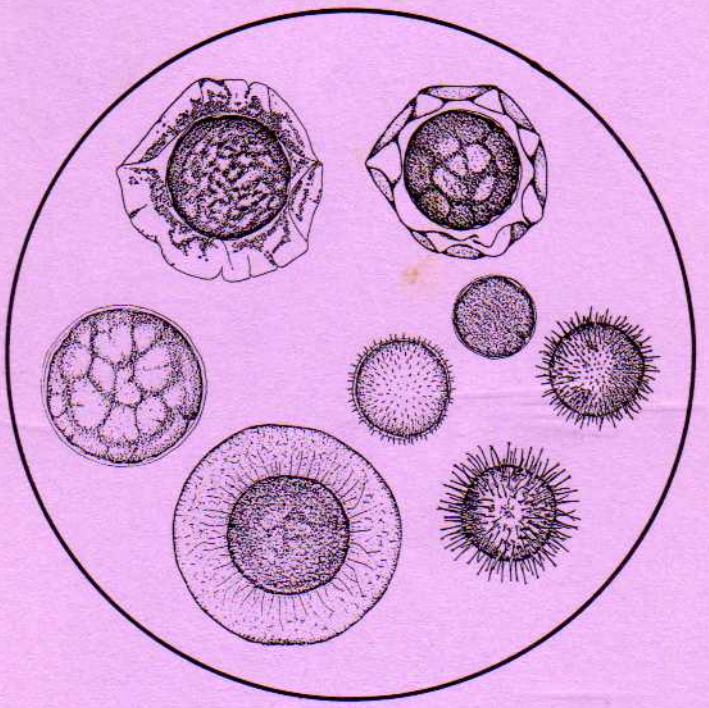
ISSN 0722-5741

MONOCULUS

Copepod Newsletter



Nr. 38

OCTOBER 1999

bis

Bibliotheks- und Informationssystem der Universität Oldenburg

North American Edition distributed by National Museums of Canada

MONOCULUS

Copepod Newsletter

Number 38 October 1999

Edited by: Hans-U. Dahms and H. Kurt Schminke, Fachbereich 7 (Biologie), Universität Oldenburg, D-26111 Oldenburg, Germany.
Produced by: Bibliotheks- und Informationssystem (BIS) der Universität Oldenburg, Ammerländer Heerstr. 67/99, D-26111 Oldenburg, Germany.
Distributed in Canada by: E.J. Maly, Concordia University, Biology Dept. 1455 de Maisonneuve Blvd. W, Quebec H3G IM8 Montreal, Canada.
Distributed in Europe and overseas by: H.-U. Dahms, Universität Oldenburg, Fachbereich Biologie, D-26111 Oldenburg, Germany.
Distributed in India by: M. Madhupratap, National Institute of Oceanography, Dona Paula, Goa 40 3004, India.
Distributed in Japan by: S.-i. Uye, Hiroshima University, Faculty of Applied Biological Science, 4-4 Kagaeniyama 1-chome, 724 Higashi-Hiroshima, Japan.
Distributed in Taiwan by: C.-t. Shih, Natn. Univ. of Taiwan, Dept. Zool., 106 Taipei, Taiwan.
Distributed in the U.S. by: Frank D. Ferrari, National Museum of Natural History, Smithsonian Institution, Department of Invertebrate Zoology, MRC 534, Washington D.C. 20560, U.S.A.
Distributed in Brazil by: Rubens Lopes.

Chad Walter (U.S.A.) is acknowledged for substantial help in providing literature sources.

This issue has been typed by: Angelika Sievers and Herta Sauerbrey. Cartoons were provided by M. Pottek (Fachbereich 7, Universität Oldenburg).

Cover: Eggs of 6 calanoid copepod species from sea-bottom muds (after Kasahara et al. 1974. Marine Biology 26: 167-171).

Birthdays in 1999:	80:	W.J.P. Smyly	Torben Wolff
	75:	E.D.S. Corner	Ted Hammer
		Michel B. Harding	Zbigniew Kabata
	70:	Patricia L. Dudley	C.H. Fernando
		George D. Grice	Jan Heeg
		Reiichiro Hirota	H. Perry Jeffries
		David Kahan	Vlastimil Kulhavy
		Livia Neagu	Taisoo Park
		Vernon E. Thatcher	David Tranter

The MONOCULUS homepage is available from the www-service under:
http://www.hrz.uni-oldenburg.de/monoculus.
We try to keep it up with the most recent information.

Deadline for the next issue of MONOCULUS: 31st March 2000.

EDITORIAL

We are all looking back to a most interesting and stimulating conference - the 7th ICOC held in Curibita. Thanks again to the organizers and their many helping hands! In this autumn issue of MONOCULUS we will include letters of Rubens Lopes, Horst Kurt Schminke and the new president Geoff Boxshall with resumés on this event. In particular we will present the talk of Carlos da Rocha in honour of Tagea Björnberg - to whom this conference was dedicated.

Some sad news also - Arthur Humes, founding member, past president of the WAC and most proliferative Copepod systematist (more than 600 copepod species were described by him) has passed away on the 16th October while being on the way to his lab at Woodshole. An obituary by J.-s. Ho will follow this editorial.

The MONOCULUS 37 spring issue has been transferred to the MONOCULUS homepage (http://www.hrz.uni-oldenburg.de/monoculus).

A compilation of all WAC-member addresses is available upon request from Hans-U. Dahms. In particular, we thank Geoff Boxshall, J.-s. Ho, Gerry Marten, Carlos Rocha, Eduardo Soares Morales, Melckzedeck Osore, Jens Hoeg, Rubens Lopes, and Horst Kurt Schminke for their contributions. Angelika Sievers, Herta Sauerbrey, and Hilde Juhl are thanked for substantial help with the text, and Mark Pottek for garnishing it with caricatures.

In view of the fact that about 350 colleagues are receiving the MONOCULUS newsletter, much more active participation would be desirable. Please, don't hesitate to send us all information that you consider interesting. Candidate members - without further notice - are requested to send a short biography.

For some time, MONOCULUS has been gathering reprints in the MONOCULUS library. You will find those here under "LITERATURE" marked by an asterisk. Therefore, keep or put MONOCULUS on your mailing list.

We wish all WAC-members a peaceful Christmas and a good and cheerful start into the new millennium!!!

Mailing

Looking at your address label you will find some additional information. This is to remind you of your status in relation to WAC and when to pay the next dues. **Members with dues waived will be removed from the mailing list.**

91-99 = WAC member, dues paid including printed year
W = Membership dues waived
NM = New member, no dues paid
NM99 = New member, dues paid including 99
CM = Candidate member, no dues paid
CM99 = Candidate member, dues paid including 99

✞ Arthur Grover Humes
22 January 1916 - 16 October 1999

Arthur G. Humes died 16 October 1999 on his way to work at the Marine Biological Laboratory in Woods Hole, Massachusetts. He had devoted his professional life to research on copepods, particularly copepods symbiotic with marine invertebrates.

Born on 22 January 1916 in Seekonk, Massachusetts, Arthur G. Humes graduated with a B.A. in 1937 from Brown University. Arthur originally considered a career as a parasitologist and entered Louisiana State University, earning his M.S. in Zoology in 1939. He entered the doctoral program of the eminent parasitologist H. J. Van Cleave at the University of Illinois and completed an extensive study of the parasitic ribbon worms Carcinonemertes. Arthur experienced his first close encounter with symbiotic copepods while collecting parasitic nemerteans from the gills and egg masses of various crabs. He was awarded his Ph.D. in 1941. In that year he published his first paper on copepods, about a new species of harpacticoid copepod, *Cancrincola plumipes*, recovered from the gill chamber of a marsh crab that he had collected while studying the parasitic ribbon worms of crabs at Louisiana State University's Marine Laboratory located at Grand Isle, Louisiana.

Upon graduation, Arthur took a teaching position with the Department of Biology at the University of Buffalo in the upstate New York. However, with the outbreak of the World War II, he was drafted in 1942 to serve in the United States Navy and worked at its medical unit in charge of malaria control. There he had an opportunity to apply his knowledge of parasitology during his military service as a Lieutenant Commander stationed in the South Pacific. Toward the end of World War II in 1945, with the northward movement of the frontlines from the South Pacific to Saipan, Iwo Jima, and Okinawa, the military life in Kalimantan (Borneo) became relatively relaxed. Thus, Arthur found a little time to resume his life-long hobby of beach combing for invertebrates, and was able to collect copepods associated with crabs and mud shrimps at Tarakan on the northeast coast of Kalimantan, Indonesia. This collecting experience in Indonesia further stimulated Arthur's interest in copepods, and throughout his life he made frequent trips to the tropics to collect symbiotic copepods.

Arthur received his honorable discharge from the U.S.N.R. in 1946 and returned to the U. S. to teach at University of Connecticut for a year before taking a teaching position in 1947 at Boston University. He was affiliated with this institution till his retirement in 1981. In 1970 Arthur was asked to become Director of the Boston University Marine Program, newly established at the Marine Biological Laboratory in Woods Hole, Massachusetts, the center of marine biology of North America. Accepting the position would require Arthur to move from Boston, and to assume administrative responsibility with which he was not especially comfortable. He did accept the directorship and made the Boston University Marine Program one of the finest marine programs in the world. In 1981, Arthur retired from the program, but continued work at the Marine Biological Laboratory. He soon agreed to a different set of responsibilities for the newly established The Crustacean Society, editor of the Journal of Crustacean Biology. He produced the first issue of the journal in 1981. Under his guidance it has become the leading international journal of crustacean research with exacting standards of quality for published manuscripts. He was to retire from the editorship at the end of 1999. Knowing his firm intent to retire, The Crustacean Society secretly planned in 1998 to publish a special issue of the Journal in 2000 to honor Arthur's great service and contribution to the Society.

In June 1954, Arthur took his first sabbatical leave, supported by a fellowship from the John Simon Guggenheim Memorial Foundation. He traveled to the French-speaking West African countries of Senegal, Sierra Leone, Ivory Coast, Nigeria, and Congo where he collected copepods associated with various marine invertebrates. Before returning to Boston

in June 1955, Arthur made a decision of significance to his research career. With the remaining funds from his fellowship he decided to fly across Africa to Station Océnographique de Nosy Bé on a tiny island off the northeastern shore of Madagascar, the large island off the east coast of Africa. At Nosy Bé he found a great diversity of marine invertebrates and their symbiotic copepods. So rewarding were his collecting efforts that he returned to Nosy Bé three times in the 60's to collect copepods: in 1960 during an expedition sponsored by the Academy of Natural Sciences of Philadelphia; in 1963-64 as a leader of the U. S. Program of Biology under the auspice of the International Indian Ocean Expedition; and in 1967 through a grant from the U. S. National Science Foundation. In 1993 Arthur published a catalogue containing 244 species of copepods that he had described and collected from Nosy Bé. But, that is not all, he had not yet touched on the many collections of notodelphyids and ascidicolids that were obtained from the tunicates. His collecting effort was not confined to Nosy Bé, Madagascar. With continuous support from the U. S. National Science Foundation, he went to collect in 1969 at Eniwetok Atoll of Marshall Islands, in 1971 at New Caledonia, and in 1975 during the Alpha Helix East Asia Bioluminescence Expedition to Mollucas.

In the 50's Arthur completed his studies of copepods collected during his sabbatical leave to West Africa. During the 60's he published mostly on the copepods collected from West Indies and Nosy Bé. In the 70's there was a gradual shift in his studies from the Caribbean Sea and western Indian Ocean to the copepods living in association with various invertebrates occurring in Eniwetok Island, Mollucas, and New Caledonia. Arthur began in the 80's to publish his works on the copepods collected in the water around deep-sea hydrothermal vents, which had been discovered in the late 70's, as well as the copepods associated with vent animals.

Arthur's greatest contribution to copepodology is his discovery and description of many symbiotic copepods which occur in association with a diversity of marine animals, ranging from primitive sponges to more specialized marine mammals. In his half century (1941-1999) of work, he published more than 250 papers and monographs on the symbiotic copepods, described no less than 650 new species and created more than 140 new genera and 16 new families. An exact number of species and genera of copepods new to science cannot be determined at this time because there are manuscripts by Arthur either in press or submitted for publication. In the history of copepodology, no copepod taxonomist has been as productive.

More than a wonderfully effective taxonomist, Arthur was a distinguished teacher as well as an excellent editor and director of scientific programs. In 1983 he served as President of the American Microscopical Society; in 1990 he was elected President of the World Association of Copepodologists. He is a Fellow of the American Academy of Arts and Sciences and a Research Associate at the Museum of Comparative Zoology of Harvard University. In 1982, William Jaspersohn, a popular writer of a series of photodocumentary books, selected Arthur among the many eminent marine biologists in Woods Hole to be the model of his new book "A Day in the Life of a Marine Biologist". The book describes Arthur's day, work in his office and laboratory, plus a field trip with students in his class in marine invertebrate zoology. It is a book very pleasantly read, about a kind and considerate gentleman who also is an excellent biologist and scholar.

Arthur is well known among his associates, colleagues, and students as a kind and considerate gentleman. This courteous nature of Arthur is also revealed in his works on the symbiotic copepods. From time to time he would produce review articles or monographs for a group of copepods or a group of hosts with all of the reported copepod associates, in order to facilitate an easy way for the interested biologists to follow. Some notable examples of such works are in his reviews of the lichomolgid-complex, xarifid copepods, poecilostomatoids associated with soft corals, copepods of holothurians, and copepods associated with sea anemones.

In his more than half-a-century affiliation with Boston University, the hardworking Arthur enthusiastically directed many of his students along the path of parasitology, copepodology, and marine invertebrate zoology that he had gingerly paved. Aside from being the teacher, mentor, and director of his students, Arthur served also the role of guardian to them. Every day at work, he would have in his office a tea time in the morning and a coffee break in the afternoon for his students to get together to relax, joke around, and talk about anything. Five of his former students followed his footsteps in copepodology, they are Roger F. Cressey, Masahiro Dojiri, Ju-shey Ho, John P. Murnane, and David C. Rosenfield. Arthur will be greatly missed by his friends and colleagues around the world in addition to his former students.

Ju-shey Ho (prepared with help from Frank D. Ferrari)

7th International Conference On Copepoda – Curitiba, Brazil

It was a great pleasure to host our triennial conference last July. We enjoyed every minute of those busy days behind the scenes! Many thanks to all 228 attendants from 37 countries who contributed with their presentations (a total of 142 posters and 64 talks), discussions and interesting conversations. Hope that you profited from the scientific and social activities as much as we did. Being aware of the difficulties in raising travel funds these days, we were extremely happy to meet so many colleagues in Curitiba. I'd like to point out that graduate students working on the different aspects of copepod research comprised 40% of the audience – such figure seems to reflect the exponential growth phase of our world association! We are now working hard on the submitted manuscripts and expect to finish the first round of revisions in a few more weeks. With our warmest regards,

Rubens M. Lopes (Ilhéus)
On behalf of the Organizing Committee

Report on the preconference workshop in São Sebastião 20 – 23 July 1999

"COEPEPOD DIVERSITY IN THE NEOTROPIS: PRESENT KNOWLEDGE AND NEW DIRECTIONS FOR RESEARCH"

Everything was perfect. It was my first trip to South America. Carlos Rocha awaited his guests at the airport in São Paulo. We were taken by taxi to the Lorena Flat Hotel in the city where others had already spent a night and from where a bus took us to São Sebastião. A welcome reception in the evening at the Ana Doce Hotel allowed first contacts with South American copepodologists among whom there were some I knew only from the literature. The next morning we sat in the lecture room of CEBIMar (Centro de Biologia Marinha), the marine research station of the University of São Paulo, a few kilometres outside São Sebastião with a magnificent view down to the sea. Steps that were easy the way down led to the beach which is the type locality of a number of copepod species. Tagea Björnberg was full of stories about the history of the station of which she herself was a prominent part.

The parade of neotropical copepods began. First came the parasitic and associated copepods, then the marine ones followed by a long row of freshwater copepods representing different nationalities and introduced first from north to south in the following order: Mexico; Nicaragua, Colombia, Venezuela, Guayana, Surinam, French Guayana, then from south to

north in the sequence Chile, Argentina, Uruguay, to end up with Brazil. As German speaking authors had left their marks in every country a summary was finally given of their achievements and taxonomic legacy written in German and of no easy access for today's South American copepodologists. This parade took one and a half days.

Before discussing the results we were introduced to a research programme of the State of São Paulo for biodiversity conservation and sustainable use which was impressive not only because of its concept but also because of the funds available for it. Nothing equivalent can be found in Germany and in many other European countries either. Inspired by such prospects the group discussions produced re-commendations for future research on neotropical copepods without aiming at formulating concrete research plans. These recommendations reveal the enormous amount of work that remains to be done starting with very basic taxonomic work. When this has been done phylogenetic and biogeographic studies may follow. The prospects were discussed further on a bus tour to the historical town of Paraty and the national reserve Parque Estudial da Serra do Mar – Nucleo Picinguaba. Finally a summary was produced which was shown as a poster at the Curibiba conference.

The organizers had done a marvellous job. As I said at the onset, everything was perfect. The next step must be concrete research projects. Without them the workshop would not be the signal it was meant to be. Here are the main conclusions and recommendations:

Gaps:

a) In taxonomic knowledge
In Brazil, very little is known about parasitic and associated copepods, marine benthic and planktobenthic copepods, and harpacticoid copepods in general. In other Latin American countries harpacticoids also are sorely in need of study. Certain groups of copepods are important in aspects of public health, fisheries, aquaculture and threatened habitats, and their study is directly relevant to and justifiable to promote human welfare.

b) In taxonomic expertise
There are some 44 taxonomists and other specialists capable of identifying copepods in Latin America, geographically distributed as follows: Brazil (13), Mexico (10), Nicaragua (2); Costa Rica (1); Colombia (2); Venezuela (2); Bolivia (2); Chile (5); Uruguay (1); and Argentina (10). Regional directories of taxonomists would be useful. The future of taxonomic research appears uncertain because of the lack of positions and low levels of support for taxonomic projects from governments.

c) In geographical coverage
Areas especially in need of investigation include: the Mexican deserts, Nicaraguan lowlands including coastal areas, the Central American bridge, the high Andean lakes, the Orinoco basin, Caribbean and Bolivian lowlands, and the Chaqueña biogeographical province. There are extensive geographical lacunae including the entire country of Guyana.

d) In habitat sampling
Certain kinds of habitats are of special interest, because they are poorly known, or may harbour especially species-rich and/or endemic copepod faunas. These include the non-limnetic zones of lakes, river systems, cryptic habitats (such as the psammon, hyporheos, and phytothelmata), coastal ecosystems, and coral reefs.

Taxonomic tools

Collections are vital resources. Identifying and rescuing "orphan" collections as well as organising directories of regional collections are also very important.
It was strongly recommended that voucher specimens from ecological surveys should be deposited in museums. Taxonomists are encouraged to produce user-friendly keys, and articles on new taxa may usefully include sections with updated keys. Phylogenetic studies should be encouraged.

Training needs

Regional or even international courses on copepod identification would provide good opportunities for junior taxonomists and ecologists to learn about identification of various groups and to improve the quality of determination of local faunas. Scholarships are required to facilitate the participation of students. Courses in phylogenetic and molecular methods should also be emphasised. The series of meetings of the "Congreso Brasileiro de Plâncton" should be reactivated.

The question of introduced / invasive species in the neotropics

Organizing a directory of invasive species and likely routes of invasion is desirable. The focus should be on estuaries and port areas. We recommend controls on ballast water, and on imported and translocated fish and crustaceans, particularly in regard to management of parasitic copepods.

Vulnerable / endangered species and habitats

An array of human activities constitute potential threats to the neotropical fauna. These include construction of dams, urban/industrial development, pollution, tourism and associated development, deforestation, and gold mining. Areas especially in need of protection are wetlands, anchialine environments, karstic habitats, mangrove areas, and saline lakes. Specialists are encouraged to alert government agencies to the existence of species of concern, i.e., *Microdiaptomus* and certain species of *Boeckella*, for example by listing them in Red Data Books.

Biogeographical indicators

Useful biogeographical indicator taxa could be hypogean harpacticoids, Diaptomidae, and Boeckellidae. Comparative studies of the South American and African faunas, as well as those of Patagonia / Antarctica / Australia would certainly contribute to the understanding of the biogeography of those continents or regions. The origin of island faunas should be better investigated. Supposedly cosmopolitan and/or amphiatlantic taxa require re-examination.

Horst Kurt Schminke (Oldenburg)

FAREWELL TO CURITIBA

by Geoff Boxshall - President elect of the WAC

It is my very pleasant duty as new President of the WAC to collectively express the heartfelt gratitude of the copepodological community to the organisers of the Seventh International Conference on Copepoda held last July in Curitiba, Brazil. It is all too easy, as we fly to and from conferences, to forget that this intense week of communication and science represents just the tip of a massive iceberg to the organisers. Rubens Lopes, the local organising committee and the legion of willing helpers had been hard at work for months and months before we arrived - preparing programmes, abstract books, websites, searching for funds and answering countless questions from participants. They are still at work now, with the editing of the proceedings volume. It was only through their sustained efforts and detailed planning that we all had rooms, food, entertainment, local transport and a science programme that did justice to our research.

So, on behalf of all the participants at the 7th ICOC in Curitiba, I would like to say a huge "thank you" again to Rubens, to the whole local committee and to all those colleagues who contributed so substantially to its success. We had a great time.

WAC BUSINESS MEETING

The WAC continues to grow and to evolve. It is an honour to thank the past president, Dr Ju-shey Ho, the Secretary (Eduardo Suarez Morales) and Treasurer (John Fornshell), and all the executive Council Members (Grace Wyngaard, Jack Greenwood, Ruth Boettger-Schnack, Hans-Uwe Dahms, Shuhei Nishida and Rubens Lopes) for their endeavours on behalf of the Association. You all did a grand job and we are all grateful for the time you spent guiding the WAC through the past three years. A short formal report of the WAC business meeting has been submitted by the Secretary (Eduardo Suarez Morales) and is also contained in this issue of Monoculus.

TAIWAN 2002

We all sincerely congratulate Prof Jiang-Shiou Hwang on his successful bid, on behalf of the copepodologists of Taiwan, to host the Eighth International Conference on Copepoda. The members voted convincingly for Taiwan as the next venue and we are delighted that Jiang is so willing and enthusiastic to invite us all in 2002. I am excited that the meeting will be held in Taiwan and I am looking forward to helping Jiang prepare for 2002. His contact details are as follows - keep watching Monoculus for more details of this next meeting.

Jiang-Shiou Hwang, Ph.D.
Director and Professor
Institute of Marine Biology
National Taiwan Ocean University
Keelung, 202 Taiwan, ROC.
Tel: 886-2-24622192 ext. 5304
Fax: 886-2-24629464
E-mail: JSHWANG@NTOU66.NTOU.EDU.TW

THE FUTURE OF THE WAC

It was apparent at the business meeting that the time is right for a re-examination of the constitution of the WAC, the structure and size of the Executive Council, and its programme of work. The new Executive Council is taking forward these issues and will prepare recommendations which will be circulated to the members *via* Monoculus and *via* a new WAC website, prior to the next conference.

We have identified a number of priority issues and for each one we have (a) member(s) of the Executive Council who will act as the focal point for any feedback and dialogue. The issues and the focal points are:

1. Reexamine the constitution of the WAC and the structure/size of the Executive Committee - and propose any changes to next meeting in 2002.
Geoff Boxshall (g.boxshall@nhm.ac.uk)

2. Circulate these proposed changes to the WAC membership well in advance of that meeting.
Geoff Boxshall (g.boxshall@nhm.ac.uk)

3. Consider the difficult question of non-paying members (a separate issue from our continuing support of those members that are unable to pay).
Eduardo Suarez Morales (esuarez@ecosur-qroo.mx)
and John Fornshell (JFORNSHE@lan.tjhsst.edu)

4. Develop a student bursary scheme.
Janet Reid (reid.janet@nmnh.si.edu)

5. Develop and publicise a Best student papers scheme ready for Taiwan 2002
Janet Reid (reid.janet@nmnh.si.edu)

6. Discuss the establishment of an electronic version of Monoculus
Hans-Uwe Dahms (HUDAHMS@hrz1.uni-oldenburg.de)

7. Establish a WAC website
Rubens Lopes (rmlopes@jacaranda.uescba.com.br)

8. Consider a phased expansion of WAC activities - into training, into pushing the profile of copepods in the general scientific arena, into inter-conference activities, etc.
Rony Huys (R.Huys@nhm.ac.uk)
Susumu Ohtsuka (ohtsuka@ipc.hiroshima-u.ac.jp)
and Grace Wyngaard (gwyngaar@nsf.gov)

Please pass any comments and ideas you have on to the appropriate focal points. We need your input.

COMPETITION

We have seen some splendid conference logos - and I know Jiang has a great one prepared for Taiwan 2002 - but the Executive Council has decided that the time is right to have a WAC logo (to be displayed on our website etc.).

So, we are going to have a competition to design it and Rubens Lopes has volunteered to be the chairman of the selection committee.

We have seen some splendid conference logos - and I know Jiang has a great one prepared for Taiwan 2002 - but the Executive Council has decided that the time is right to have a WAC logo (to be displayed on our website etc.).

So, we are going to have a competition to design it and Rubens Lopes has volunteered to be the chairman of the selection committee.

So, all you budding artists and designers - send your entries to me (Geoff Boxshall, The Natural History Museum, London SW7 5BD, UK) or direct to Rubens (rmlopes@jacaranda.uescba.com.br). They can be hard copy or electronic files.

The closing date will be 31st January 2000 - this should give you all sufficient time and inspiration as the new Millennium dawns.

Geoff Boxshall (London)
WAC President (200-2002)

NEW PHONE/FAX/e-mail

Geoff A. Boxshall FRS,
Phone: +44 (0)207-942-5749
Fax: +44 (0)207-942-5433
Email: g.boxshall@nhm.ac.uk

A Homage to Tagea

Brazilian copepodologists and many colleagues from other countries would, we believe, in this opening session of the 7th ICOC, like to pay homage to a colleague who has had, and continues to have, an outstanding role in the development of copepodology in Brazil: Prof. TAGEA KRISTINE SIMON BJÖRNBERG.

Tagea has dedicated herself to science and teaching for 51 years. She has been a prominent figure in Brazilian oceanography and zoology. She was responsible for the upbringing of several generations of oceanographers, and more important still, of us Brazilian copepodologists. Several of her graduate students continued with the study of copepods, and then trained other students. Almost all present-day Brazilian copepodologists and many planktonologists in some way fell under Tagea's influence in their early careers.

Even though Tagea was associated with the University of São Paulo for most of her career, she also worked in Curitiba for some time. Here was where Tagea had her first chance to give classes in a University course. This was from 1952 to 1954, when she helped Prof. Jesus Moure to establish the Department of Zoology of the Federal University of Paraná, which is hosting this Conference today.

Returning to São Paulo in 1954, Tagea also collaborated in the organization and installation of the Plankton Section of the Oceanographic Institute of the University of São Paulo. From 1961 to 1966 she organized and eventually became the head of the Nekton Section of the Institute. In 1965 she lectured in the Advanced Latin-American Course on Planktonology in the Institute of Marine Biology of Mar del Plata, Argentina, under UNESCO sponsorship. For several years afterwards she worked actively as a consultant in several projects by students who had participated in that course. Thus we believe that many Latin-American planktonologists would like especially to join with us in expressing our appreciation.

In the beginning of her career as a researcher, Tagea dedicated herself to the study of tornaria larvae of *Balanoglossus*. During the second period of research, she dedicated herself entirely to the study of plankton, focusing specifically on the Appendicularia, in collaboration with Dr. Liliana Forneris. This collaboration resulted in 4 articles, the results of which are still valid and are a "must read" for everyone in Brazil interested in these animals.

In the beginning of the 60's, encouraged by Dr. João de Paiva Carvalho, Tagea began to study Brazilian marine copepods. Her first article on copepods was published in 1963. This extensive and significant work established the relationships of copepod species assemblages to the water masses along the Brazilian coast. Following the same line of studies, in 1973 she published an article on marine copepods collected along the western coast of South America.

At that time also, Tagea participated in a cruise of the Soviet oceanographic ship M. Lomonossoff, under UNESCO sponsorship. The resulting article, published in 1964, dealt with the distribution of deep-sea copepods.

In 1972, she published what was possibly her most influential contribution, entitled "Developmental stages of some tropical and subtropical planktonic marine copepods". In this article, she described 158 developmental stages of copepod species belonging to 19 families (slides de pranchas). Many of these species are very frequent and abundant in Brazilian waters. She also included a chapter on the evolution of copepods based on nauplii and their movements.

Fifteen master's theses and 10 doctoral dissertations were produced under her competent supervision, and two others are now in preparation. The subjects of those works include the anatomy, systematics, life cycle, distribution, and feeding of benthic and planktonic copepods from marine, brackish, and fresh waters, the systematics and distribution of amphipods, and the distribution of several planktonic groups such as jellyfish, cladocerans, ostracods, Sergestidae, and fish eggs and larvae.

Her participation in the Ottawa ICOC together with her impressive presentations and fervent pleas for more appreciation of the nauplii and more research focus on them, which attracted the attention of many colleagues, is very well known.

But we want to talk about more than Tagea's scientific contributions, which many of us present recognize as being extremely important for the progress of copepodology in the world, and especially in Brazil.

Tagea has dedicated herself to science and teaching for 51 years. She has been a prominent figure in Brazilian oceanography and zoology. She was responsible for the upbringing of several generations of oceanographers, and more important still, of us Brazilian copepodologists. Several of her graduate students continued with the study of copepods, and then trained other students. Almost all present-day Brazilian copepodologists and many planktonologists in some way fell under Tagea's influence in their early careers.

Even though Tagea was associated with the University of São Paulo for most of her career, she also worked in Curitiba for some time. Here was where Tagea had her first chance to give classes in a University course. This was from 1952 to 1954, when she helped Prof. Jesus Moure to establish the Department of Zoology of the Federal University of Paraná, which is hosting this Conference today.

Returning to São Paulo in 1954, Tagea also collaborated in the organization and installation of the Plankton Section of the Oceanographic Institute of the University of São Paulo. From 1961 to 1966 she organized and eventually became the head of the Nekton Section of the Institute. In 1965 she lectured in the Advanced Latin-American Course on Planktonology in the Institute of Marine Biology of Mar del Plata, Argentina, under UNESCO sponsorship. For several years afterwards she worked actively as a consultant in several projects by students who had participated in that course. Thus we believe that many Latin-American planktonologists would like especially to join with us in expressing our appreciation.

In the beginning of her career as a researcher, Tagea dedicated herself to the study of tornaria larvae of *Balanoglossus*. During the second period of research, she dedicated herself entirely to the study of plankton, focusing specifically on the Appendicularia, in collaboration with Dr. Liliana Forneris. This collaboration resulted in 4 articles, the results of which are still valid and are a "must read" for everyone in Brazil interested in these animals.

In the beginning of the 60's, encouraged by Dr. João de Paiva Carvalho, Tagea began to study Brazilian marine copepods. Her first article on copepods was published in 1963. This extensive and significant work established the relationships of copepod species assemblages to the water masses along the Brazilian coast. Following the same line of studies, in 1973 she published an article on marine copepods collected along the western coast of South America.

At that time also, Tagea participated in a cruise of the Soviet oceanographic ship M. Lomonossoff, under UNESCO sponsorship. The resulting article, published in 1964, dealt with the distribution of deep-sea copepods.

In 1972, she published what was possibly her most influential contribution, entitled "Developmental stages of some tropical and subtropical planktonic marine copepods". In this article, she described 158 developmental stages of copepod species belonging to 19 families (slides de pranchas). Many of these species are very frequent and abundant in Brazilian waters. She also included a chapter on the evolution of copepods based on nauplii and their movements.

Fifteen master's theses and 10 doctoral dissertations were produced under her competent supervision, and two others are now in preparation. The subjects of those works include the anatomy, systematics, life cycle, distribution, and feeding of benthic and planktonic copepods from marine, brackish, and fresh waters, the systematics and distribution of amphipods, and the distribution of several planktonic groups such as jellyfish, cladocerans, ostracods, Sergestidae, and fish eggs and larvae.

Her participation in the Ottawa ICOC together with her impressive presentations and fervent pleas for more appreciation of the nauplii and more research focus on them, which attracted the attention of many colleagues, is very well known.

But we want to talk about more than Tagea's scientific contributions, which many of us present recognize as being extremely important for the progress of copepodology in the world, and especially in Brazil.

We would also like to talk about Tagea the teacher, the advisor, and the friend, solicitous of her colleagues and students, always smiling, ready to collaborate with everybody, communicative and playful.

Rare indeed are courses in which 50 to 60 undergraduate students decide to throw a party for their professor to commemorate the end of a course. And you, Tagea, had the opportunity of enjoying many such moments.

Who of your colleagues in the Zoology Department of the University of São Paulo, where you worked for more than 20 years, doesn't remember the Christmas parties in the 70's? Those parties are unforgettable. Besides the good food, drinks, and conviviality, everybody would anxiously wait for the arrival of Santa Claus during the party. We returned to old times of childhood and deliciously relived the old fantasies. It was very exciting to wait for the large door to open and, with the sound of a bell, who entered? Tagea, of course, dressed as Santa Claus! Not having a reindeer and a sleigh, she conjured up a very Brazilian solution and entered the room riding the stuffed tapir which spent the rest of the year on display at the entrance of the Department. Dudu, as the tapir is affectionately called, continues to occupy his place in the hall. If he could say anything, he would certainly say he misses those good old times.

Well, we could say much more, but we know that everyone here appreciates the value of your long scientific and academic career, and how pleasant it has been to work with you. To mark this special occasion we would like to offer you a small token of our appreciation, which we hope you will like.

Finally, the Organizing Committee dedicates to you this Conference. Thank you!

Carlos E.F. Rocha (Brazil)

WAC BUSINESS MEETING

Date: July 29, 1999 (during the 7th International Conference on Copepoda)
Time: 16:45 to 18:00
Place: Barigui Park Convention Center, Curitiba, Brazil.

1.- Report of the General Secretary (ES-M).

The number of candidates asking for membership in the WAC was of 46; all of them were unanimously accepted. The number of inscribed members of the WAC increased to 872. There were two resignations. The number of countries with copepodologists represented in the WAC is now 69.

2.- Report of the Treasurer (JF).

A general balance was presented (the figures are available). Although the balance showed a healthy financial situation, special recommendations from the treasurer were: 1) payment of 3 years dues during each meeting; 2) members should keep paying their dues.

3.- Election of new WAC officers.

In order to maintain an administrative continuity of the WAC, the positions of General Secretary (ES-M) and of Treasurer (JF) were not put up for re-election. Two copepodologists were nominated to become the President of the WAC: Geoff Boxshall, and Jeff Turner. By a majority vote of WAC members, Geoff Boxshall was elected as the new President of the WAC. The Vice-President position was between two nominees: Hans G. Dam and Janet W.

Reid. By majority vote Janet Reid was elected as Vice-President of the WAC.

The Executive Council was also restructured. Two members, Jack Greenwood and Ruth Boettger-Schnack, had served for two terms, and Shuhei Nishida indicated his wish not to serve a second term after completion of his first. Grace Wyngaard, with one term in the EC, was re-elected. Hans Dahms, editor of Monoculus, remains on the EC. Three new members of the EC were elected by direct vote: these were Rubens Lopes, Susumu Ohtsuka, and Rony Huys.

4.- Venue of the 8th International Conference on Copepoda

Two proposals were presented to the consideration of the WAC members. The first was presented by Professor Jiang-Shiou Hwang of the National Taiwan Ocean University at Keelung - requesting the venue for Taiwan. The second was presented by Ioanna Siokou-Frangou, to have the next WAC Conference in Greece. By direct majority vote of WAC members present, Taiwan was selected to host the next Conference on Copepoda in 2002. Professor Hwang becomes a member of the Executive Council.

Eduardo Suarez Morales (Chetumal, Mexico)
Secretary WAC

Financial Statement of the World Association of Copepodologists

1997

Funds transferred from Germany	$14,429.14
Dues Paid	$ 1,088.00
Banking Fees	$ 89.65
December 31, 1997	$15,427.49

1998

Funds transferred from Germany	$15,427.49
Dues Paid	$ 1,354.00
Banking Fees	$ 50.13
MONOCULUS	$ 1,991.33
December 31, 1998	$14,740.03

1999

Funds transferred from Germany	$14,740.03
Dues Paid	$ 1,080.00
Banking Fees	$ 20.00
December 31, 1999	$15,800.03

John A. Fornshell (Alexandria, USA)
Treasurer WAC

... ANNOUNCEMENTS ...

INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE - 4th Edition

At long last! The new and considerably revised Fourth Edition of the Code was published two weeks ago. Full details are available on the Commission's Website www.iczn.org. The standard cost for a copy is £40 or $65, but a 25 % discount is offered to individual members of a scientific society (such as WAC) buying one copy for personal use. Institutions or booksellers buying five or more copies are also offered a discount. For Airmail, please add £2 or $3.

Copies can be ordered by e-mail from:
London - iczn@nhm.ac.uk - you can pay in sterling by credit card (Visa or Mastercard only) giving number and expiry date, or by sterling or dollar cheque payable to "ITZN"
or:
Washington - smithd@nmnh.si.edu - payment by dollar cheque (not credit card!).

Rony Huys (London)

Zooplankton Guides, the guides to the identification of microinvertebrates of the continental waters of the world

Volume 14: Copepoda: Cyclopoida. Genera *Paracyclops, Ochridacyclops* and key to the Eucyclopinae by S. Karaytug

Volume 15: Copepoda: Calanoida. Diaptomidae, Paradiaptominae by N.A. Rayner

Please see our enclosed ZOOPLANKTON GUIDES leaflet for further details, prices and ordering information for this unique series.

Furthermore we are proud to announce the publication of:

SOUTH ATLANTIC ZOOPLANKTON, edited by D. Boltovskoy
ISBN 90-5782-035-8. Dutch Guilders 950.00/US$ 500.00

This fascinating work consists of 1,724 pages (with 700 full pages of illustrations) and is hardbound in two volumes, large format (19.5 x 26 cm). It includes a taxonomic index and ca. 3,500 bibliographic references. This beautifully produced book is worth every investment and offers maximum added-value to your research. It is the most complete guide to marine zooplankton ever produced in a single major work. The following crustacean groups are covered: Ctenopoda and Onychopoda (18 pp), Ostracoda (54 pp), Copepoda (232 pp), Mysidacea (42 pp), Amphipoda (100 pp), Euphausiacea (42 pp), Larval Decapoda (Brachyura) (74 pp).

For detailed information see our World Wide Web! Or apply for special leaflet, giving all details of this major reference work on South Atlantic Zooplankton.

Internet E-mail: backhuys@backhuys.com
World Wide Web : www.backhuys.com

JOURNAL OF CRUSTACEAN BIOLOGY

The Crustacean Society has introduced an online Web page where contributors to the Journal of Crustacean Biology can determine the status of their manuscripts. The page is located at the Society's web site at URL http://www.lam.mus.ca.us/~tcs/. The manuscript status page will be updated monthly.

David K. Camp
Editor, Journal of Crustacean Biology

... LETTERS LETTERS LETTERS ...

Dear members of the WAC, I want to inform you that I have changed my address. In the last ten days my wife and myself left the country because of the war. Besides NATO's strike against Yugoslavia, in Montenegro everything is preparing for the civil war, which is the worst war that can happen. As we have seen such a war in Bosnia, we did not want to wait for it to come to us. We are in one way very lucky, because my wife has a sister in Italy, so we are now at the safe. What is also very important, we have successfully transferred all of our collection, literature, and working equipment (microscope, computer etc.) so that we are now able to continue with our work. My wife works on ostracods (Crustacea, Ostracoda) and for six years we were together collecting material from Serbia and Montenegro. A great part of the copepod material is now part of my Ph.D., which is almost complete.

Very soon I expect my six papers to be printed. Now I am preparing some new manuscripts, also about Balkan copepod fauna (new *Allocyclops*, some new and interesting *Elaphoidella*, subterranean species of the genus *Eucyclops*, etc.). Unfortunately, I am now unemployed, but I am offering my services all over the world. So please, if you want, you can recommend me at any place that you think I would be useful. Of course, I would be very satisfied with a job in a small institute, museum, or other institution at any remote spot.

T. Karanovic (Bellizzi, Italy)

... INTERVIEWING COPEPODOLOGISTS ...

Professor **Ju-shey Ho** - the outgoing WAC President

During the just concluded International Copepod Conference (ICOC) in Curitiba, Brazil, I had the honour of interviewing one of the founder members of the World Association of Copepodologists (WAC) who is also the outgoing President of the Association, Professor Dr. Ju-shey Ho.

The following is the excerpt of our interview:

Osore: Dr. Ho, I thank you for granting me the opportunity to interview you. Could you briefly tell our readers about your academic and professional background?

Prof. Ho: I graduated from National Taiwan University in Taipei, Taiwan in 1958 with a major in Fishery Biology. After completion of the 18-month military service, I worked as a Teaching Assistant in the Department of Zoology of my Alma Mater for two and one-half years before going to Boston University to study symbiotic copepods with Dr. Arthur G. Humes. In the beginning, I was a Teaching Fellow working for Dr. Humes in charge of the laboratory portion of his class of Invertebrate Zoology. But two years later, I was moved to a position of Research Assistant and worked for Dr. Humes on his vast collections of symbiotic copepods obtained from the invertebrates of Madagascar. This experience of working with Dr. Humes has tremendously expanded my understanding of the symbiotic copepods, because before then, I worked only on those parasitic on fishes. Upon completion of my doctorate degree in 1969, I continued to work with Dr. Humes on the symbiotic copepods of marine invertebrates for another year before taking up my current job of teaching at the California State University, Long Beach.

Osore: When did you develop interest in copepod research?

Prof. Ho: When I was a Teaching Assistant in the Department of Zoology at National Taiwan University, there came a Fullbright Visiting Professor - an eminent parasitologist, Dr. Glenn A. Noble - to teach "Animal Parasitology" and I was assigned to work with him. At that time, there was no biological supply house in Taiwan and so an assistant was responsible for collection and preparation of materials needed in the laboratory exercises of the class. Therefore, I spent the first half of the summer of 1960 travelling around the island collecting any kind of animal parasites that I could get my hands on. During the second half of the same summer, I stayed in the laboratory, searched through the literature with an attempt to place a name on each and every parasite that I had collected, ranging from the trypanosomatid flagellates to mallophagan insects. It was during this later part of the preparatory work I learned that the parasitic Copepoda of Taiwan are practically unknown. Although Japanese zoologists had studied and published many papers on the metazoan parasites of the fishes of Taiwan during the 50 years of Japanese occupation (1895 - 1945), there was only one paper that dealt with a species of freshwater parasitic Copepoda - *Ergasilus japonicus* sp. nov. - by Isokiti Harada which appeared in 1930. It was right there and then I decided to work on the parasitic copepods. I wanted to be the first Taiwanese to work on parasitic Copepoda.

Osore: As the outgoing President of the WAC, what advice would you like to give to young and upcoming copepod researchers regarding this field?

Prof. Ho: We need to remind ourselves constantly that Copepoda are the most common and most abundant metazoans in the waters that cover more than two-thirds of the surface of the Earth. Thus, we are working on a very important group of aquatic animals. Also, what we know now about the copepods is only the tip of the iceberg, there is a lot more of the unknown hidden in every aspect of the copepod biology waiting to be studied and investigated. And we should keep in mind that, as we work on our own chosen subject(s) on this fascinating group of animals, we should make every possible endeavour to inform the general public about the important roles that copepods play in nature. It is only with the general public's understanding that we can continue to ask for support to our studies and research on the Copepoda.

Osore: What role do you intend to play in the preparation and hosting of the forthcoming WAC Conference in the year 2002 which will in fact be held in your country of origin, Taiwan?

Prof. Ho: The Constitution/Bylaws of WAC states clearly that the Local Secretary shall take a leading role in organizing the ICOC and the local organizers have the financial responsibility for the conference. Therefore, I shall work closely with Dr. Jiang-Shiou Hwang when I am called upon to help. Having served two terms on Executive Council of the WAC (1987-1990, 1990-1993), one term each as the Vice President (1993-1996) and President (1996-1999), and attended all of the previous ICOC, I shall be competent to work with the Local Organizing Committee on the planning of the 8th ICOC in 2002.

Osore: Most African nations and many other developing countries are often underrepresented in WAC fraternity and in copepod research generally, yet they are located in areas adjacent to high copepod diversity. What role should WAC play to encourage them to join?

Prof. Ho: As you have witnessed this time at the Curitiba conference, a large number of the attendants are from the countries of Latin America, representing the largest number of Latin American participation in the history of ICOC. Similarly, when the ICOC was held in Europe, we saw the largest representation of European participants; in Ottawa and Baltimore, the largest delegation of North American researchers; and in Karuizawa, the largest group of Japanese copepodologists. Thus, the best way the WAC can do to encourage the participation of researchers from the African nations is to sponsor an ICOC in a nation in Africa. Of course, this has to be initiated by a copepodologist in Africa who is willing to lead the organization for the ICOC.

Osore: Based on the founding objectives of WAC, would you say that much progress has been achieved to date since the association was established or has the development been very slow?

Prof. Ho: The WAC was officially established in 1987 at the 3rd ICOC held in London. The purpose for establishing this Association was simply to promote and support "interest in all aspects of research on Copepoda". The uninterrupted publication of the biannual MONOCULUS and continuous sponsorship of the triennial ICOC with publication of the conference proceedings speak for themselves the progress that the WAC has been achieving so far. I can see that the Association is striving toward obtaining more researchers to join the membership and raising more funds to assist members' participation in ICOC. Although the WAC is far from getting all of its members (over 800) to the ICOC, but, slowly, we are getting there. For instance, at the first ICOC held in Amsterdam, there were only 126 attendants; but the attendance is nearly doubled at the last ICOC taken place in Curitiba.

Osore: Members from poor countries often feel that the annual membership fee of US$ 20 is very prohibitive considering their monthly income of less than US$ 200. What is your advice to them?

Prof. Ho: As I reported at the Business Meeting during the 7th ICOC in Curitiba, the members of WAC who feel that the annual membership fee of US$ 20 is "prohibitive", can apply to the WAC's Executive Council to have the dues waived. They will receive the MONOCULUS as the regular members. Once approved, the waver is good for 3 years. Of course, a continuation of waiver can be granted if the applicant's financial situation is not improved.

Osore: Nowadays most journals and newsletters are going on-line and are thus accessible via the internet. Is the future of MONOCULUS as a hard copy paper version doomed? If so, shouldn't WAC intervene not only to maintain the new electronic version but also to retain the hard copy version for the benefit of those without internet access?

Prof. Ho: The Officers of WAC met prior to the Business Meeting during the 7th ICOC and discussed on several issues that were brought up via e-mail before meeting in Curitiba. One of the issues discussed was about going on-line of the MONOCULUS and registration for the ICOC. The Executive Council passed a resolution specifying that: while to maintain the electronic version, the hard copy version of MONOCULUS is to be issued and distributed continuously to all members. The WAC's EC is well aware of the limitation of access to the internet in some places.

Osore: The cornerstone for any association and its future prospects heavily depend on the active participation of its youthful members. What strategy would you advice WAC to initiate in order to win and maintain young scientists?

Prof. Ho: Yes, vitality of an association needs a constant infusion of young blood and the WAC is no exception to this rule. The Executive Council of WAC is aware of this but due to the lack of fund, nothing could be done in the past. As you remember, the WAC Treasurer, Dr. John Fornshell, reported at the Business Meeting in Curitiba showing us that, for the first time, the WAC finance is in a "healthy" state, with enough fund to pay for the publication and distribution of MONOCULUS for the next three years. With this assurance the Executive Council at Curitiba meeting decided that a part of the WAC fund should be allocated to the establishment of small "grants in aid" for research on the copepods. In addition, the WAC should set up awards for the best poster and best oral presentation for the graduate students in the future ICOC. The new Executive Council shall work out the details, rules and requirements for these new installations.

Osore: As we approach the new millennium, what is your vision for WAC and its future?

Prof. Ho: In as much as copepodologists are dealing with a group of animals that are the most common and most abundant metazoans in the lakes, rivers and seas, the information generated by them through their works will grow larger and larger. Thus, the Association

made up of these workers shall create a strong sense of belonging and accomplishment for its members by acting as an information management center. This center shall collect and manage all kinds of information pertaining to copepodology and make it available to the public. This is particularly important when the fisheries of the world are moving from the fishing/catching of the past millennium to the farming/rearing of the new millennium. We know the copepods are food to fish larvae and, at the same time, pests to the fishes in aquaculture. Thus, for the copepodologists, regardless of working on the free-living forms or parasitic forms, they all have works to do and at the same time need to be informed of the progress in other areas or from other parts of the world.

Osore: Is there any final word that you would like to tell members of WAC and all the readers of MONOCULUS in general?

Prof. Ho: I would like to reiterate what I have said in my Maxilliped Lecture at the Curitiba conference. If we are to promote the copepodology to a noticeable branch of the modern biological sciences, we need to pay more attention to the symbiotic copepods. Currently, more than one-third of the reported copepods (4,200/12,000) exist as symbionts, yet we have less than 10% of the members of WAC working on them. We do need more researchers from every walk of copepodology to join these 10% of the WAC members in their endeavour to build up our knowledge on the symbiotic copepods.

Melckzedeck K.W. Osore (Mombasa, Kenya)

NOTES & NEWS

Tumors in Freshwater Zooplankton

Zooplankton, near the bottom of marine and freshwater food chains, can develop tumors like those of higher life forms according to scientists at the Commerce Department's National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory and the University of Michigan Centre for Great Lakes and Aquatic Sciences in Ann Arbor, Michigan.

The evidence, including photographs, will be presented on May 27 during the annual meeting of the International Association for Great Lakes Research, which begins on May 24 in Cleveland, Ohio. Although tumors in zooplankton were reported in 1994 from an area of the Baltic Sea, this is the first time photographs have been taken of the abnormalities and that preliminary evidence has been presented that the tumors are cancerous. The affected zooplankton are Copepoda and Cladocera, which are crustaceans that are usually less than an eighth of an inch in size.

Tumors, or neoclasms, have been found in a variety of invertebrates such as molluscs, insects, and flatworms, but reports of tumors on crustaceans are rare.

Earlier research speculated that tumors might form in zooplankton, but the organisms would die at moulting before tumors would be obvious. The team found large tumors on juveniles and on young, recently moulted adult zooplankton in Lake Michigan.

Researchers found tumors in several species of copepods and cladocerans.

Predatory species were more likely to have tumors than herbivorous species.

Preliminary analyses suggest that tumors are more common nearshore than offshore.

Zooplankton showing the tumors were collected during 1995 and 1998 as part of GLERL's food web and water-quality monitoring programme and as part of Michigan Sea Grant-Supported research by D. Jude on larval fish and zooplankton interactions in the nearshore zone. Analysis of the tumors by T. Rizki showed a high frequency of dividing cells, which is suggestive of cancerous growths. M. Omair was the first one to observe the abnormalities in a

contract to identify and count zooplankton in preserved samples from GLERL's monitoring study. Only a few samples have been analysed so far.

"We can only speculate as to when the tumors first occurred in Lake Michigan zooplankton," said Dr. Vanderploeg. "Because such tumors have never been seen until now, despite the many programmes on the Great Lakes that have monitored or collected zooplankton, we suspect the occurrence of the tumors is a recent phenomenon in the Great Lakes in general and in Lake Michigan in particular."

It is also possible that previous monitoring efforts, restricted to a few spring and late summer collections, would have missed the tumors because of their limited seasonal coverage and focus on offshore surface waters. The research team plans to examine archived collections and make new collections at many nearshore and offshore sites to find hot spots that might be associated with some environmental factor. Careful microscopic analyses of the tumors also may give some insight into their cause.

Joyce Gross (NOAA, USA)
e-mail: Joyce.W.Gross@noaa.gov

Meeting of German Carcinologists

There is no national society of carcinologists in Germany, but this does not in any way prohibit our German colleagues from maintaining an active meeting agenda. Thus, the 9th Meeting of German Carcinologists (9. Crustaceologen-Tagung) was recently held in Berlin from 25-28 February 1999 under the auspices of Prof. Gerhard Scholz of the Humboldt University with more than 75 attendees. Although these meetings are intended as informal gatherings, this certainly did not reflect on the quality of the many oral and poster presentations during the two full days of sessions. As part of the welcome reception, the meeting was opened by a "behind the doors" tour of the adjacent Museum für Naturkunde. As this was an evening tour, one experienced the still far from adequate lighting conditions in this marvellous building. However, this only made a large sauropod (which I still call "Brachiosaurus") appear even more impressive. Fortunately, there was no need for parallel sessions for the oral presentations, and all posters were on display for the duration, so active discussion could take place around them during the breaks. On the second evening, Prof. Horst Kurt Schminke of the University of Oldenburg gave a most entertaining talk on "Crustacean diversity: spectacular or modest". This took place in a very old amphitheatre which made for a better lecture hall than many modern facilities. This was followed by a buffet which extended into the late evening. After the official two days ended by a symposium dinner, the meeting concluded Saturday morning with a tour of one of Berlin's two zoos, the Tierpark Friedrichsfelde, enabling us to get a glimpse behind the scenes. Prof. Scholz and the many colleagues assisting him made a tremendous effort to make this a very smoothly run meeting. Naturally the language of the talks and most posters were in German. But attendees from adjacent countries were also present and very welcome, and anyone with the slightest grasp of German was able to benefit from this event as languages mixed easily during the breaks. The 10th such meeting will be hosted by Prof. Angelika Brandt of the Hamburg University and I am confident that carcinologists in Northern Europe will all look forward to this event.

Jens T. Høeg (Denmark)
jthoeg@zi.ku.dk

... OFFERS OFFERS OFFERS ...

Very rich literature about Copepods (Calanoids, Cyclopoids, and Harpacticoids) - ALL ORIGINAL, not copies, more with original dedications! - are available free of charge.
A list of them can be ordered from:
Dr. Corneliu Plesa
Str. Gh. Dima 28/27
3400 Cluj-Napoca 6
Romania
or by e-mail (see in MONOCULUS 36, p. 35).

... ESSAY ESSAY ESSAY ESSAY ESSAY ...

CYCLOPOIDS, MOSQUITOES, AND DENGUE HEMORRHAGIC FEVER

Gerald G. Marten
School of Policy Studies
Kwansei Gakuin University
Sanda, Hyogo 669-1337, Japan
Email: marten@venus.dti.ne.jp

(This history of dengue fever, and the use of cyclopoid copepods to control mosquitoes that transmit the disease, is based on a source document prepared in collaboration with Scott Halstead and Vu Sinh Nam for an article to appear in Scientific American magazine next year.)

The last *Aedes aegypti* mosquito in Phanboi was seen in August 1994. It was a significant moment for this village in Vietnam because this mosquito is the principal vector of Dengue Hemorrhagic Fever (DHF) (Halstead 1997, 1998), an "emergent" disease that has hospitalized nearly two million Vietnamese and killed more than 13,000 children since appearing in Vietnam forty years ago. It was also of general significance for mosquito-borne disease control because it was the first time in more than 20 years that even local eradication of any kind of mosquito had been documented anywhere in the world, and it was accomplished without pesticides. The keystone to success was biological control with *Mesocyclops*, a tiny crustacean that preys on mosquito larvae. The stories of DHF and *Mesocyclops* illustrate how modernization creates new public health problems and how ecological technologies can contribute to sustainable solutions.

Dengue is a flavivirus related to yellow fever. It may have originated in non-human primates, which still provide a natural reservoir in Africa and Asia. Non-human primates do not show symptoms, but humans can be seriously ill. First-time dengue infections in children are usually mild, often unnoticed, but first time infections in adults are often severe. Fatalities are rare, but high fever, chills, headache, vomiting, severe prostration, muscle and bone aches, and severe weakness for more than a month after the fever subsides make dengue fever an illness that many adults remember as the worst they ever experienced.

Aedes aegypti (AE) (Christophers 1960) is the principal vector of both dengue and yellow fever. Originally a tree-hole-breeding mosquito in Africa, it long ago acquired an urban lifestyle by breeding in similar situations around human habitations. AE now breeds in man-made containers such as water storage tanks, wells, clogged rain gutters, and discarded objects such as tires, tin cans, and jars that collect rainwater. The mosquito lays her eggs on the side

of a container a few millimeters above the water level. The eggs can sit for months without hatching if they remain dry, but they hatch within minutes if covered with water. The fact that this normally happens only when more water is added to a container increases the probability that a container will have enough water for the larvae to complete their development before the container dries out.

Starting in the Sixteenth Century with expansion of European colonialism and trade, AE spread around the world by hitching rides in water storage containers on boats. Dengue and AE were together in Asia for centuries without a serious problem because the distribution of AE was limited by *Aedes albopictus*, an indigenous Asian mosquito that is physiologically capable of transmitting dengue but not associated with significant dengue transmission in practice. Asian towns and cities were well endowed with trees and shrubs, and *Aedes albopictus* competitively excluded AE wherever there was vegetation.

The spread of DHF was probably delayed by the appearance of DDT in 1943. DDT was like a miracle. It was harmless to vertebrates at concentrations used to kill insects, and it was effective for months after application. In 1955 the World Health Organization began a global campaign to spray every house in malarial areas with DDT. Malaria virtually disappeared from many areas by the mid-1960s, and at the same time AE disappeared from most of Latin America and some parts of Asia such as Taiwan.

The incredible success of DDT was short-lived because mosquitoes evolved resistance that spread quickly around the world, probably accelerated by heavy use of DDT for agriculture. Third World governments could not afford to continue intensive spraying, particularly when alternatives to DDT such as malathion cost more than ten times as much. Malaria started to return in force by the late 1960s, and by the mid-1970s AE returned to the areas from which it had previously been eradicated. Dengue did not return to the United States because window screening and air conditioning led to an indoor life style that reduced the contact between people and mosquitoes. However, the four dengue serotypes and DHF spread rapidly through tropical Asia, settling into a permanent pattern of recurring local DHF outbreaks as the four serotypes continued to circulate. DHF entered the Americas in 1981 with an epidemic in Cuba that hospitalized 116,000 people in three months. Dengue quickly spread through much of Latin America, sometimes punctuated by dengue fever epidemics of hundreds of thousands of people, but DHF was generally sporadic because most areas had only one serotype. Although dengue was common in many parts of sub-Sahara Africa, it was not a major health problem because Africans are generally resistant to severe dengue infection.

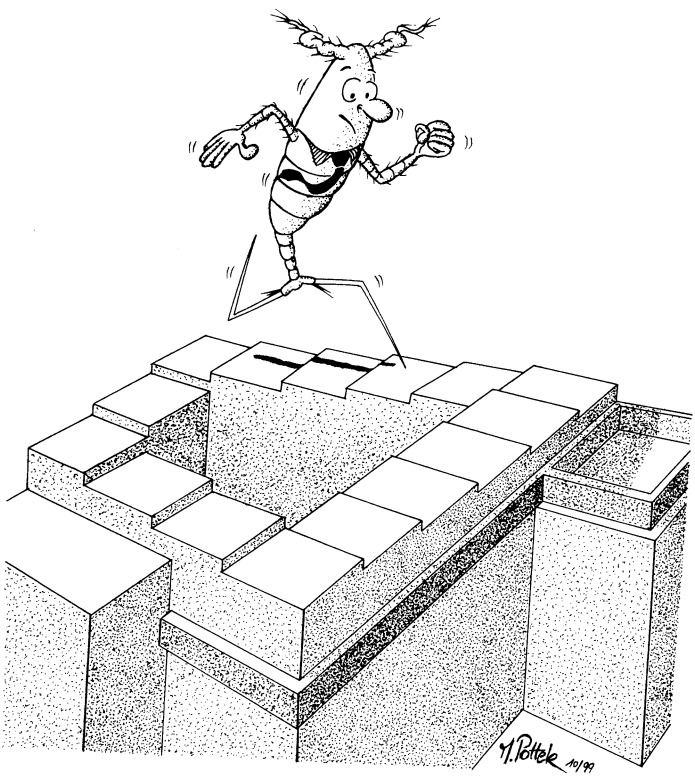
There has been no noticeable decrease in dengue fever or DHF cases during the past 20 years. Worldwide about 50-100 million people are infected with dengue each year. There are several million clinical dengue fever cases and hundreds of thousands of DHF cases each year. Fatalities have remained high in some countries, but other countries have reduced fatalities dramatically by providing extensive medical treatment. Several hundred thousand people are hospitalized with DHF in Vietnam and Thailand every year, but the fatality rate is less than 0.3%. Nonetheless, the economic costs are high. Patients require 1-3 weeks of hospitalization, and parents lose work time while caring for sick children in hospitals. Global warming could eventually extend the geographic range of dengue as higher temperatures, and consequently shorter viral incubation times in mosquitoes, stimulate transmission.

Though biological control with predators of AE larvae offers the possibility of functioning without the frequently repeated applications necessary for pesticides, biological control did not receive serious consideration when the DDT strategy collapsed. Fish were widely used against

malarial mosquito larvae prior to the DDT era, but the use of fish for AE control was limited because fish were expensive and did not survive for long in most containers. Besides, many people did not want fish in their water storage containers, particularly if they used the water for drinking. Many aquatic animals such as planaria, dragon fly nymphs, and aquatic bugs were known to prey on mosquito larvae, but none had ever proved effective enough or practical enough to go into operational use. Mosquito-control professionals and public health officials, who relied heavily on chemical pesticides throughout their careers, considered biological control a "pipe dream". Opportunities for profit were too remote to stimulate research and development by the private sector.

This was the situation in the early 1980's, when Francois Riviere ("Louis Malarde" Medical Research Institute, Tahiti) reported that virtually no *Aedes* larvae survived in water-filled containers if the copepod *Mesocyclops aspericornis* was present (Riviere and Thirel 1981). Soon after, the same thing was observed independently in Colombia and Hawaii (Suarez et al. 1984, Marten 1984).

Cyclopoid copepods are different from other aquatic invertebrates that prey on mosquito larvae. If mosquito larvae are numerous, cyclopoids eat only a small part of each larva, giving each copepod the capacity to kill 30-40 larvae per day, far more than they actually eat. Even more important is their large numbers. Cyclopoids eat small animals up to twice their own



size, but they also eat phytoplankton, protozoa, and rotifers – a diet that provides enough food to make cyclopoid copepods the most abundant predator in most freshwater habitats. The total capacity of a cyclopoid population to kill mosquito larvae is enormous. Most species of cyclopoids are too small (0.3-1.2 mm body length) to prey on even the smallest mosquito larvae, but *M. aspericornis* and other large species of cyclopoids (1.2 mm body length or more) attack and consume newly hatched mosquito larvae without hesitation. About 10% of the places with water where mosquitoes might breed have natural populations of *Mesocyclops* or other large cyclopoids, which drastically reduce the survival of mosquito larvae. Malarial mosquito larvae *(Anopheles)* have been observed to be consistently absent from aquatic habitats in Latin America that contained natural populations of *Mesocyclops* longisetus, the largest known species of *Mesocyclops* (Marten et al. 1989).

The same thing that happens in nature can be achieved by introducing appropriate cyclopoid species to sites that don't already have them. *Anopheles* larvae virtually disappeared after *M. longisetus* and several other species of *Mesocyclops* were introduced to rice fields and small marsh areas in Louisiana (Marten et al. 1994a). Unfortunately, the potential of cyclopoids for malaria control has not been developed further because control of *Anopheles* mosquitoes has been almost entirely abandoned. Ecological management of relatively complex *Anopheles* breeding habitats has not appealed to malaria-control practitioners accustomed to the simplicity of pesticides. Contemporary malaria control is based almost entirely on anti-malarial drugs, whose long-term effectiveness is doubtful due to drug-resistance already widespread among malarial parasites.

The development of cyclopoid copepods for dengue control has been much more successful because cyclopoids are so effective and easy to use in the simple container habitats where AE breeds. It is unusual for cyclopoids to get into man-made containers on their own, but they thrive in many kinds of containers when introduced, and they do so independently of the supply of mosquito larvae. Typical populations are 100 adult copepods in a rainwater-filled tire, 500-2,000 in a 200-liter water storage drum, and 10,000 in a larger cement tank. The largest species usually kill more than 99% of the AE larvae, and they usually stay in a container for as long as there is water. Even without water, they can survive as long as there is moisture.

Subsequent research focused on finding the best copepod species to use against AE in various parts of the world. Suitable species were always available locally because cyclopoids large enough to kill mosquito larvae occur naturally virtually everywhere that AE is a problem. Brian Kay (Queensland Institute of Medical Research) surveyed Australian and Southeast Asia cyclopoids and field-tested them in wells and water storage containers (Brown et al. 1991, Jennings et al. 1995, Russell et al. 1996). The New Orleans Mosquito Control Board began a search for promising species in the Western Hemisphere, developing procedures to mass-produce copepods for operational use and working out details of how to use them (Marten 1990a, Marten et al. 1994a, 1994b).

The simple life cycle of cyclopoid copepods and their ability to thrive on a diet of protozoa made mass production easy and inexpensive. The New Orleans Mosquito Control Board's production system (Marten et al. 1997) uses bacteria on decomposing wheat seed as food for *Chilomonas* (a flagellate protozoan that provides food for young cyclopoids) and *Paramaecium caudatum* (a ciliate protozoan that provides food for the larger stages). The system is simple, inexpensive, and highly resilient, functioning in open containers of any size or shape. One hundred adult female *Mesocyclops* produce about 25,000 new adult females within a month. Females are inseminated during adolescence and require no further contact with males to produce 50-100 eggs weekly during their several months life span. Although males

and females are born in equal numbers, adult females enormously outnumber adult males because females are larger and eat the males.

Taxonomic revisions and species identifications by copepod specialists were crucial for evaluating the potential of copepods for practical mosquito control because superficially similar species can be so different in their ability to survive in different aquatic habitats. Janet Reid (Smithsonian Institution) has had a central role in almost every study during the past fifteen years. More recently Maria Holynska (Zoological Institute, Polish Academy of Sciences) revised Southeast Asian *Mesocyclops* and assisted with their identification.

The New Orleans Mosquito Control Board found that nearly all large cyclopoid copepods prey on mosquito larvae, except gigantic *Homocyclops ater* (3 mm body length), which has completely different habits from other cyclopoids. However, predation on AE larvae was not in itself sufficient for effective AE control. Natural populations of *Acanthocyclops vernalis*, for example, killed mosquito larvae in temporary pools on the ground, where this copepod could survive in dry soil for more than a year. When introduced to containers, *Acanthocyclops* eliminated AE larvae as long as their adults grew to full-size, but *Acanthocyclops* often multiplied to such large numbers in containers that they exhausted their food supply, making them too stunted to kill AE larvae.

The first demonstration of how effective *Mesocyclops* could be on a larger scale began in 1993, when Vu Sinh Nam (Vietnam National Institute of Hygiene and Epidemiology) introduced three local species of *Mesocyclops (M. woutersi, M. thermocyclopoides, M ruttneri)* to Phanboi. Like most of rural Vietnam, the two main sources of AE in this village of 400 houses were several-thousand-liter cement tanks that nearly every house uses for long-term storage of rainwater from the roof, and clay jars (20-200 liter capacity) used to store water for immediate use. Vietnam had tried projects with fish for people to put in their containers, but long-term coverage of the important containers in a community seldom exceeded 20%.

Most communities in the program have repeated the scenario at Phanboi, with AE declining to zero within 12-18 months after *Mesocyclops* introduction. The few exceptions have been urban communities, where AE has declined but not disappeared, the reason being incomplete coverage of the houses by local collaborators. It is sometimes necessary to recruit collaborators of unproved reliability in urban areas that lack ongoing house-to-house health programs. While most new collaborators do a good job, some do not, and their task can be complicated by lower social cohesion in cities. This year the program will face its greatest challenge as it extends to southern Vietnam, whose tropical climate is ideal for AE and dengue transmission throughout the year. New kinds of containers will be encountered as the program expands. For example, ant traps are a major breeding habitat in one area, and empty fish sauce jars that collect rainwater are a problem in another area.

Vietnam reported 234,000 DHF cases in 1998, responsible for more deaths than any other infectious disease. In 1999 the government initiated a high-priority national dengue program with *Mesocyclops* in a leading role. The program has both emergency response and prevention. The government provides MacElisa kits to local health workers for rapid blood analysis of suspected dengue cases so an immediate emergency response can go into action wherever dengue is confirmed. Health teams use ultra-low-volume backpack sprayers to apply insecticide to every house in an outbreak neighborhood. In recent years the government has encouraged dengue outbreak neighborhoods to capture fish from local ponds to put in their

water storage containers, but as the supply of *Mesocyclops* increases, *Mesocyclops* will be mailed to outbreak areas on foam rubber cubes for immediate distribution to every house.

The key to sustainable long-term DHF control is prevention, which in Vietnam's national dengue program means applying the Phanboi model. Television publicity and school education programs are making *Mesocyclops* a household word. A Government Inquiry Telephone Line refers interested communities to health workers who can provide *Mesocyclops* and explain their use. With twelve million households in high-risk areas, the potential number of households to be served is enormous. The bottleneck is training health workers and local collaborators. Some provinces are now setting up their own *Mesocyclops* production and training centers.

Can other countries use *Mesocyclops* as successfully as Vietnam? The prospects are particularly promising in Southeast Asia, where DHF is a major health problem, public concern is high, and most AE breeding habitats are similar to the water storage containers that have proved ideal for *Mesocyclops* in Vietnam. Public motivation is not so strong outside Southeast Asia, and some of the breeding habitats are not so ideal for *Mesocyclops*. While dengue control in other areas will often require substantially more than *Mesocyclops* and container recycling, *Mesocyclops* can eliminate AE production from at least some kinds of containers almost everywhere that dengue is a problem. Marco Suarez, for example, is using *Mesocyclops longisetus* in small storm-drain catch basins in Colombia.

The mechanics of production and distribution are not an obstacle to extending *Mesocyclops* to other countries. Production is inexpensive, and shipment to local distributors is easy. While production and distribution in Vietnam is by national, provincial, and local government, distribution in other countries could use any combination of government, NGOs, and the private sector that works under local conditions. The key to successful use of *Mesocyclops* is community organization. It is straightforward enough to put copepods in containers and re-stock the containers whenever copepods are lost, but it is essential to make sure that everyone does it. Success can proceed neighborhood by neighborhood. One hundred houses that work together can free themselves of AE even if houses in the surrounding area do nothing.

The most promising strategy is to distribute *Mesocyclops* where local networks provide the greatest prospects for success. Vietnam has the advantage that most of its dengue is in rural areas where community organization is strongest and house-to-house health programs are already functioning well. Fortunately, thousands of communities in other countries also have house-to-house networks of one sort or another for primary health care, family planning, paramedical malaria treatment, agricultural extension, religious charity, small business support, etc. These same networks could serve as vehicles for distributing *Mesocyclops* and ensuring their proper use on a community scale. Even private marketing networks, which so effectively distribute insecticide spray cans and mosquito coils, could have a role if rewards based on community use are built into the incentive system. With each success, the demonstration effect should stimulate more communities to organize so that they can use *Mesocyclops* successfully.

REFERENCES:

M.D. Brown, B.H. Kay, and J.K. Hendrix. 1991. Evaluation of Australian Mesocyclops (Copepoda: Cyclopoida) for mosquito control. J. Med. Entomol. 28: 618-623

S.R. Christophers. 1960. Aedes Aegypti (L.). The Yellow Fever Mosquito. Its Life History, Bionomics and Structure. Cambridge Univ. Press, 721 pages

D.A. Focks, D.G. Haile, E. Daniels, and G.A. Mount. 1993. Dynamic life table model for Aedes aegypti (Diptera: Culicideae): analysis of the literature and model development. J. Med. Entomol. 30: 1003-1017

C.D. Jennings, B. Phommasack, B. Sourignadeth, and B.H. Kay. 1995. Aedes aegypti control in the Lao People's Democratic Republic, with reference to copepods. Am J. Trop. Med. Hyg. 53: 324-330

S.B. Halstead. 1997. Epidemiology of dengue and dengue hemorrhagic fever. In D.J. Gubler and G. Kuno (eds.), Dengue and Dengue Hemorrhagic Fever, p. 23-44. CAB International, New York
S.B. Halstead. 1998. Dengue and dengue hemorrhagic fever. In R.D. Feigin and J.D. Cherry (eds.), Textbook of Pediatric Infectious Diseases, p. 1984-1993. W.B. Sanders Co, Philadelphia
G.G. Marten. 1984. Impact of the copepod Mesocyclops leuckarti pilosa and the green alga Kirchneriella irregularis upon larval Aedes albopictus (Diptera: Culicidae). Bull. Soc. Vector Ecol. 9: 1-5
G.G. Marten, R. Astaeza, M.F. Suárez, C. Monje, and J.W. Reid. 1989. Natural control of larval Anopheles albimanus (Diptera: Culicidae) by the predator Mesocyclops (Copepoda: Cyclopoida). J. Med. Entomol. 26: 624-627
G.G. Marten. 1990a. Evaluation of cyclopoid copepods for Aedes albopictus control in tires. J. Am. Mosq. Control Assoc. 6: 681-688
G.G. Marten. 1990b. Elimination of Aedes albopictus from tire piles by introducing Macrocyclops albidus (Copepoda, Cyclopidae). J. Am. Mosq. Control Assoc. 6: 689-693
G.G. Marten, W.Y. Che, and E.S. Bordes. 1993. Compatibility of cyclopoid copepods with mosquito insecticides. J. Am. Mosq. Control Assoc. 9: 150-154
G.G. Marten, E.S. Bordes, and M. Nguyen. 1994a. Use of cyclopoid copepods for mosquito control. Hydrobiologia 292/293:491-496
G.G. Marten, G. Borjas, M. Cush, E. Fernández, and J.W. Reid. 1994b. Control of larval Ae. aegypti (Diptera: Culicidae) by cyclopoid copepods in peridomestic breeding containers. J. Med. Entomol. 31: 36-44
G.G. Marten, M. Nguyen, G. Thompson, and E.S. Bordes. 1997. Copepod production and application for mosquito control. New Orleans Mosquito Control Board, New Orleans, Louisiana, 43 pages
F. Riviere and R. Thirel. 1981. La predation du copeopods Mesocyclops leuckarti pilosa sur les larves de Aedes (Stegomyia) aegypti et Ae. (St.) polynesiensis essais preliminaires d'utilization comme de lutte biologique. Entomophaga 26: 427-439
F. Riviere, B.H. Kay, J.M. Klein, and Y. Sechan. 1987. Mesocyclops aspericornis (Copepoda) and Bacillus thuringiensis var. israelensis for the biological control of Aedes and Culex vectors (Diptera: Culicidae) breeding in crab holes, tree holes, and artificial containers. J. Med. Entomol. 24: 425-430
V.S. Nam, N.T. Yen, B.H. Kay, G.G. Marten, and J.W. Reid. 1998. Eradication of Aedes aegypti from a village in Vietnam, using copepods and community participation. Am. J. Trop. Med. Hyg. 59:657-660
B.M. Russell, L.E. Muir, P. Weinstein, and B.H. Kay. 1996. Surveillance of the mosquito Aedes aegypti and its biocontrol with the copepod Mesocyclops aspericornis in Australian wells and gold mines. Med. Vet. Entomol. 10: 155-160
F.L. Soper, D.B. Wilson, S. Lima, and W.S. Antunes. 1943. The organization of permanent nation-wide anti-Aedes aegypti measures in Brazil. The Rockefeller Foundation, New York, 137 pages
M.F. Suarez, D. Ayala, M.J. Nelson, and J.W. Reid. 1984. Hallazgo de Mesocyclops aspericornis (Daday) (Copepoda: Cyclopoidae) depredador de larvas de Aedes aegypti en Anapoima-Colombia. Biomedica 4: 74-76
A.W. Vasconcelos, A.C. Sleigh, B.H. Kay, C.P. Cabral, D.B. Araujo, Z.M. Ribiero, P.H. Braga, and J.S. Cavalcante. 1992. Community use of copepods to control Aedes aegypti in Brazil. In S.B. Halstead and H. Gomez-Dantes (eds.), Dengue--a Worldwide Problem, a Common Strategy, Proc. International Conference on Dengue and Aedes aegypti Community-based Control, p. 139-144. Mexican Ministry of Health and Rockefeller Foundation, Mexico

... LITERATURE LITERATURE LITERATURE ...

(Sources marked by an asterisk* have been donated to the MONOCULUS library)

1994

*GALASSI, D.P. & PESCE, G.L. - 1994: *Metacyclops geltrudeae* n.sp., a new cyclopid from ground waters of Venezuela (Copepoda, Cyclopidae). Crustaceana 67(3): 284-287.

1995

*KUNZ, H. - 1995: *Schizopera hawaiiensis* sp.n. (Copepoda, Harpacticoida) aus einer Lagune of Oahu, Hawaii-Inseln. Mitt. hamb. zool. Mus. Inst. 92: 65-72.

*REID, J. - 1995: Redescription of *Parastenocaris brevipes* Kessler and description of a new species of *Parastenocaris* (Copepoda: Harpacticoida: Parastenocarididae) from the U.S.A. Can. J. Zool. 73: 173-187.

1996

*PESCE, G.L., DE LAURENTIIS, P. & HUMPHREYS, W.F. - 1996: Copepods from ground waters of Western Australia, I. The genera *Metacyclops*, *Mesocyclops*, *Microcyclops* and *Apocyclops* (Crustacea: Copepoda: Cyclopidae). Records of the Western Australian Museum 18: 67-76.

*PESCE, G.L., DE LAURENTIIS, P. & HUMPHREYS, W.F. - 1996: Copepods from ground waters of Western Australia, II. The genus *Halicyclops* (Crustacea: Copepoda: Cyclopidae). Records of the Western Australian Museum 18: 77-85.

1997

*DE LAURENTIIS, P., PESCE, G.L. & HALSE, S.A. - 1997: Discovery of the first representative of the genus *Neocyclops* Gurney in Australia, and description of *Neocyclops* (*Neocyclops*) *petkoskii* n.sp. (Copepoda, Alicyclopinae). Bulletin Zoölogisch Museum, Universiteit van Amsterdam 16(3): 15-19.

MARTÍNEZ ARBIZU, P. & MOURA, G. - 1997: Atergopediidae, a new familiy of harpacticoid (Crustacea) from oligotrophic Arctic Sediments, Zool. Beitr. N.F. 38 (2): 189-210

*NAGASAWA, K., IKUTA, K. & KITAMURA, S. - 1997: Distribution of *Salmincola carpionis* (Copepoda: Lernaeopodidae) in the buccal cavity of salmonids. Bull. Natl. Res. Inst. Aquacult. 26: 35-39.

*SPIRIDONOV, V.A. & KOSOBOKOVA, K.N. - 1997: Winter ontogenetic migrations and the onset of gonad development in large dominant calanoid copepods in the Weddell Gyre (Antarctica). Mar. Ecol. Prog. Ser. 157: 233-246.

1998

APOSTOLOV, A. - 1998: Two new stygobiontic harpacticoid copepods from the Pyrenees. Memoires de Biospeologie 25: 1-6.

BALSEIRO, E. & MODENUTTI, B.E. - 1998: Pelagic communities and ecosystem processes in Andean Patagonian lakes. Ecologia Austral 8(2): 183-189.

BAMSTEDT, U. & K. KARLSON. - 1998: Euphausiid predation on copepods in coastal waters of the Northeast Atlantic. Marine Ecology Progress Series 172: 149-168.

BAYLY, I.A.E. - 1998: New species of *Calamoecia* and *Boeckella* (freshwater Copepoda: Calanoida) from Western Australia and Queensland. Journal of the Royal Society of Western Australia 81(4):177-182.

BONECKER, S.L.C., NOGUEIRA, C.R., BONECKER, A.C.T. & DIAS, C.O. - 1998: Influence of pulp mill effluent on marine zooplankton and ichthyoplankton communities in southern Brazil. Tropical Ecology 39 (1): 31-38.

*BRUGGEN, A.C. - 1998: W. Vervoort, eminent zoologist and museum director, a sketch of his life and work on the occasion of his 80th birthday in 1997. Zool. Verh. Leiden 323: 1-15.

CRUZ, P.L., CONDE-PORCUNA, J.M. & CARRILLO, P. - 1998: Diel variation in the egg ratio of *Hexarthra bulgarica* in the high mountain lake La Caldera (Spain). Hydrobiologia 387/388: 295-300.

DIEGUEZ, M. & E. BALSEIRO. - 1998: Colony size in *Conochilus hippocrepis*: Defensive adaptation to predator size. Hydrobiologia 387-388: 421-425.

*FERRARI, F.D. & DAHMS, H.-U. - 1998: Segmental homologies of the maxilliped of some copepods as inferred by comparing setal numbers during copepodid development. Journal of Crustacean Biology 18(2): 298-307.

*GEE, J.M. - 1998: A revision of the genus *Limnocletodes* Borutsky, 1926 (Copepoda: Harpacticoida: Cletodidae) with a description of a new species from southeast Asian mangrove forests. The Raffles Bulletin of Zoology 46(2): 399-418.

*GRICE, K., KLEIN BRETELER, W.C.M., SCHOUTEN, S. & GROSSI, V. - 1998: Effects of zooplankton herbivory on biomarker proxy records. Paleoceanography 13(6): 686-693.

HEINRICH, A.K.. - 1998: Copepods *Neocalanus plumchrus* and *N. flemingeri* in winter plankton in the Bering Sea. Okeanologiya 38 (3): 397-400. (Russian)

HEINRICH, A.K.. - 1998: On the biology of common copepods *Neocalanus plumchrus* and *N. flemingeri* in the Bering Sea. Okeanologiya 38 (6): 891-894. (Russian)

HEINRICH, A.K.. - 1998: Description of *Arietellus mohri* male (Crustacea, Calanoida, Arietellidae). Zoologicheskii Zhurnal 77 (8): 979-981. (Russian)

HIRST, A.G. & BATTEN, S.D. - 1998: Long-term changes in the diel vertical migration behaviour of *Calanus finmarchicus* in the North Sea are unrelated to fish predation. Marine Ecology Progress Series 171 (2): 307-310.

HOLLAND, T.A. & D.G. JENKINS. - 1998: Comparison of processes regulating zooplankton assemblages in new freshwater pools. Hydrobiologia 387/388: 207-214.

IRIGOIEN, X., R. HEAD, U. KLENKE, H.B. MEYER, D. HARBOUR, B. NIEHOFF, et al.. - 1998: A high frequency time series at weathership M, Norwegian Sea, during the 1997 spring bloom: Feeding of adult female *Calanus finmarchicus*. (et al. = H.J. Hirche & R. Harris) Marine Ecology Progress Series 172: 127-137.

JENKINS, D.G. & UNDERWOOD, M.O. - 1998: Zooplankton may not disperse readily in wind, rain, or waterfowl. Hydrobiologia 387-388: 15-21.

KOSOBOKOVA, K.N.. - 1998: New data on the life cycle of *Calanus glacialis* in the White Sea (based on the seasonal observations of the development of its genital system). Okeanologiya 38 (3): 387-396. (Russian)

LINDSTROM, Torolf. - 1998: Short-term changes of crustacean plankton reproduction and juvenile survival in some acidified and limed high mountain lakes. Nordic Journal of Freshwater Research 74: 127-140.

MACY, W.K., S.J. SUTHERLAND & E.G. DURBIN. 1998: Effects of zooplankton size and concentration and light intensity on the feeding behavior of Atlantic mackerel *Scomber scombrus*. Marine Ecology Progress Series 172: 89-100.

MARNEFFE, Y., S. COMBLIN & J.P. THOME. - 1998: Ecological water quality assessment of the Butgenbach lake (Belgium) and its impact on the River Warche using rotifers as bioindicators. Hydrobiologia 387/388: 459-467.

*JOHNSSON, R. - 1998: Maxillopoda - Copepoda. Siphonostomatoida Monstrilloida In: YOUNG, P.S. (ed.). Catalogue of Crustacea of Brazil. Rio de Janeiro: Museu Nacional 6: 261-262.

*JOHNSSON, R. - 1998: A new species of *Orecturus* Humes 1992, Siphonostomastoida (Crustacea, Copepoda) associated with *Echinaster* sp. and sponges in Bahia (Brazil). Bol. Mus. Nac., N.S., Zool., Rio de Janeiro 395: 1-7.

*KANG, H.-K. & KANG, Y.J. - 1998: Growth and development of *Acartia steueri* (Copepoda: Calanoida) in the laboratory. J. Korean Fish. Soc. 31(6): 842-851.

*KARANOVIC, T. - 1998: Two interesting species of the genus *Elaphoidella* Chappuis, 1929 (Crustacea, Copepoda) from Balkan Peninsula. Mémoires de Biospéologie 25: 25-33.

*KOSKI, M., KLEIN BRETELER, W. & SCHOGT, N. - 1998: Effect of food quality on rate of growth and development of the pelagic copepod *Pseudocalanus elongatus* (Copepoda, Calanoida). Mar. Ecol. Prog. Ser. 170: 169-187.

*MALTA, J.C. - 1998: Maxillopoda. Branchyura. In: YOUNG, P.S. (ed.). Catalogue of Crustacea of Brazil. Rio de Janeiro: Museu Nacional 6: 67-74.

* MARKHASEVA, E.L. - 1998: Geographical distribution of aetideid Copepoda (Copepoda: Calanoida) in the world ocean. In: PIERROT-BULTS, A.C. & VAN DER SPOEL, S. (eds.). IOC Workshop Report 142: 250-256.

*MARKHASEVA, E.L. - 1998: New species of the genus *Xanthocalanus* (Copepoda, Calanoida, Phaennidae) from the Laptev Sea. Journal of Marine Systems 15: 413-419.

*MARKHASEVA, E.L. & KOSOBOKOVA, K.N. - 1998: New and rare species of calanoid copepods from the central Arctic Basin (Crustacea, Copepoda). Zoosystematica Rossica 7(1): 45-53.

MENU-MARQUE, S.A. & LOCASICO de MITROVICH, C. - 1998: Distributión de las espencies del Género *Boeckella* (Copepoda Calanoida: Centropagidae) en la Argentina. Physis (Buenos Aires) Secc. B, 56 130-131: 1-10

MODENUTTI, B.E., BALSEIRO,E., del CARMEN,D.M. QUEIMALINOS, C. & ALBARINO, R. - 1998: Heterogeneity of fresh-water Patagonian ecosystems. Ecologia Austral 8 (2): 155-165.

*NAGASAWA, K., IKUTA, K., NAKAMURA, H., SHIKAMA, T. & KITAMURA, S. - 1997: Occurrence and effects of the parasitic copepod *Salmincola carpionis* on salmonids in the Nikko District, central Japan. Journal of Marine Systems 15: 269-272.

*NAGASAWA, K., TANAKA, S. & BENZ, G.W. - 1998: *Trebius shiinoi* n.sp. (Trebiidae: Siphonostomatoida: Copepoda) from uteri and embryos of the Japanese angelshark *(Squatina japonica)* and the clouded angelshark *(Squatina nebulosa)*, and redescription of *Trebius longicaudatus*. J. Parasitol. 84(6): 1218-1230.

NASSAL, B., BURGHARD, W. & MAIER, G. - 1998: Predation by juvenile roach on the calanoid copepod *Eudiaptomus gracilis* and the cyclopoid copepod *Cyclops vicinus*: A laboratory investigation with mixed and single prey. Aquatic Ecology 32 (4): 335-340.

ONSRUD, M.S.R. & KAARTVEDT, S. - 1998: Diel vertical migration of the krill *Meganyctiphanes norvegica* in relation to physical environment, food and predators. Marine Ecology Progress Series 171: 209-219.

PETERSEN, J.E., SANFORD, L.P. & KEMP, W.M. - 1998: Coastal plankton responses to turbulent mixing in experimental ecosystems. Marine Ecology Progress Series 171(1): 23-41.

RAHKOLA, M., KARJALAINEN, J. & AVINSKY, V.A. - 1998: Individual weight estimates of zooplankton based on length-weight regressions in Lake Ladoga and Saimaa lake system. Nordic Journal of Freshwater Research 74: 110-120.

RANJIT, S.A.J.A. & BENSAM, P. - 1998: A new species of *Peroderma* Heller (Lernaeoceriformes: Copepoda) from sardines off the Porto Novo coast, India. Journal of the Bombay Natural History Society 95 (3): 473-476.

*REID, J.W. - 1998: Maxillopoda - Copepoda. Harpacticoida. In: YOUNG, P.S. (ed.). Catalogue of Crustacea of Brazil. Rio de Janeiro: Museu Nacional 6: 75-127.

RIOS, J.E.. - 1998: Seasonal abundance of the demersal copepod *Pseudodiaptomus cokeri* (Calanoidea: Pseudodiaptomidae) in a Caribbean estuarine environment. Revista de Biologia Tropical 46 (3): 661-672.

*SANTOS-SILVA, E.N. - 1998: Maxillopoda - Copepoda. Freshwater Calanoida. In: YOUNG, P.S. (ed.). Catalogue of Crustacea of Brazil. Rio de Janeiro: Museu Nacional 6: 201-220.

SAMRAOUI, B., SEGERS, H., MAAS, S., BARIBWEGURE, D. & DUMONT, H.J. - 1998: Rotifera, Cladocera, Copepoda, and Ostracoda from coastal wetlands in northeast Algeria. Hydrobiologia 386: 183-193.

SCHMIDT, K., KAHLER, P. & von BODUNGEN, B. - 1998: Copepod egg production rates in the Pomeranian Bay (Southern Baltic Sea) as a function of phytoplankton abundance and taxonomic composition. Marine Ecology Progress Series 174: 183-195.

*SCHNACK-SCHIEL, S.B., THOMAS, D., DAHMS, H.-U., HAAS, C. & MIZDALSKI, E. - 1998: Copepods in Antarctic Sea ice. Antarctic Research Series 73: 173-182.

*SCHRAM, T.A., KNUTSEN, J.A., HEUCH, P.A. & MO, T.A. - 1998: Seasonal occurrence of *Lepeophtheirus salmonis* and *Caligus elongatus* (Copepoda: Caligidae) on sea trout *(Salmo trutta)*, off southern Norway. ICES J. Mar. Sci. 55 : 163-175.

SCHULZ, K. - 1998: A new species of *Xantharus* Andronow, 1981 (Copepoda: Calanoida) from the mesopelagic zone of the Antarctic ocean. Helgoländer Meeresunters., 52, 41-49

SHIEL, R.J., GREEN, J.D. & NIELSEN, D.L. - 1998: Floodplain biodiversity: Why are there so many species? Hydrobiologia 387-388: 39-46.

STEVENS, C.J. & HEAD, E.J.H. - 1998: A model of chlorophyll a destruction by *Calanus spp.* and implications for the estimation of ingestion rates using the gut fluorescence method. Marine Ecology Progress Series 171: 187-198.

de TROCH, M., J. MEES & E. WAKWABI. - 1998: Diets of abundant fishes from beach seine catches in seagrass beds of a tropical bay (Gazi Bay, Kenya). Belgian Journal of Zoology 128 (2): 135-154.

URBAN-RICH, J.L., HANSELL, D.A. & ROMAN, M.R. - 1998: Analysis of copepod fecal pellet carbon using a high temperature combustion method. Marine Ecology Progress Series 171: 199-208.

VEIT-KOEHLER, G.. - 1998: Meiofauna study in the Potter Cove: Sediment situation and resource availability for small crustaceans (Copepoda and Peracarida). Berichte zur Polarforschung 299: 132-136.

VIITASALO, M. & RAUTIO, M. - 1998: Zooplanktivory by *Praunus flexuosus* (Crustacea: Mysidacea): functional responses and prey selection in relation to prey escape responses. Marine Ecology Progress Series 174: 77-87.

*VON VAUPEL KLEIN, J.C. - 1998 : Interpretation of character phylogenies in calanoid copepods by implementing Dollo's law. J. Crust. Biol. 18(1): 153-160.

*VON VAUPEL KLEIN, J.C. & GRASSMANN, D. - 1998: Character phylogenies in *Candacia* and *Paracandacia* (Copepoda, Calanoida) and the inevitably paraphyletic nature of many nominal taxa above subspecies level. J. Mar. Syst. 15: 441-449.

1999

ADRIAN, R., WALZ, N., HINTZE, T., HOEG, S. & RUSCHE, R. - 1999: Effects of ice duration on plankton succession during spring in a shallow polymictic lake. Freshwater Biology 41 (3): 621-632.

ATKINSON, A., WARD, P. HILL, A., BRIERLEY, A.S. & CRIPPS, G.C. - 1999: Krill-copepod interactions at South Georgia, Antarctica, II. *Euphausia superba* as a major control on copepod abundance. Marine Ecology Progress Series 176: 63-79.

AGUIRRE-MACEDO, M.L. & KENNEDY, C.R. - 1999: Diversity of metazoan parasites of the introduced oyster species *Crassostrea gigas* in the Exe Estuary. Journal of the Marine Biological Association of the United Kingdom 79 (1): 57-63.

BELL, E.M, & P.J. LAYBOURN. - 1999: Annual plankton dynamics in an Antarctic saline lake. Freshwater Biology 41 (3): 507-519.

BENETTON, M.L.F.N. & MALTA. J.C.O. - 1999: Morphology of the naupliar stages and copepodite I from *Perulernaea gamitanae* Thatcher & Paredes, - 1985 (Crustacea:

Cyclopoida: Lernaeidae), parasite of tambaqui, *Colossoma macropomum* (Cuvier, 1818), (Osteichthyes: Characidae) reared in the laboratory. Acta Amazonica 29 (1): 97-121. (Portugese)

BENKIRANE, O., F. COSTE & A. RAIBAUT. - 1999: On the morphological variability of the attachment organ of Lernaeopodidae (Copepoda: Siphonostomatoida). Folia Parasitologica Ceske Budejovice 46 (1): 67-75.

BILLIONES, R.G., TACKX, M.L., & DARO, M.H. - 1999: The geometric features, shape factors and fractal dimensions of suspended particulate matter in the Scheldt estuary (Belgium). Estuarine Coastal and Shelf Science 48 (3): 293-305.

BREITBURG, D.L., SANDERS, J.G., GILMOUR, C.C., HATFIELD, C.A., OSMAN, R.W., et al.. - 1999: Variability in responses to nutrients and trace elements, and transmission of stressor effects through an estuarine food web. (et al. = G.f. Riedel, S.P. Seitzinger & K.G. Sellner). Limnology and Oceanography 44 (3 PART 2): 837-863.

BROADHURST, M.K., D.T. BARKER & S.J. KENNELLY. - 1999: Scale-loss and survival of juvenile yellowfin bream, *Acanthopagrus australis*, after simulated escape from a Nordmore-grid guiding panel and release from capture by hook and line. Bulletin of Marine Science 64 (2): 255-268.

BUDNICHENKO, E.V., FIRULINA, A.V. & BULGAKOVA, Y.V. - 1999: Feeding conditions of the Azov Sea anchovy *Engraulis encrasicolus maeoticus* during the summer-autumn period of 1995-1996. Voprosy Ikhtiologii 39(2): 233-240. (Russian)

BURTON, R.S., RAWSON, P.D. & EDMANDS, S. - 1999: Genetic architecture of physiological phenotypes: Empirical evidence for coadapted gene complexes. American Zoologist 39 (2): 451-462.

CERVETTO, G., GAUDY, R. & PAGANO, M. - 1999: Influence of salinity on the distribution of *Acartia tonsa* (Copepoda, Calanoida). Journal of Experimental Marine Biology and Ecology 239(1): 33-45.

CHAE, J.H. & NISHIDA, S. - 1999: Spectral patterns of the iridescence in the males of *Sapphirina* (Copepoda: Poecilostomatoida). Journal of the Marine Biological Association of the United Kingdom 79 (3): 437-443.

CHICK, J.H., van den AVYLE, A.M.J. - 1999: Effects of zooplankton spatial variation on growth of larval striped bass: An experimental approach. Transactions of the American Fisheries Society 128 (2): 339-351.

CHMURA, G.L., SMIRNOV, A. & CAMPBELL, I.D. - 1999: Pollen transport through distributaries and depositional patterns in coastal waters. Palaeogeography Palaeoclimatology Palaeoecology 149 (1-4): 257-270.

CIERI, M.D. & STEARNS, D.E. - 1999: Reduction of grazing activity of two estuarine copepods in response to the exudate of a visual predator. Marine Ecology Progress Series 17: 157-163.

CLARKE, N.V. & RAYNER, N.A. - 1999. Freshwater Crustacea (Ostracoda, Copepoda, Branchiopoda, Cladocera) of the Cuvelai wetlands in northern Namibia. Cimbebasia 15: 117 -126.

CLARKE, R.D. - 1999: Diets and metabolic rates of four Caribbean tube blennies, genus *Acanthemblemaria* (Teleostei: Chaenopsidae). Bulletin of Marine Science 65 (1): 185-199.

CYR, H. & CURTIS, J.M. - 1999: Zooplankton community size structure and taxonomic composition affects size-selective grazing in natural communities. Oecologia Berlin 118 (3): 306-315.

DAVENPORT, J., BUTLER, A. & CHESHIRE, A. - 1999: Epifaunal composition and fractal dimensions of marine plants in relation to emersion. Journal of the Marine Biological Association of the United Kingdom 79 (2): 351-355.

DAWSON-LEIGH, H.J., PIKE, A.W. HOULIHAN, D.F. & McVICAR-Alasdair, H. - 1999: Changes in physiological parameters and feeding behaviour of Atlantic salmon *Salmo salar*

infected with sea lice *Lepeophtheirus salmonis*. Diseases of Aquatic Organisms 35 (2): 89-99.

de NIMAI, C. & MAITY. R.N. - 1999: Larval development of *Onchocamallanus bagarii* (Nematoda: Camallanidae) in copepods. Folia Parasitologica Ceske Budejovice 46 (1): 53-58.

DOLGANOVA, N.T., HIRAKAWA, K. & Takahashi, T. - 1999: Seasonal variability of the copepod assemblage and its relationship with oceanographic structures at Yamato Tai, central Japan Sea. Bulletin of the Japan Sea National Fisheries Research Institute 49: 13-35.

ESCRIBANO, R. & McLAREN, I. - 1999: Production of *Calanus chilensis* in the upwelling area of Antofagasta, northern Chile. Marine Ecology Progress Series 177: 147-156.

ETCHEGOIN, J.A. & IVANOV, V.A. - 1999: Parasitic copepods of the narrownose smooth-hound shark *Mustelus schmitti* (Chondrichthyes: Triakidae) from Argentina. Folia Parasitologica Ceske Budejovice 46 (2): 149-153.

FORGET, J., PAVILLON, J.F., BELIAEFF, B. & BOCQUENE, G. - 1999: Joint action of pollutant combinations (pesticides and metals) on survival (LC50 values) and acetylcholinesterase activity of *Tigriopus brevicornis* (Copepoda, Harpacticoida). Environmental Toxicology and Chemistry 18 (5): 912-918.

GARCIA, B.E.. - 1999: Food of introduced mosquitofish: Ontogenetic diet shift and prey selection. Journal of Fish Biology 55 (1): 135-147.

GREEN, J.D., SHIEL, RJ. & LITTLER, R.A. - 1999: *Boeckella major* (Copepoda: Calanoida): A predator in Australian ephemeral pools. Archiv für Hydrobiologie 145 (2): 181-196.

GREY, J. & JONES, R.I. - 1999: Carbon stable isotopes reveal complex trophic interactions in lake plankton. Rapid Communications in Mass Spectrometry 13 (13): 1311-1314.

GUISANDE, C., MANEIRO, I. & RIVEIRO, I. - 1999: Homeostasis in the essential amino acid composition of the marine copepod *Euterpina acutifrons*. Limnology and Oceanography 44 (3): 691-696.

*GÜNTHER, S., GEORGE, K.H. & GLEITZ, M. - 1999: High sympagic metazoan abundance in platelet layers at Drescher Inlet, Weddell Sea, Antarctica. Polar Biol. 22: 82-89.

HANSEN, B.W., NIELSEN, T.G. & LEVINSEN, H. - 1999: Plankton community structure and carbon cycling on the western coast of Greenland during the stratified summer situation. III. Mesozooplankton. Aquatic Microbial Ecology 16 (3): 233-249.

HARDING, W. & WRIGHT, S. - 1999: Initial findings regarding changes in phyto- and zooplankton composition and abundance following the temporary drawdown and refilling of a shallow, hypertrophic South African coastal lake. Lake and Reservoir Management 15 (1): 47-53.

HIRAKAWA, K., MORITA,A., NAGATA, H. & HIRAI, M. - 1999: Seasonal variability of the zooplankton assemblage and its relationship with oceanographic structures at Yamato Tai, central Japan Sea. Bulletin of the Japan Sea National Fisheries Research Institute 49: 37-56. (Japanese)

HIRST, A.G., SHEADER, M. & WILLIAMS, J.A. - 1999: Annual pattern of calanoid copepod abundance, prosome length and minor role in pelagic carbon flux in the Solent, UK. Marine Ecology Progress Series 177 (1): 133-146.

HOLZ, J.C. & HOAGLAND, K.D. - 1999: Effects of phosphorus reduction on water quality: Comparison of alum-treated and untreated portions of a hypereutrophic lake. Lake and Reservoir Management 15 (1): 70-82.

*HOSFELD, B. - 1999: Ultrastructure of ionocytes from osmoregulatory integumental windows of *Tachidius discipes* and *Bryocamptus pygmaeus* (Crustacea, Copepoda, Harpacticoida) with remarks on the homology of nonsensory dorsal organs of crustaceans. Acta Zoologica (Stockholm) 80: 61-74.

HUMES, A.G.. - 1999: Copepoda (Cyclopinidae and Misophriidae) from a deep-sea hydrothermal site in the northeastern Pacific. Journal of Natural History 33 (7): 961-978.

IGUCHI, N., WADA, Y. & HIRAKAWA, K. - 1999: Seasonal changes in the copepod assemblage as food for larval anchovy in western Wakasa Bay, southern Japan Sea. Bulletin of the Japan Sea National Fisheries Research Institute 49: 69-80. (Japanese)

JERLING, H.L. & CYRUS, D.P. - 1999: The zooplankton communities of an artificially divided subtropical coastal estuarine-lake system in South Africa. Hydrobiologia 390: 25-35.

*JOHNSSON, R. - 1999: *Cletopontius titanus* new species, a new siphonostomatoid (Crustacea: Copepoda) associated with sponges from Brazil. Bulletin of Marine Science 64(2): 195-200.

JOHNSTON, N.T., STAMFORD, M.D.,ASHLEY, K.I. & TSUMURA, K. - 1999: Responses of rainbow trout *Oncorhynchus mykiss* and their prey to inorganic fertilization of an oligotrophic montane lake. Canadian Journal of Fisheries and Aquatic Sciences 56 (6): 1011-1025.

*JONES, J.B. & ZEIDLER, W. - 1999: The occurrence of *Pachypygus gibber* (Thorell, 1859) (Copepoda: Notodelphyidae) in Australian waters. Transactions of the Royal Society of S. Aust. 123(2): 81-82.

JUERGENS, K., SKIBBE, O. & JEPPESEN, E. - 1999: Impact of metazooplankton on the composition and population dynamics of planktonic ciliates in a shallow, hypertrophic lake. Aquatic Microbial Ecology 17 (1): 61-75.

KALMAN, M., EL-MANSY, A., CSABA, S. & FERENC, B. - 1999: Experimental studies on the intra-oligochaete development of myxosporean fish parasites. Magyar Allatorvosok Lapja 121 (5): 283-291. (Hungarian)

*KARANOVIC, T. - 1999: *Ceuthonectes petkovskii*, a new species of harpacticoid copepod from Montenegro (Crustacea, Canthocamptidae). Bulletin Zoölogisch Museum, Universiteit van Amsterdam 16(14): 97-104.

*KARAYTUG, S. - 1999: Copepoda: Cyclopoida. Genera *Paracyclops*, *Ochridacyclops* and key to the Eucyclopinae. In: DUMONT, H.J.F. (ed.). Guides to the identification of the microinvertebrates of the continental waters of the world. Backhuys Publishers, Leiden. 14: 1-217.

KOSKI, M., VIITASALO, M. & H.KUOSA, H. - 1999: Seasonal development of mesozooplankton biomass and production on the SW coast of Finland. Ophelia 50 (2): 69-91.

KUSK, K.O. & WOLLENBERGER, L. - 1999: Fully defined saltwater medium for cultivation and toxicity testing with marine copepod *Acartia tonsa*. Environmental Toxicology and Chemistry 18 (7): 1564-1567.

LAVANIEGOS, B.E. & GONZALEZ, N.E. - 1999: Changes in the copepod community during the 1992-93 ENSO at San Lorenzo Channel, Gulf of California. Ciencias Marinas 25 (2): 239-265.

LAVOIE, D.M., SMITH, L.D. & RUIZ, G.M. - 1999: The potential for intracoastal transfer of non-indigenous species in the ballast water of ships. Estuarine Coastal and Shelf Science 48 (5): 551-564.

LEVINE, S.N., BORCHARDT, M.A., BRANER, M. & SHAMBAUGH, A.D. - 1999: The impact of zooplankton grazing on phytoplankton species composition and biomass in Lake Champlain (USA-Canada). Journal of Great Lakes Research 25 (1): 61-77.

LEVINSEN, H., NIELSEN, T.G., & HANSEN, B.W. - 1999: Plankton community structure and carbon cycling on the western coast of Greenland during the stratified summer situation. II. Heterotrophic dinoflagellates and ciliates. Aquatic Microbial Ecology 16 (3): 217-232.

LINZ, G.M., BLEIER, W.J., OVERLAND, J.D. & H.J. HOMAN. - 1999: Response of invertebrates to glycophosphate-induced habitat alterations in wetlands. Wetlands 19 (1): 220-227.

LUIZI, F.S., B. GARA, R.J. SHIELDS & N.R. BROMAGE. - 1999: Further description of the development of the digestive organs in Atlantic halibut (*Hippoglossus hippoglossus*) larvae, with notes on differential absorption of copepod and *Artemia* prey. Aquaculture 176 (1-2): 101-116.

MALY, E.J. & M.P. MALY. - 1999: Body size and sexual size dimorphism in calanoid copepods. Hydrobiologia 391: 173-179.

*MARTINEZ-ARBIZU, P. - 1999: New Erebonasteridae (Copepoda) from Vilkitzky Strait in the Arctic and from a Pacific hydrothermal vent site (Northern Fiji Basin). Journal of Crustacean Biology 19(1): 93-105.

MENN, I. & W. ARMONIES. - 1999: Predatory *Promesostoma* species (Plathelminthes, Rhabdocoela) in the Wadden Sea. Journal of Sea Research 41 (4): 309-320.

*MONCHENKO, V.I. & VON VAUPEL KLEIN, J.C. - 1999: Oligomerization in Copepoda Cyclopoida as a kind of orthogenetic evolution in the animal kingdom. Crustaceana 72(3): 241-264.

MORAVEC, F., V. VIDAL-MARTINEZ, & M.L. AGUIRRE. 1999: Branchiurids (*Argulus*) as intermediate hosts of the daniconematid nematode *Mexiconema cichlasomae*. Folia Parasitologica Ceske Budejovice 46 (1): 79.

N'GORAN, Y.N. & PAGANO, M. - 1999: *Vinciguerria nimbaria* diet from an eastern area of the Tropical Atlantic Ocean. Cybium 23 (1): 85-92. (French)

NAGASAWA, T.. - 1999: Early life history of yoroi-mebaru, *Sebastes hubbsi*, in the Sado Strait, Sea of Japan. Bulletin of the Japan Sea National Fisheries Research Institute 49: 97-108.

NANTON, D.A. & J.D. CASTELL. - 1999: The effects of temperature and dietary fatty acids on the fatty acid composition of harpacticoid copepods, for use as a live food for marine fish larvae. Aquaculture 175 (1-2): 167-181.

NICHOLAS, K.R. & NASH, R.D.M. - 1999: Rare records of *Euchaeta* species (Crustacea:Copepoda) in the Irish Sea. Journal of the Marine Biological Association of the United Kingdom 79 (2): 367-368.

NISHIMURA, A., NAGASAWA, A.K., ASANUMA, T., AOKI, H. & KUBOTA, T. - 1999: Age, growth, and feeding habits of lanternfish, *Stenobrachius leucopsarus* (Myctophidae), collected from the near-surface layer in the Bering Sea. Fisheries Science Tokyo 65 (1): 11-15.

NOLAN, D.T., REILLY, P. & WENDELAAR, B.S. - 1999: Infection with low numbers of the sea louse *Lepeophtheirus salmonis* induces stress-related effects in postsmolt Atlantic salmon (*Salmo salar*). Canadian Journal of Fisheries and Aquatic Sciences 56 (6): 947-959.

*OHTSUKA, S., GRYGIER, M.J. & TORIGOE, K. - 1999: The phylogeny, zoogeography, and ecology of marine cavernicolous crustaceans. Taxa 6: 3-13.

OLSEN, Y., EVJEMO, J.O. & OLSEN, A. - 1999: Status of the cultivation technology for production of Atlantic halibut (*Hippoglossus hippoglossus*) juveniles in Norway/Europe. Aquaculture 176 (1-2): 3-13.

*OOISHI, S. - 1999: Female and male *Botryllophilus ruber* (Copepoda: Cyclopoida) associated with the compound ascidian *Botryllus schlosseri*. Journal of Crustacean Biology 19(3): 556-577.

PAGANO, M., SAINT JEAN, L., ARFI, R., BOUVY, M. & GUIRAL, D. - 1999: Zooplankton food limitation and grazing impact in a eutrophic brackish-water tropical pond (Cote d'Ivoire, West Africa). Hydrobiologia 390: 83-98.

POULIN, R. - 1999: Body size vs abundance among parasite species: Positive relationships? Ecography 22 (5): 246-250.

POWLIK, J.J.. - 1999: Habitat characters of *Tigriopus californicus* (Copepoda: Harpacticoida), with notes on the dispersal of supralittoral fauna. Journal of the Marine Biological Association of the United Kingdom 79 (1): 85-92.

RABETTE, C. & LAIR, N. - 1999: Spatial and temporal distribution of benthic stages of *Cyclops vicinus* and *Chaoborus flavicans* in relation to abiotic factors and benthic fauna. Hydrobiologia 390: 61-72.

RAYNER, N.A.. - 1999: *Paradiaptomus peninsularis*, *P. hameri* and *P. warreni*, three new species of *Paradiaptomus* (Calanoida: Diaptomidae) from South Africa. Hydrobiologia 391: 87-98.

RHUDY, K.B., SHARMA, V.K., LEHMAN, R.L. & McKEE, D.A. - 1999: Seasonal variability of the Texas 'brown tide' (*Aureoumbra lagunensis*) in relation to environmental parameters. Estuarine Coastal and Shelf Science 48 (5): 565-574.

*REID, J.W. - 1999: Técnicas taxonômicas para copépodes. Limnotemas 1: 12 pp.

*REID, J.W. - 1999: New records of *Bryocyclops* from the continental U.S.A., Puerto Rico, and Brazil (Copepoda: Cyclopoida: Cyclopidae). Journal of Crustacean Biology 19(1): 84-92.

*REID, J.W., STRAYER, D.L., McARTHUR, J.V., STIBBE, S.E. & LEWIS, J.J. - 1999: *Rheocyclops*, a new genus of copepods from the southeastern and central U.S.A. (Copepoda: Cyclopoida: Cyclopidae). Journal of Crustacean Biology 19(2): 384-396.

ROUBAL, F.R.. - 1999: Extent of gill pathology in the toadfish *Tetractenos hamiltoni* caused by *Naobranchia variabilis* (Copepoda: Naobranchiidae). Diseases of Aquatic Organisms 35(3): 203-211.

ROUBAL, F.R. & GRAHAM, D. - 1999: Monthly variation in recruitment, infection, size, fecundity and mating of *Naobranchia variabilis* (Copepoda: Naobranchiidae) parasitic on the gills of toadfish *Tetractenos hamiltoni* from Moreton Bay, Australia. Marine and Freshwater Research 50 (4): 291-298.

RUSAK, J.A., YAN, N.D., SOMERS, K.M. & McQUEEN, D.J. - 1999: The temporal coherence of zooplankton population abundances in neighboring north-temperate lakes. American Naturalist 153 (1): 46-58.

SANDULLI, R. & PINCKNEY, J. - 1999: Patch sizes and spatial patterns of meiobenthic copepods and benthic microalgae in sandy sediments: A microscale approach. Journal of Sea Research 41 (3): 179-187.

SAUTOUR, B. & CASTEL, J. - 1999: Grazing activity of mesoplanktonic copepods in a shallow bay during an algal spring bloom (Marennes-Oleron Bay, France). Journal of the Marine Biological Association of the United Kingdom 79 (1): 73-84.

SHIELDS, R.J., Gara, B. & Gillespie, M.J.S. - 1999: A UK perspective on intensive hatchery rearing methods for Atlantic halibut (*Hippoglossus hippoglossus L.*). Aquaculture 176 (1-2): 15-25.

SHIELDS, R.J., BELL, J.G., LUIZI, F.S., GARA, B., BROMAGE, N.R. & SARGENT, J.R. - 1999: Natural copepods are superior to enriched *Artemia nauplii* as feed for halibut larvae (*Hippoglossus hippoglossus*) in terms of survival, pigmentation and retinal morphology: Relation to dietary essential fatty acids. Journal of Nutrition 129 (6): 1186-1194.

SHIOMOTO, A., Y. ISHIDA, K. NAGASAWA, K. TADOKORO, M. TAKAHASHI & K. MONAKA. - 1999: Distribution of chlorophyll-a concentration in the Transition Domain and adjacent regions of the central North Pacific in summer. Plankton Biology and Ecology 46 (1): 30-36.

SMITH, T.J., McVEY, D.C., JENKINS, W.E., DENSON, M.R., HEYWARD, L.D. et al.. - 1999: Broodstock management and spawning of southern flounder, *Paralichthys lethostigma*. (et al. = C.V. Sullivan & D.L. Berlinsky) Aquaculture 176 (1-2): 87-99.

SNYDER, D.J. & PETERSON, M.S. - 1999: Foraging and prey selection by bluespotted sunfish *Enneacanthus gloriosus* (Holbrook) in backwater, vegetated ponds in coastal Mississippi. Journal of Freshwater Ecology 14 (2): 187-196.

SOMMARUGA, R. & GARCIA, P.F. - 1999: UV-absorbing mycosporine-like compounds in planktonic and benthic organisms from a high-mountain lake. Archiv fuer Hydrobiologie 144 (3): 255-269.

SOROKIN, Y.I., SOROKIN, P.Y. & RAVAGNAN, G. - 1999: Analysis of lagoonal ecosystems in the Po River Delta associated with intensive aquaculture. Estuarine Coastal and Shelf Science 48 (3): 325-341.

SPADINGER, R. & MAIER, G. - 1999: Prey selection and diel feeding of the freshwater jellyfish, *Craspedacusta sowerbyi*. Freshwater Biology 41 (3): 567-573.

SPENCER, M., FISHER, N.S. & WANG, W.X. - 1999: Exploring the effects of consumer-resource dynamics on contaminant bioaccumulation by aquatic herbivores. Environmental Toxicology and Chemistry 18 (7): 1582-1590.

STOTTRUP, J.G., BELL, J.G. & SARGENT, J.R. - 1999: The fate of lipids during development and cold-storage of eggs in the laboratory-reared calanoid copepod, *Acartia tonsa* Dana, and in response to different algal diets. Aquaculture 176 (3-4): 257-269.

SUZUKI, K., NAKAMURA, Y. & HIROMI, J. - 1999: Feeding by the small calanoid copepod *Paracalanus sp.* on heterotrophic dinoflagellates and ciliates. Aquatic Microbial Ecology 17 (1): 99-103.

TAKAMURA, N., MIKAMI, H., MIZUTANI, H. & NAGASAKI, K. - 1999: Did a drastic change in fish species from kokanee to pond smelt decrease the secchi disc transparency in the oligotrophic Lake Towada, Japan? Archiv für Hydrobiologie 144 (3): 283-304.

TASKINEN, J. & SAARINEN, M. - 1999: Increased parasite abundance associated with reproductive maturity of the clam *Anodonta piscinalis*. Journal of Parasitology 85 (3): 588-591.

TOLONEN, A.. - 1999: Application of a bioenergetics model for analysis of growth and food consumption of subarctic whitefish *Coregonus lavaretus* (L.) in Lake Kilpisjarvi, Finnish Lapland. Hydrobiologia 390: 153-169.

TSUCHIYA, A. & SAWAMOTO, S. - 1999: Estimation of plankton biomass with sound speed measurement. Journal of the School of Marine Science and Technology Tokai University 47: 11-29.(Japenese)

UTNE-PALM, A.C.. - 1999: The effect of prey mobility, prey contrast, turbidity and spectral composition on the reaction distance of *Gobiusculus flavescens* to its planktonic prey. Journal of Fish Biology 54 (6): 1244-1258.

WILLETTE, T.M., COONEY, R.T., & HYER, K. - 1999: Predator foraging mode shifts affecting mortality of juvenile fishes during the subarctic spring bloom. Canadian Journal of Fisheries and Aquatic Sciences 56 (3): 364-376.

YANG, Y.F., Huang, X.F. & Liu, J.K. - 1999: Long-term changes in crustacean zooplankton and water quality in a shallow, eutrophic Chinese lake densely stocked with fish. Hydrobiologia 391: 195-203.

YOSHII, K., MELNIK, N.G., TIMOSHKIN,O.A., BONDARENKO, N.A., ANOSHKO, P.N. et al.. - 1999: Stable isotope analyses of the pelagic food web in Lake Baikal. (et al. = T. YOSHIOKA & E. WADA). Limnology and Oceanography 44 (3): 502-511.

... CANDIDATE MEMBER ...

I have been working as a researcher at the Institute of Fish Resources for seven years. The main topics of my scientific work are:

- investigating the mesozooplankton abundance and biomass in the Bulgarian Black Sea waters, both in offshore and coastal regions,
- maintaining and processing the long-term data (collected since 1954) of mesozooplankton seasonal and annual dynamics.

Nowadays, I am working at my dissertation, in which seven years' data of mesozooplankton composition (with predominating group Copepoda), rate correlations, temporal patterns in mesozooplankton abundance have been included.

During the last ten years significant changes in the zooplankton community in the Black Sea have occurred due to the introduction and mass development of the ctenophore species, *Mnemiopsis mccradyi*. The predator impact led to a strong decrease in the Copepoda density and shifts in seasonal patterns of many copepod representatives.

Short Biography

born on 1/11/1967 in Varna, Bulgaria
Education: University "Konstantin Preslavski" Shumen, Bulgaria, 1990, Master of Arts.
Additional qualification: Programme of zooplankton research organized by UgNIRO, Kerch, Ukraine, 1991.
Languages: English, German, Russian
Home address: Benkovski 26 street, apt. 19, 9000 Varna, Bulgaria
e-mail: mihnev@mbox.digsys.bg

Vesselina Vassileva Michneva (Varna, Bulgaria)

... NEW MEMBER...

SHIMODE, Shinji
Seto Marine Biological Laboratory
Graduate School of Science
Kyoto University
459 Shirahama
Wayakama
649-2211
JAPAN

CHANGE OF ADDRESS

DE TROCH, Marleen
Marine Biology Section/Zool. Inst.
University Gent
Ledeganckstraat 35
B-9000 Gent
BELGIUM
Tel: (32)-(0)9-2645214
Fax: (32)-(0)9-2645344
E-mail: Marleen.Detroch@rug.ac.be

GAVIRIA, Santiago (Dr.)
Universidad de Antioquia
Departamento de Biologia
Limnologia
A.A. 1226 Medellin
COLOMBIA
Tel: (57)-4-105625
Fax: (57)-4-2330120

KARANOVIC, T.
c/o Accursio Venezia
Via Brescia 3
I-84092 Bellizzi (SA)
ITALY

O'REILLY, Myles
Scottish Environment Protection Agency
SEPA West Region HQ
5 Redwood Crescent
Peel Park
East Kilbride
GB-Glasgow G74 5PP
U.K.

PESCE, Giuseppe L. (Prof.)
Dipartimento di Scienze Ambientali
Università di L'Aquila
Via Vetoio L'Aquila
ITALY
Fax: 039-0862-433205
E-mail: giuseppe.pesce@aquila.infn.it
Web: http://www.glpesce.net
http://www.univaq.it/~sc_amb/pesce.html

SCHIZAS, Nikolaos (Dr.)
Department of Ecology and Evolution
University of Chicago
1101 E. 57th St.
Chicago, IL 60637
U.S.A.
E-mail: nschizas@fmppr.fmnh.org

CHANGE OF PHONE- / FAX- AND E-MAIL ADDRESSES

Kabata, Bob (Canada): zkabata@home.com
Yindee, Weera (Thailand): wachira1999@hotmail.com and weeyin@thaimail.com
Pesce, Giuseppe L. (Italy): giuseppe.pesce@aquila.infn.it
Web pages on copepods:
http://www.glpesce.net/fauna.html
http://www.glpesce.net/cyclopid.html
http://www.glpesce.net/arpact.html
http://www.glpesce.net/copepod.html
http://www.glpesce.net
http://www.univaq.it/~sc_amb/pesce.html

REMOVED - ADDRESS UNKNOWN

DAWSON, Leigh H.J.
University of Aberdeen
Dept. Zoology
Tillydrone Avenue
AB9 2TN Aberdeen
GREAT BRITAIN

KURBJEWEIT, Frank
Ernst-Moritz-Arndt-Universität
Inst. für Geographie
Koordinierungsbüro Boddenforschung
Friedrich-Ludwig-Jahn-Str. 16
D-17489 Greifswald
GERMANY

THE WORLD OF COPEPODA

HTTP://WWW.NMNH.SI.EDU/IZ/COPEPOD

Kope = Greek for "oar" Podos = Greek for "foot" Hence = oar-footed, referring to their broad paddle-like swimming legs

Sapphirina auronitens
Claus, 1863

Pontellina plumata
Dana, 1852

Copilia vitrea
(Haeckel, 1864)

Oncaea venusta
Philippi, 1843

(from Giesbrecht, 1892)

These aquatic crustaceans are very diverse and are the most numerous Metazoan in the water community. The copepod habitat ranges from fresh water to hypersaline conditions, from subterranean caves to water collected in bromeliad leaves or leaf litter on the ground and from streams, rivers, lakes to the sediment layer in the open ocean. Their habitats also range from the highest mountains to the deepest trenches in the world and from the cold polar ice-water interface to the hot active hydrothermal vents. They are free-living, symbiotic, internal or external parasites on almost every phylum of animals in water. Ecologically they are important if not vital links in the food chain linking microscopic algal cells from juvenile fish to whales. Copepods also have the potential to act as control mechanisms for malarial mosquito larvae and are also important as intermediary hosts of many parasite diseases. Branchiura are also included with the Copepoda, since many parasitic copepod researchers also study these parasites of fish, commonly referred to as sea lice.

THE WILSON COPEPOD LIBRARY

The bibliographic database was developed and is maintained by staff of the Wilson Copepod Library and contains all the literature for copepods and branchiurans. Current staff organizing the day to day operations of this Library are T.Chad Walter, Janet W. Reid, Frank D. Ferrari, Adrienne C. Boniface, and Lana Ong. The Library is constantly requesting literature to be deposited with us, especially a copy of your reprints.

PLEASE SEND YOUR REPRINTS TO :

WILSON COPEPOD LIBRARY
SMITHSONIAN INSTITUTION
DEPARTMENT OF INVERTEBRATE ZOOLOGY
WASHINGTON, DC 20560-0163

The Subclass Copepoda is comprised of 10 Orders:

Calanoida	Cyclopoida	Gelyelloida	Harpacticoida	Misophrioida
Monstrilloida	Mormonilloida	Platycopioida	Poecilostomatoida	Siphonostomatoida

The literature has reported approximately 209 families, 2,280 genera and 19,580 species.

The Class Branchiura is comprised of 1 Family and 4 Genera

Argulus Chonopeltis Dipteropeltis Dolops

This Web Page Contains 4 Databases:

BIBLIOGRAPHY OF ALL KNOWN COPEPOD AND BRANCHIURA LITERATURE

TAXONOMIC LIST OF REPORTED COPEPOD AND BRANCHIURA GENERA AND SPECIES

COPEPOD AND BRANCHIURA RESEARCHERS OF THE WORLD

COPEPOD AND BRANCHIURA TYPE HOLDINGS DEPT. INVERTEBRATE ZOOLOGY

T. Chad Walter
Department of Invertebrate Zoology
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560-0163

WALTER.CHAD@NMNH.SI.EDU