was found that probably two ecotypes with different temperature optima could be distinguished. In the present study the extent of the possible differences between the polymorphic forms of *P. remata* females is investigated on the level of external morphometric characters, and trophi ultrastructure (using SEM). As a result of this study, the possibility to separate these forms should become evident

89. Relative energy investiment in the offspring of sessile Rotifera.

Robert L. Wallace, Jacob J. Cipro, & Ryan W. Grubbs
Department of Biology, Ripon College, Ripon,
Wisconsin, USA 54971-0248

Correlations of egg and body volumes of 65 species of oviparous, sessile rotifers (Collothecidae, n = 30; Flosculariidae, n = 35) were determined from size measurements documented in the literature. While egg volume increased as a function of body volume, relative egg volume decreased with increasing body volume indicating that the relative energy investiment per offspring is smaller in the larger bodied species of both families. These results are similar to those reported by Walz et al. (1995) for 43 species of mainly planktonic rotifers. However, regression coefficients for relative egg volume as a function of body volume for the two families were significantly different from each other and that of the planktonic species. Relative investiment of energy per offspring was highest in planktonic species, intermediate in the Flosculariidae, and lowest in the Collothecidae.

90. Habitat stability, species succession and rates of mixis in rotifer populations at Heuco Tanks State Park, TX.

E. P. Walsh, L. Arroyo and A. Frias
Department of Biological Sciences,
University of Texas at El Paso, El Paso, TX 79968.

It is widely thought that sex evolved as a mechanism for promoting genetic diversity enabling organisms to adapt to changing environments. In this study, aquatic habitats varying in stability were sampled to determine seasonal differences in species composition, sexual status, and population densities of rotifers. Planktonic rotifers from each habitat were identified and reproductive status recorded every 3 weeks for 2 years. Eighty-nine percent of small ephemeral huecos (n= 1 9) were inhabited by the bdelloid rotifer *Philodina roseola* during the study period, occurring at densities up to 191,000 ind./liter. Monogonont rotifers were found sporadically in these ponds. In semi-permanent ponds, monogonont species were dominant. Highest species diversity was in permanent ponds(having water 75-100% of sampling dates). Sexual . reproduction in *Keratella* was first observed in January of both years in permanent ponds. In the these ponds sexual reproduction is correlated with habitat stability. In the less stable pond rates of mixis reached over 90% in the *Keratella* population while in the more stable pond, less than 40% of the population was sexually reproducing at any time. Results were similar for Brachionus populations.

91. Rotifer dynamics and thermal stratification in the polymictic shallow Müggelsee (Berlin, Germany)

Norbert Walz and Birgit Eckert
Institut fur Gewasserökol. & Binnenfisherei, Müggelseedamm 260,
12587 Berlin GERMANY

The population dynamics of rotifers and cladocerans were investigated in the shallow eutrophic and polymictic Müggelsee from Juną to November 1995. Samples were taken twice a week. *Keratella cochlearis* was the only rotifer which was found during the whole period and this species showed also the highest abundance. During the exceptional long period of thermal stratification the population dynamics of the zooplankton was most likely exclusively controlled by biotic factors. During perods of mixis, however, temperature was the likely controlling factor. Food supply was the limiting factor for population growth of *Keratella* and *Synchaeta*. In contrast, food supply and predation pressure of cyclopoid copepods were the population controlling factors for *Pompholyx* and presumably for *Trichocerca*. In the stable summer period three small cladocerans were dominant in the Müggelsee (*Daphnia cucullata, Chydorus sphaericus, Eubosmina coregoni*). Larger cladoceran species seemed to be depressed by blooms of cyanobacteria and -probably - by high fish predation. Resuspended particles after mixing events are unlikely to negatively influence rotifer dynamics. In contrast, the food supply improved for the herbivorous zooplankton after a mixis event.

Hitherto, no explanation was found for the significant negative correlation between the discharge of the River Spree flowing through the lake and the abundance of several zooplankton species, especially since the fluctuation of the discharge was only in the percent range of the residence time.

92. A taxonomical and. ecological survey of rotifer communities in China

Zhuge Yan & Huang Xiangfei
Institute of Hydrobiology, Chinese Academy of Sciences
Wuhan, Hubei 430072, P.R.China

The book "Fauna of Freshwater Rotifera of China" was published in 1961 by Wang Jiaji. Quite a few systematic treatments in the book are, however no longer warranted today and the species diversity is too limited considering the vast area of China. For these reasons, some new taxonomical approaches to the chinese rotifera has been carried out. The composition and distribution of benthic, periphytic and planktonic rotifers in different habitats from six typical areas of China (Hainan island, southwest, central south, north, northeast, northwest areas) were investigated during 1995-1996. More than 400 rotifer taxa were identified. Of which, at least five species are new to science, 150 are new records for China. Description and comments are presented on the hitherto unknown species of rotifers and on some insufficiently known taxa. The characteristics of freshwater rotifer fauna of China is analyzed by means of Multivariate analysis. Meanwhile, an attempt is made to clarify the chinese rotifer fauna in the light of recent development in rotifer zoogeography.

93. Rotifer algal consumption as a modifying factor in interspecies competition

Roman Zurek and Agnieska Pociecha
Institute of Freshwater Biology, Polish Academy of Sciences
Ul. Slawkowska 17, 31-016 Krakow, Poland

Growth rates of few alga species have been tested. There were chosen one small species flagellate non det.5 µm in diameter, larger green algae : Eudorina sp. 50-80 µm in diameter, Pandorina morum 40-50 µm in diameter and small diatom 33 µm. As consumer *Brachionus calciflorus* was used. Concerning flagellate, it is able both to be autotroph, as well as to catch other microorganisms, especially diatoms. The results of competition in mixed two- or three species cultures of alga, and modifications of the above results caused by eating of some competitors via were *Brachionus calciflorus* estimated. *B.calciflorus* can limit growth of edible species and modify results of "beaker" succession.

Workshop on Rotifer Taxonomy

Contributions:
Oral presentations:

- A historical evaluation of taxonomic research on Rotifera (H. Segers)
- Preparation of rotifer trophi for light and scanning electron microscopy (W.H. De Smet)

- The rotifer corona by SEM (G. Melone)
- Cross-mating tests re-discovered: A tool to assess species boundaries in rotifers (R. Rico-Martinez)
- Allozyme electrophoresis: Its application to rotifers (A. Gomez)
- Resolving taxonomic problems in the Rotifera using DNA sequencing (E.J. Walsh)
- Numerical taxonomy as a tool for rotifer systematics (T. Nogrady)
- Taxonomic problems within the sessile families. (R.L. Wallace)
- The International Code of Zoological Nomenclature and its application to Rotifera (H. Segers)

Poster:
Preparation of Rotifer Trophi for SEM Examination: a Rapid Method (G.O. Watson & R.J. Shiel

Demonstration:
- Instruments for use in rotifer studies (H.L. Taylor)

Abstracts

94. A historical evaluation of taxonomic research on Rotifera

Hendrik Segers
Laboratory of Animal Ecology, Zoogeography and Nature Conservation, University of Gent, K.L. Ledeganckstraat 35, B - 9000 Gent, Belgium.

Many of the major identification- and text books on Rotifera, but also works treating general problems of taxonomy or zoogeography complain about contemporary rotifer taxonomy. On the other hand, rotifer taxonomy has remained reasonably stable for the last decades, with minor shifts at higher taxonomic levels. To objectivize this, the state of taxonomic research in Rotifera is evaluated by comparing the total number, and number of valid names established per decade in several large rotifer genera. The quality of taxonomic research appears poor, especially regarding the last decades. This may be due to the proliferation and scatter of relevant literature; the high intraspecifc variability in Rotifera and adherence to a typological approach to their taxonomy; and neglected taxonomic education.

95. Preparation of rotifer trophi for light and scanning electron microscopy

Willem H. De Smet
Department of Biology, University of Antwerp, R.U.C.A.-campus, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium

The study of the rotifer trophi contributes significantly to the resolution of phylogenetic relationships. Besides, reliable identification of most illoricate and several loricate species is only possible by examination of the trophi. Several methods are available for the preparation and study of trophi morphology. The use of clearing agents (e.g. polyvinyl-lactophenol) and compressing devices with intact animals is seldomly satisfactory for detailed trophi structure determination, which can only be performed after dissolving the soft tissues and lorica. The different extraction techniques that have been described are briefly reviewed, and the highly simplified and quick method we use routinely is presented and illustrated.

96. The rotifer corona by SEM

Giulio Melone
Department of Biology, State University of Milan, Via Celoria 26, 20133 Milano, Italy

The Scanning electron microscope (SEM) is a powerful instrument which is very useful to observe the surface of objects at the ultrastructural level. In the last 15 years, the author developed techniques to prepare Rotifera for SEM observation, in order to obtain images of preserved specimens that simulate their natural appearance.

One typical rotifer feature is the rotatory apparatus, and the SEM can be useful to study its organization. The comparison between complete rotatory apparatuses and deciliated specimens showing only the prints or the rests of the cilia allows to understand the organization of the corona.

The method used to prepare rotifers for observation with SEM is presented.

97. Cross-mating tests re-discovered: a tool to assess species boundaries in rotifers

Roberto Rico-Martinez
Universidad Autonoma de Aguascalientes, Centro Basico, Departamento de Quimica, Avenida Universidad 940, Aguascalientes, Ags. C.P. 20100, Mexico.

The recent isolation of a mate recognition pheromone in the marine rotifer *Brachionus plicatilis* Müller has brought new light on the mate recognition system of rotifers. We are presently understanding the importance of mating behaviour as a highly efficient process used by rotifers to choose conspecifics. There are many differences in the main characteristics of mating behaviour in members of five different families of rotifers. The present work proposes the use of these characteristics to assess a few cases where species boundaries between two or more species of rotifers are doubtful. The method proposed here can assess quantitatively the response of males of one species to a female of the doubtful taxa by measuring the percentage of mating attempts and the number of completed copulations. The data generated by this method can then be used together with molecular, cladistic, and evolutionary data to determine the species boundaries in these doubtful cases. This approach can help us distinguish between morphological differences between true evolutionary species and morphological differences induced by responses of rotifers to environmental or ecological factors.

98. Allozyme electrophoresis: its application to rotifers

Africa Gomez
Departament de Microbiologia i Ecologia, Universitat de Valencia, Burjassot, E-46100 SPAIN

Allozyme electrophoresis is a well established technique revealing genetic variation that has given optimal results in all kind of organisms. However, in rotifers it has been applied scarcely and only in a few species. In this paper we introduce the methods of acetate allozyme electrophoresis, including laboratory set up equipment and staining recipes that have successfully applied to rotifers after our experience with brachionids. In addition, we revise the literature published on allozyme electrophoresis in rotifers and discuss the main results obtained and the future prospects of this technique. We conclude that this technique is still promising and can yield important results in rotifer population genetics, ecology and systematics.

99. Resolving taxonomic problems in the Rotifera using DNA sequencing

Elizabeth J. Walsh
Department of Biological Sciences, University of Texas at El Paso, El Paso, TX 79968 USA

Methods for extracting DNA from individual rotifers, amplification of the DNA and sequencing will briefly be reviewed. Instances were DNA sequence data may be particularly useful in resolving taxonomic problems will be highlighted. Advantages and disadvantages of the sequencing data will be discussed.

100. Numerical taxonomy as a rool for rotifer systematics

Thomas Nogrady
Queen's University, Kingston, Ontario K7L 3N6, Canada

The methods using multivariate analysis (ordination, canonical correspondance analysis, correlation analysis, clustering algorithms) and relevant commercial computer programs will be outlined. The problems of using different kinds of data (phenological, biochemical) and potential pitfalls of numerical analyses will be discussed.

101. Taxonomic problems within the sessile families.

R.L. Wallace
Department of Biology, Ripon College, Ripon, WI 54971-0248, USA

Several issues continue to plague taxonomic work on the sessile families (Atrochidae, Collothecidae, Flosculariidae) (NB: Family Conochilidae is often included within this grouping). Questions of some significance regarding the taxonomy of these forms include the following. (1) What importance should be attributed to the arrangement of dorsal and ventral (lateral) antennae? (2) Is the shape of pellets or other architectural elements in the tubes of tube formers of any significance? (3) Are variations of the morphology of trophi (i.e., number of clavate teeth) important? (4) Are the variations in the number of lobes or lobe morphology meaningful (e.g., in the Collothecidae)? (5) Is absolute size a valid criterion for specific designation? (6) At what level does coloniality become noteworthy? (7) Is substratum loyalty meaningful? Finally, we do not know to what degree hybridization occurs among these taxa? Until workers can resolve these problems we will continue to have a poor taxonomic understanding of the sessile Rotifera. One promising solution to these questions might be to apply the principles of cladistic analysis using both molecular and morphological data sets.

102. The International Code of Zoological Nomenclature and its application to Rotifera

Hendrik Segers
Laboratory of Animal Ecology, Zoogeography and Nature Conservation, University of Gent, K.L. Ledeganckstraat 35, B - 9000 Gent, Belgium.

Although a strict adherence to the rules of Zoological Nomenclature has been advocated by many Rotifererologists, their correct application remains problematic, even to date. To illustrate this, an example is given in which a name (Lecane amazonica) has repeatedly been misused. Additionally, attention is drawn to some common misconceptions and easily preventable errors.

103. Preparation of rotifer trophi for SEM examination: a rapid method

Garth O. Watson and Russell J. Shiel, Murray-Darling Freshwater Research Centre, PO Box 921, Albury, NSW 2640, Australia.

A rapid micro-manipulative trophi extraction method is described whereby rotifer trophi can be cleared from tissue and desiccated, individually or severally, on a microscope slide under dark-field dissecting microscope optics. The working volume consists of droplets on a siliconized microslide of, sequentially, sodium hypochlorite, rinse water, and a dehydration series to 100% ethanol. The process can be watched throughout, to minimise loss of fragile structures such as alulae, or disarticulation of trophi components. The cleared trophi are transferred by micropipette in a drop of final ethanol to carbon-tape on an SEM stub, where they can be oriented to the desired position with a micro-needle prior to complete evaporation of the alcohol. The advantage of the method is rapidity and precise control of the erosion process. Time from specimen extraction to mounting the cleared trophi on the stub can be as little as a few minutes, with a high success rate.

104. Instruments for use in rotifer studies

Howard L. Taylor
1812 Wood Hollow Court, Sarasota, Florida 34235-9146, USA

The important function of four instruments is discussed:
(1) The darkground stereo microscope in scanning collections and isolating rotifers and their trophi;
(2) The Microcompressor for movement and aspect control of specimen;
(3) The diaphragm pipette for stirring, isolating, metering and transfer;
(4) The pyrex needle and its many uses.

Call for material

Proalidae/Dicranophoridae

Willem De Smet, Department of Biology, University of Antwerp, R.U.C.A.-campus, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium requests specimens (no matter which ones) of Dicranophoridae and Proalidae. He can be contacted at < wides@ruca.ua.ac.be>

Rotifers of Surtsey?

Has anyone surveyed or come across a survey of the rotifers, especially the bdelloids, of Surtsey? Surtsey is a volcanic island off Iceland that was formed between 1963-1967. I know that some work has been done with

microorganisms, including algae. Please reply to Aydin Orstan by e-mail (bdelloid1@aol.com)."

South Atlantic rotifers?

Any information on published species lists, or indeed any records of marine and estuarine rotifers from the South Atlantic, would be appreciated. Contact Russ Shiel at MDFRC, PO Box 921, Albury, NSW 2640, Australia, or e-mail at shielr@mdfrc.canberra.edu.au

e-mail addresses

e-mail addresses will be collated at the Minnesota rotifer meeting for publication in *Rotifer News* #30. If you are recently connected to the Internet, and did not attend the Minnesota meeting, please advise your e-mail address to Russ Shiel <shielr@mdfrc.canberra.edu.au>

News'n'Views

In the absence of incoming news items for the global community, newsn'views is newsless....any contributions gratefully accepted for the next issue!!

Updated Bibliography

Ed. note: To maintain a comprehensive list of recent publications - authors should remember to pass on copies, or at least publication details, to one of the regional editors, or directly to Russ Shiel at MDFRC. In the list below, only the address for reprints is included. Every effort has been made to include a summary, however some lists sent by authors did not contain summaries, so these papers remain unseen. Some papers include keywords in lieu of a summary. The major subject areas in each citation are categorized below - many papers include several topics.

Aquaculture: 8, 28, 30;

Anatomy/Morphology/Physiology: 16;

Biochemistry/Genetics/Pharmacology: 4;

Biogeography/Taxonomy: 5, 7, 11, 12, 13, 22, 23, 24, 25, 26, 27, 29;

Ecology/Population dynamics/Food webs: 1, 2, 6, 10, 14, 15, 17, 21;

Reproduction: 9, 19, 20;

Toxicology: 3, 18.

1. AKINBUWA, O. & I.F. ADENIYI, 1996. Seasonal variation, distribution and interrelationships of rotifers in Opa Reservoir, Nigeria. *Afr. J. Ecol.* 34, 351-363. <<Obafemi Awolowo Univ., Dept Zool, Ife, Nigeria.>> The seasonal

variations, spatial distribution and interrelationships of rotifers in Opa Reservoir, Nigeria were studied and the relationship between rotifer species and certain physico-chemical parameters of the water described. The population density of rotifers was maximal during the rainy season, mostly concentrated at the top of the water column. Rotifer communities in the riverine source station were different from the open lake communities and rotifer population density was poorest in the riverine section. Significant correlations were found between rotifers and several physico-chemical parameters of which oxygen was the most pronounced. Considerable affinity and close associations were also found to exist between rotifer species.

2. DEIMLING, E.A., W.J. LISS, G.L. LARSON, R.L. HOFFMAN & G.A. LOMNICKY, 1997. Rotifer abundance and distribution in the northern Cascade mountains, Washington, U.S.A. *Arch. Hydrobiol.* 138, 345-363. <<Oregon State Univ., Dept Fisheries & Wildlife, Oak Creek Lab. Biol., Corvallis, OR 97331 USA>> In this study of Cascade mountain lakes in Washington state, both cluster analysis and detrended correspondence analysis (DCA) grouped dominant rotifer taxa. With both statistical techniques, each cluster of lakes was associated with characteristic physico-chemical variables and dominant crustacean zooplankton. Small, microphagous, loricate (hard-bodied) rotifers (*Keratella* or *Kellicottia*) dominated lakes: in 4 of the clusters; these lakes generally had low to moderate nutrient concentrations and low cladoceran densities. *Conochilus unicornis* dominated lakes in a fifth cluster; these lakes had relatively high levels of alkalinity and conductivity and also had high densities of cladocerans and diaptomids. *Collotheca mutabilis* dominated a single lake which composed a sixth cluster; this was a large deep lake with low alkalinity and conductivity. No significant relationships were evident between vertebrate predation and rotifer taxa.

3. DELVALLS, T.A., L.M. LUBIAN, M.G. DELVALLE & J.M. FORJA, 1996. Evaluating decline parameters of rotifer *Brachionus plicatilis* populations as an interstitial water toxicity bioassay. *Hydrobiologia* 341, 159-167<<L.M. Lubian, CSIC, Inst. Ciencias Marinas Anadalucia, Apartado Oficial, Puerto Real 11510, Cadiz, Spain.>> Population decline of the rotifer *Brachionus plicatilis* was evaluated as a sensitive and reliable bioassay for assessing toxicity of marine sediment interstitial water. Results indicated that, for each of the specified assays, the three parameters of the B. plicatilis population decline test were sensitive to concentrations of contaminants dissolved in interstitial waters (principally: total ammonia, Cu, Cr and alkylbenzenesulphonates) but not to particulate organic matter. Nevertheless, the presence or absence of mixed antibiotics with the contaminants may influence the *B. plicatilis* population decline test, principally by retarding the hatching of eggs. Based on these results, *B. plicatilis* is confirmed as an appropriate organism for use as an indicator of interstitial water contamination, using either decline rate, TL(50) or both parameters. The presence of particulate matter has no effect on these parameters, but the bacterial population may be an influence, although to a lesser extent than the toxicants.

4. DE MEESTER, L. 1996. Local genetic differentiation and adaptation in freshwater zooplankton populations: Patterns and processes. *Ecoscience* 3, 385-399. <<Catholic Univ Leuven, Lab Ecol & Aquaculture, Naamesestr 59, B-3000 Louvain, Belgium.>> The island-like nature of limnetic habitats creates opportunities for local genetic differentiation and adaptation to develop. It is argued that whereas the analysis of (quasi) neutral markers emphasizes the importance of long-lasting founder effects and genetic drift, the pattern of local genetic differentiation of ecologically relevant traits may often reflect local adaptation. In reviewing the data, the importance of temporal and spatial habitat selection in maintaining genetic polymorphism for ecologically relevant traits is emphasized, without denying the importance of stochasticity. Most available data are on *Daphnia*, but studies on other organisms in general confirm the patterns observed in this genus. A hypothetical scheme of the processes leading to local genetic differentiation and adaptation in zooplankton is discussed, with an indication of the data necessary to fill certain gaps in our knowledge. Attention is drawn to the frequent opportunities for local adaptation in cyclically parthenogenetic organisms (e.g., *Daphnia*, monogonont rotifers) and the processes leading to local adaptation in cyclically parthenogenetic, obligately parthenogenetic and obligately sexual species are compared.

5. DE SMET, W.H. 1996. Description of *Proales litoralis* sp. nov. (Rotifera,Monogononta:Proalidae) from the marine littoral. *Hydrobiologia* 335: 203-208. <<Department of Biology, University of Antwerp, R.U.C.A.-campus, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium.>> This new species is described

6. DOBBERFUHL, D.R., R. MILLER & J.J. ELSER, 1997. Effects of a cyclopoid copepod (*Diacyclops thomasi*) on phytoplankton and the microbial food web. *Aquatic Microb. Ecol.* 12, 29-37. << Arizona State Univ, Dept Zool, Tempe, AZ 85287 USA.>> Rotifers are among the microconsumers mentioned in this study. A plankton community unconditioned by *Diacyclops thomasi* predation was incubated with and without *D. thomasi* for 10 d. Microconsumer grazing rates on bacteria and phytoplankton, ciliate abundance, chlorophyll, phytoplankton biovolume, and bacterial abundance were quantified before and after incubation. *D. thomasi* significantly reduced ciliate abundances relative to controls *lacking D. thomasi. D. thomasi* treatments also had higher chlorophyll concentration, bacterial abundance and maximum growth capacity of phytoplankton relative to controls. These results are consistent with the hypothesis that increases in *D. thomasi* in Castle Lake following food web manipulation affected limnological processes by affecting microconsumer abundances with subsequent effects on algae and bacteria

7. DUMONT, H.J. & H. SEGERS, 1996. Estimating lacustrine zooplankton species richness and complementarity. *Hydrobiologia* 341, 125-132. <<State Univ. Ghent, Lab. Anim. Ecol., Ledeganckstr. 35, B-9000 Ghent, Belgium.>> Literature and original information reveals that lakes at any latitude may be expected to lodge +50 spp. of cladocerans, against +150

spp, of rotifers in the temperate, and +210 spp. in the tropical zone. Collector's curves can be used to estimate the number of species present at any point in time in a lake. Hyperbolic regression and Chao's non-parametric estimator were used to extrapolate from species numbers observed to true numbers present. Estimates for rotifers were better (had lower variances) than for cladocerans, and both were better in the temperate than in the tropical zone, where more species co-exist than in the temperate zone but where many more species are rare. Approximate numbers of samples required to approach true instantaneous species richness were calculated. However, a test in a (sub)tropical lake in Brasil where such an 'asymptotic' number of samples was collected and examined failed to reduce the variance, while recording a number of species higher than predicted. We conclude that seasonal succession was still significant here, and that more research is needed to determine the minimum number of sampling repeats needed for a full census. Lakes with an ATBI (All Taxa Biological Inventory) for rotifers and cladocerans were compared by a complementarity index. This revealed geographic gradients between lakes, strong for cladocerans, but less so for rotifers. It is argued that this mainly reflects a difference in the state of taxonomic advancement between these two groups, and that the theory of cosmopolitanism must be abandoned for both.

8. DURAY, M.N., L.G. ALPASAN & C.B. ESTUDILLO, 1996. Improved hatchery rearing of mangrove red snapper, *Lutjanus argentimaculatus*, in large tanks with small rotifer (*Brachionus plicatilis*) and *Artemia*. *Israeli J. Aquaculture - Bamidgeh* 48, 123-132. <<S.E. Asian Fisheries Devt Ctr, Dept Aquaculture, POB 256, Iloilo 5901, Philippines.>> A hatchery rearing scheme for the red snapper, Lutjanus argentimaculatus, is described. The feeding regime consisted of *Chlorella*, *Brachionus*, *Artemia* and minced fish. The average survival rate at day 24 was 27% in 3-ton tanks but only 3% in 0.5-ton tanks. From an initial length of 2.15 mm at stocking, larvae grew to 8.2 mm on day 24 and 30.6 mm on day 55. Growth and survival were best when larvae were fed screened *Brachionus* (<90 µm) during the first 14 days. Larvae fed *Artemia* at 1, 2 and 3 per ml per day weighed similarly on day 35 but were longer at the higher feeding levels and survived better at the lower levels. Larvae fed *Artemia* at 2 per ml had a higher survival when the ration was given four times a day rather than 1-2 times a day.

9. GOMEZ, A. & M. SERRA, 1996. Mate choice in male *Brachionus plicatilis* rotifers. *Functional Ecology* 10, 681-687. <<Univ. Valencia, Dept Microbiol. & Ecol., E-46100 Burjassot, Spain.>> 1. Some proximate mechanisms that increase the probability of successful copulation are examined in Brachionus plicatilis Muller (Rotifera), a cyclical parthenogen. By means of behavioural tests, an analysis was performed as to whether male choice exists concerning female age. Second, male direct discrimination of sexual (mictic) and parthenogenetic (amictic) females, on the basis of male behaviour after encountering both kinds of females, was examined. 2. Results showed that the probability of male mating initiation decreases with the age of female, and that males copulate almost exclusively with

females less than 24-h old. Preference for sexual females was also found in the probability of mating initiation, but no preference for copulating sexual females was found. 3. As only young, sexual females are fertilizable, these mechanisms would enhance the likelihood of a male copulating with a sexually receptive female, and thus male fitness. 4. A theoretical model shows that the surprisingly low degree of male preference for sexual females can be adaptively explained on the basis of relative frequency of young females and mictic females in the population when the sexual phase occurs.

10. HABERMAN, J. 1996. Contemporary state of the zooplankton in Lake Peipsi. *Hydrobiologia* 338, 113-123. <<Inst. Zool. Bot. Estonian Acad. Sci., Vörtsjärv Limnol Stn, EE2454, Rannu, Tartumaa, Estonia.>> L. Peipsi is one of the richest fish lakes in Europe. Food web inter-relationships are described. Herbivorous zooplankton production is 10% of primary production. Predatory zooplankton consume 50% of herbivorous zooplankton. About 6% of phytoplankton energy reaches fishes, with the detrital food chain regarded as of little importance. L. Peipsi is considered moderately eutrophic.

11. HALSE, S.A., R.J. SHIEL & G.B. PEARSON, 1996. Waterbirds and aquatic invertebrates of swamps on the Victoria-Bonaparte mudflat, northern Western Australia. *J. Roy. Soc. W.A.* 79, 217-224. <<CALM, Wildl. Res. Centre., PO Box 51, Wanneroo, WA 6065, Australia.>> Survey results from this remote mangrove/mudflat area of W.A. are tabulated. 62 spp. of waterbirds and at least 131 spp. of invertebrates were recorded. Some 30 spp. of rotifers were noted, at low diversity (2-15 spp. per site). *Scaridium elegans* Segers & De Meester was recorded for the first time from Australia, with 5-6 spp. of brachionids, euchlanids and lecanids apparently undescribed.

12. INGRAM, B.A., J.H. HAWKING & R.J. SHIEL, 1997. Aquatic life in freshwater ponds: a guide to the identification and ecology of life in aquaculture ponds and farm dams in south eastern Australia. *CRCFE Ident. Guide* 9, 1-105. <<Mar. Freshw. Res. Inst., Snobs Creek, Priv. Bag 20, Alexandra Vic. 3714, Australia.>> This guides series is aimed at providing identification keys and ecological information to a wide audience, in this case, to undergraduate and postgraduate students, naturalists, aquaculturists, *inter alia*. All commonly-encountered biota, from algae & macrophytes through protists, rotifers, macroinvertebrates and vertebrates are included. Keys throughout are to families and genera. 8 pp. of colour plates, 250 b&w line drawings.

13. JOSE DE PAGGI, S. 1996. Rotifera (Monogononta) diversity in subtropical waters of Argentina. *Annls Limnol.* 32, 209-220. << Consejo NaCl Invest Cient & Tecn, Inst NaCl Limnol, Macia 1933, RA-3016 Santo Jose, Santa Fe, Argentina.>> The rotifer fauna of twenty five localities (mainly shallow lakes)from Corrientes, Argentina was studied. 136 taxa were identified, 20 of which, from the genera *Lecane, Lepadella, Ploesoma, Ptygura, Squatinella, Testudinella* and *Trichocerca* are new to the

Argentine fauna. Most of these are (sub)tropical in distribution, and 8% are endemic to South America. *Ploesoma africana* Wulfert, *Ptygura kostei* n.sp., *Testudinella brevicaudata* Yamamoto and *Trichocerca vernalis* Hauer are recorded from the Neotropical region for the first time. The rotiferan species richness of this area, is remarkable. The highest diversity was recorded from vegetated lakes, with acid waters, where one locality yielded 56 species.

14. JURGENS, K., S.A. WICKHAM, K.O. ROTHHAUPT & B. SANTER, 1996. Feeding rates of macro- and microzooplankton on heterotrophic nanoflagellates. Limnol. Oceanogr. 41, 1833-1839. <<Max Planck Inst Limnol, POB 165, D-24302 Plön, Germany.>> Thirteen metazooplankton and three ciliate species were examined for their ability to prey on heterotrophic nanoflagellates (HNF). Grazing losses of two species of HNF, *Bodo saltans* (kinetoplastid) and *Spumella* sp. (chrysomonad), were estimated in batch experiments by the disappearance of HNF in the presence or absence of predators. Nearly all species examined caused mortality of HNF, but to different extents. Individual clearance rates ranged from a few mu l ind.(-1) h(-1) with ciliates and rotifers to a few ml ind.(-1) h(-1) with daphnids. Weight-specific clearance rates revealed that oligotrichous ciliates were the most efficient feeders on HNF, whereas differences among the filter-feeding metazoans (rotifers, calanoid copepods, cladocerans) were relatively slight. Cyclopoid copepods had the lowest weight-specific clearance rates and can be assumed to be inefficient grazers on HNF. Clearance rates of filter-feeders increased significantly with body length. These rates resemble the allometric relationships of herbivorous zooplankton feeding on phytoplankton. Although four grazer species had higher feeding rates on the bodonid than on the chrysomonad flagellates, the overall clearance rate: body length relationship was independent of the HNF species.

15. KIRK, K.L., 1997. Life-history responses to variable environments: Starvation and reproduction in planktonic rotifers. *Ecology* 78, 434-441. <<New Mexico Inst. Min. & Technol., Dept Biol., Socorro, NM 87801 U.S.A.>> The life-history responses of nine species of planktonic rotifers to food deprivation were compared using cohort life-table experiments. Allometric patterns of energy storage and respiration rate lead to the prediction that larger species should have greater starvation resistance than smaller species. Contrary to this prediction, when rotifers were acclimated to high resource levels and starved as young adults, body mass did not predict starvation time, Rather, there was a trade-off between survival and reproduction during starvation. Some species did not reproduce during starvation and had high starvation times (up to 5.0 d). Other species maintained or increased fecundity relative to fed controls and had low starvation times (as low as 0.4 d). Species with more rapid senescence when fed tended to have shorter starvation times. However, the interspecific trade-off between survival and reproduction remained after removing the effect of control survivorship. Differences in life-history responses to starvation may be critical in determining competitive outcome and community structure in variable environments. When

acclimated to low food levels prior to food deprivation, simulating conditions of declining resource abundance in nature, rotifer starvation time decreased. Juveniles had longer starvation times than adults, further supporting the idea that allocating energy to reproduction decreases starvation resistance.

16. KLEINOW, W. & H. WRATIL, 1996. On the structure and function of the mastax of *Brachionus plicatilis* (Rotifera), a scanning electron microscope analysis. *Zoomorphology* 116, 169-177. <<Zool. Inst. Univ. Köln, Weyertal 119, D50923 Köln, Germany.>>Individual *B. plicatilis* were sectioned and examined under SEM to determine orientation and structure of the trophi in relation to the mastax and to the animal. High quality photographs and detailed descriptions accompany inferred functional aspects, with conclusions drawn from the SEM observations.

17. LAYBOURN-PARRY, J, M. JAMES, D. MCKNIGHT, J. PRISCU, S. SPAULDING & R.J. SHIEL, 1997. The microbial plankton of Lake Fryxell, Southern Victoria Land, Antarctica during the summers of 1992 and 1994. *Polar Biol.* 17, 54-61. <<Univ. Nottingham, Dept Physiol. & Env. Sci., Loughborough LE12 5RD, Leics. England.>> This study of bacterioplankton and protists includes the first record of planktonic metazoans in the Dry Valley lakes of this region - two species of the bdelloid rotifer genus *Philodina*. Possible trophic interactions are discussed and comparisons with other continental Antarctic lakes made.

18. MARNEFFE, Y., S. COMBLIN, J.C. BUSSERS & J.P. THOME, 1996. Biomonitoring of the water quality in the river Warche (Belgium): Impact of tributaries and sewage effluent. *Neth. J. Zool.* 46, 337-350. <<Univ Liege, Lab Ecol Anim & Ecotoxicol, Inst Zool, Quai Van Beneden 22, B-4020 Liege, Belgium.>> Important seasonal and longitudinal changes of physical, chemical and biological water quality occur. The deterioration of the water quality in the river Warche is obvious in two sectors of the river. Strong organic pollution and eutrophication were observed between the source and the sampling station located downstream of Bullingen. Indeed, along this sector, tributaries, sewage and dairy effluent flow into the Warche and induce significant increase of nitrate, nitrite, ammonium and phosphate concentrations. As a consequence, biotic indices decrease significantly downstream of Bullingen and the most abundant rotifer species are clearly eutrophic indicators. Another important decrease of water quality was observed downstream of an important paper mill effluent which induces a significant increase of temperature and of nitrite and sulphate concentrations. The presence of two lakes along the Warche course induces downstream either a restoration of the water quality during a mixing period of the lake or an increase of ammonium and phosphate concentrations after water stratification as a result of a temperature gradient in the lake.

19. POURRIOT, R. & C. ROUGIER, 1997. Reproduction rates in relation to food concentration and temperature in three species of the genus *Brachionus* (Rotifera). *Annls Limnol.* 33, 23-31. <<Univ Paris 06, Ura 1367,

Lab. Geol. Appl., B123, 4 Pl Jussieu, F-5252 Paris 05, France.>> The influence of various algal (*Chlorella*) concentrations (from 5.10^3 to 1.10^7 cells mL^{-1} on the population dynamic is studied at two temperatures (16 & 24 °C) in three species, *Brachionus angularis*, *B. calyciflorus* (with two clones) and *B. plicatilis*. By observing about fifteen isolated females, the net reproduction rate, R(0), the intrinsic population growth rate, r(m), the threshold, food level (for which r(m)=0), S-0, and the algal concentration, Ks, supporting the maximum population growth rate (or one-half) are determined. The values of these variables are compared with each others and with the literature data. The low values observed in the B. plicatilis strain are conspicuous. This peculiarity is related to the metabolism of the species adapted to various salinity and food conditions.

20. RICO-MARTINEZ, R., B. DINGMANN & T.W. SNELL, 1996. Surface glycoproteins potentially involved in mate recognition in nine freshwater rotifer species. *Arch. Hydrobiol.* 138, 1-10. <<Univ. Autonoma de Aguascalientes, Centr. Basico, Dept de Quimica, Boulevard Univ. 940, Aguascalientes, Ags., C.P. 20100, Mexico.>> A surface protein in *Brachionus plicatilis* functions as a mate recognition pheromone. A polyclonal antibody to this glycoprotein binds to the body surface of nine freshwater rotifer species at sites important in mating behaviour - corona and foot in brachionid species, elsewhere in non-brachionids.

21. SAIKAWA, M. 1997. Light and electron microscopy of Zoophagus tentaclum, a rediscovered rotifer-capturing aquatic fungus from Japan. *Mycologia* 89, 268-273<<Tokyo Gakugei Univ, Dept Biol, Nukuikita Machi, Koganei, Tokyo 184, Japan.>> *Zoophagus tentaclum* Karling was recovered from submerged dead leaves collected in a mountain stream at Mito-sawa, Hinohara-mura, Tokyo, Japan. This is the first report of this fungus since its discovery. The trapping organ of the fungus is a short, lateral branch distally bearing several narrow tentacle-like hyphae, each terminating in a knob. The morphology of the rotifer-capturing fungus was almost identical to that described by Karling. Infection is initiated when a rotifer attempts to swallow the whole trapping organ. Electron microscopy revealed that the apical portion of one of the tentacles was pinched by a pair of unci of the rotifer's trophi, and an adhesive exuded only from that portion of the tentacle found in the trophi. Then, an accessory infective branch developed, not from the tentacle, but from the distal portion of the lateral branch before penetration into the rotifer. Such a branch, developing before penetration of the host, has not been reported for the other two species of the genus, *Z. insidians* and *Z. pectosporus*. The fungus was also found to capture a species of testaceous rhizopod.

22. SANOAMUANG, L.-O. 1996. *Lecane segersi* n sp (Rotifera, Lecanidae) from Thailand. *Hydrobiologia* 339, 23-25. <<Khon Kaen Univ., Fac. Sci., Dept Biol., Khon Kaen 40002, Thailand.>> Lecane segersi n.sp. collected from a swamp in Udornthani province, northeastern part of Thailand, is described and figured. It is closely related to the common, warm-stenotherm Lecane papuana (Murray), but distinguished by the presence of inwardly directed antero-lateral spines.

23. SEGERS, H. & P. PHOLPUNTHIN, 1997. New and rare Rotifera from Thale-Noi Lake, Pattalang Province, Thailand, with a note on the taxonomy of Cephalodella (Notommatidae). *Annls Limnol.* 33, 13-21. <<State Univ. Ghent, Dept MSE, Lab. Anim. Ecol. Zoogeog. & Nat. Conservat., Kl Ledeganckstr 35, B-9000 Ghent, Belgium.>> The rotifer fauna present in Thale-Noi Lake, Pattalang Province, Thailand on the 16th September 1995 is reported. A total of 106 species, the majority of which belong to the genera *Lecane* (31%), *Lepadella* (13%) and *Brachionus* (9%) are recorded. *Cephalodella songkhlaensis* n.sp. and *Trichocerca siamensis* n.sp. are described, *Lecane calcaria* Harring & Myers is redescribed. An additional fourteen rotifer species are recorded for the first time from Thailand. The genera *Metadiaschiza* Fadeew and *Paracephalodella* Berzins are synonymized with *Cephalodella* Bory de St. Vincent.

24. SEGERS, H. & R. POURRIOT, 1997. On a new and puzzling American rotifer (Rotifera: Monogononta, Lecanidae). *J. Nat. Hist.* 31, 383-388. <<address above.>>A new species of monogonont rotifer, *Lecane difficilis* n. sp., is described from French Guyana. The taxon also occurs in Brazil and North Carolina, USA, following reassessment of illustrated literature records. The superficial similarity of *L. difficilis* with the Old World tropical *L. unguitata* (Fadeew) may account for some non-verifiable records of the latter from the New world.

25. SEGERS, H. & Q-X. WANG, 1997. On a new species of *Keratella* (Rotifera: Monogononta: Brachionidae). *Hydrobiologia* 344, 163-167. <address above.>>*Keratella sinensis* n. sp. is described from L. Yaoquan, PRC> It probably occurs also in Korea and Japan. It is characterised by an unusually smooth lorica and strongly reduced anterior spines. It is the first recorded endemic planktonic rotifer for north east Asia.

26. SEGERS, H., W.H. DE SMET & D. BONTE, 1996. Description of *Lepadella deridderae deridderae* n. sp., n. subsp. and *L. deridderae alaskae* n. sp., n. subsp. (Rotifera : Monogononta, Colurellidae). Belgian Journal of Zoology 126, 117-122<<RUG, Dept MSE, Zoogeog & Nat Conservat, Lab Anim Ecol, Kl Ledeganckstr 35, B-9000 Ghent, Belgium.>> A new species of Lepadella, L. deridderae n.sp., and two of its subspecies, deridderae and alaskae are described from a temporary pond in the "Westhoek" Nature Reserve, De Panne, Belgium, and a trench of a tundra polygon at Point Barrow, Alaska. The new species belongs to the group of L. triptera, and is diagnosed by having five dorsal carinas.

27. SONG, M.O. & W. KIM, 1996. Taxonomic study on the digonont rotifers of Korea: six new records of philodinid rotifers. *Korean J. Syst. Zool.*, 12, 349-358. <<Six bdelloid rotifers are newly recorded from Korea: *Philodina vorax, Philodina flaviceps, Philodina acuticornis odiosa, Didymodactylus carnosus, Macrotrachela multispinosa crassispinosa, Macrotrachela papillosa*. All these are fully redescribed and illustrated.

28. TOCHER, D.R., G. MOURENTE & J.R. SARGENT, 1997. The use of silages prepared from fish neural tissues as enrichers for rotifers (Brachionus plicatilis) and Artemia in the nutrition of larval marine fish. Aquaculture 148, 213-231. <<Univ Stirling, Dept Biol & Mol Sci, NERC, Unit Aquat Biochem, Stirling FK9 4LA, Scotland.>> Marine fish larvae have a requirement for large quantities of n-3 highly unsaturated fatty acids (HUFA), particularly docosahexaenoic acid (DHA; 22: 6n-3), and dietary deficiencies of these induce a range of pathologies in fish including behavioural abnormalities. Therefore, there is a growing demand for natural lipids highly enriched in DHA as nutritional supplements during larval development. In the present study, DHA-rich products were obtained from fish neural tissues by a procedure involving ensiling in organic acids followed by neutralisation, drying, milling and sieving to produce the final particulate, crumbed products. Lipid content varied in the neural tissue silages from 5.5% to 46.5% but all lipid contained high percentages of DHA and high DHA:EPA (eicosapentaenoic acid; 20:5n-3) ratios ranging from 3.5 to 5.4. Tuna eye silage was a high lipid, high triacylglycerol (90.6% of total lipid) product and was particularly effective in increasing DHA content, outperforming a commercial product, in rotifer (Brachionus plicatilis) enrichment. Cod brain/eye silage had an intermediate content (18.2%) of lipid, which contained almost 50% as phospholipid, and proved as effective as a commercial enricher in increasing DHA content in Artemia nauplii, Moreover, Artemia nauplii, enriched with the cod brain/eye silage were more effective than nauplii enriched with a commercial enricher in increasing the DHA content of larval turbot brain. In conclusion, tuna eye and cod brain/eye silages are useful as enrichers of Artemia nauplii and rotifers for feeding marine fish larvae prior to weaning onto pelleted formulated diets.

29. VIRRO, T. 1996. Taxonomic composition of rotifers in Lake Peipsi. *Hydrobiologia* 338, 125-132.<<Tartu State Univ, Dept Zool & Hydrobiol, 46 Vanemuise St, EE-2400 Tartu, Estonia.>> 161 rotifer taxa 46 of which are new records for Estonia were identified in the north-western part of Lake Peipsi. The greatest number of taxa occurred in August (93), followed by September (79). In all, 19 families (Monogononta) are represented with 41 genera. The dominant families are Brachionidae (32 taxa) and Synchaetidae (16). The species of *Anuraeopsis, Conochilus, Kellicottia, Keratella, Notholca, Polyarthra* and *Synchaeta* are dominating. The taxonomic composition is analysed in the ecological aspect. Some species of zoogeographic interest, including a supposedly endemic *Ploesoma peipsiense*, are reported.

30. ZHENG, F., T. TAKEUCHI, M. KOBAYASHI, J. HIROKAWA & T WATANABE, 1997. A study of vitamin E absorption in rotifer and cod larvae and the effect of DHA content in rotifer for cod larvae. Nippon Suisan Gakkaishi 63, 77-84. <<Tokyo Univ Fisheries, Dept Aquat Biosci, Minato Ku, Tokyo 108, Japan.>> An experiment was conducted to determine the absorption of vitamin E (VE, alpha-toc.) in rotifer and cod larvae, and the effect of DHA content in rotifer on the dropsy rate of cod larvae. In this experiment, rotifers were enriched with dry shark eggs

supplemented with different levels of three types VE, such as DL-alpha-toc. acetate, DL-alpha-toc. free, or D-alpha-toc. free. It was shown that D-alpha-toc. free was accumulated in rotifer more efficiently than DL-alpha-toc. free. Cod larvae can convert DL-alpha-toc, acetate to a free type of VE, but its absorption was low compared with the free type of VE. Furthermore, it was also found that the occurrence of dropsy rate in cod larvae reduced when the DHA content in rotifer was increased.

New taxa reported

New rotifers described since the last issue of the newsletter, their geographical region, and the refence in which they are cited, are listed below:

MONOGONONTA

Cephalodella songkhlaensis Segers & Pholpunthin, 1997: Thailand #23
Keratella sinensis Segers & Wang, 1997: China #25
Lecane difficilis Segers & Pourriot, 1997: French Guyana #24
Lecane segersi Sanoamuang, 1996: Thailand #22
Lepadella deridderae deridderae Segers *et al.* 1996: Belgium #26
Lepadella deridderae alaskae Segers *et al.* 1996: Alaska #26.
Proales litoralis De Smet, 1996: marine #4
Trichocerca siamensis Segers & Pholpunthin, 1997: Thailand #23

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