Abstracts of the International Symposium

"Speciation In Ancient Lakes 6", SIAL 6

Bogor, August 26 – 30, 2012

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Edited by

Thomas von Rintelen, Björn Stelbrink, Daisy Wowor, Heryanto

Berlin & Bogor 2012

PROGRAM

Sunday 26 August 2012

17.00-21.00	Ice breaker: light dinner, snacks and drinks at Taman Anggrek, Bogor Botanical Garden

Monday 27 August 2012

08.30-09.30	Registration, poster fixation
09.30-09.50	**Opening ceremony**
	SIAL 6 Organizer (Dr. Thomas von Rintelen)
	Head of Research Center of Biology (Dr. Siti Nuramalijati Prijono)
Oral session, Chair:	Ristiyanti Marwoto
09.50-10.40	**Koen Martens**: Species and Speciation in Ancient Lakes (SIAL) – A Review (Almost) 20 Years after Mont Rigi
10.40-11.10	**Coffee break**
Oral session, Chair:	Frank Riedel
11.10-12.00	**Tom Wilke**: Old Lakes, Old Taxa?
12.00-12.25	**Teofil Nakov**: Phylogenetic Insight into the Origins of Endemic Diatom Diversity
12.25-12.50	**Torsten Hauffe**: The Role of Niche-Based vs. Neutral Processes in Shaping Gastropod Communities in Ancient Lake Ohrid
12.50-14.00	**Lunch break**
Oral session, Chair:	James Russell
14.00-14.50	**David A. Fowle**: The Biogeochemistry of Lake Matano, Malili Lakes, Indonesia
14.50-15.15	**Anna Gladkikh**: Biodiversity of Cyanobacteria in Biofilms from Lake Baikal
15.15-15.40	**Christine Cocquyt**: Potential of Changes in Phytoplankton Composition and Abundances to Predict Cholera Outbreaks at Lake Tanganyika
15.40-16.10	**Coffee break**
Oral session, Chair:	Bert Van Boxclaer
16.10-16.35	**James J. Vaillant**: The Zooplankton of Sulawesi Reveal the Importance of Hybridization for Speciation in Plankton
16.35-17.00	**Mikhail E. Daneliya**: Molecular Exploration of the Baikalian Amphipod Radiation
17.00-17.25	**Irina Kaygorodova**: Baikal Leeches: Historical Review and Further Perspectives of Study

Tuesday 28 August 2012

Oral session, Chair: Doug Haffner

08.30-09.20	**Thomas C. Johnson**: Contemplating Great Lakes of the Past and Future
09.20-10.10	**James M. Russell**: Lacustrine Scientific Drilling of Large Tropical Lakes
10.10-10.40	**Coffee break**

Oral session, Chair: Roland Schultheiß

10.40-11.05	**G. Doug Haffner**: Origin, Limnology and Evolutionary History of the Ancient Lakes of Sulawesi, Indonesia
11.05-11.30	**Denis Roy**: The Origins of a Species Flock in Ancient Lake Matano, Sulawesi
11.30-11.55	**Fabian Herder**: Ecological Speciation in Ancient Lake Matano: The Species Flock of "Roundfin" Sailfin Silversides
11.55-12.20	**Jobst Pfaender**: Testing for Ecomorphological Adaptation and Related Individual Fitness Consequences in Lake Matano's Incipient "Sharpfin" Sailfin Silversides Radiation
12.20-13.30	**Lunch break**

Oral session, Chair: Thomas von Rintelen

13.30-14.20	**Christian Albrecht**: Do Lake Characteristics Explain Biodiversity and Endemism?
14.20-14.45	**Ryan P. Walter**: Interlacustrine Connectivity and Intralacustrine Divergence in *Paratherina* Sailfin Silversides from Sulawesi's Malili Lakes
14.45-15.10	**Jefry J. Mamangkey**: Distribution and Growth of Endemic Butini Fish (Glossogobius matanensis) in Towuti Lake, South Sulawesi
15.10-15.40	**Coffee break**

Oral session, Chair: Renny Hadiaty

15.40-16.05	**Thomas von Rintelen**: Freshwater Shrimp Species Flocks From the Ancient Lakes of Sulawesi, Indonesia: The Geography of Speciation
16.05-16.30	**Annawaty**: Preliminary Study of Atyid Shrimps of Lake Lindu, Sulawesi Indonesia
16.30-16.55	**Christoph D. Schubart**: New Data on Diversity of Freshwater Crabs from Sulawesi and the Sequential Succession of Colonization of the Ancient Lakes
16.55-17.20	**Nur R. Isnaningsih**: Notes on Radula, Shell Morphology and Habitat Preferences of the Endemic Freshwater Snail Genus *Tylomelania* Sarasin & Sarasin, 1897 From the Ancient Lake Poso, Sulawesi (Gastropoda: Cerithioidea: Pachychilidae)

Poster session

17.30-18.00

Wednesday 29 August 2012

07.00 -	Full day excursion at Cibodas Botanical Garden: snacks, lunch and drinks

Thursday 30 August 2012

Oral session, Chair: Fabian Herder

08.30-09.20	**Walter Salzburger**: Evolution in Darwin's Dreamponds: The Adaptive Radiations of Cichlid Fishes in the East African Great Lakes
09.20-10.10	**Martine Maan**: Interacting Effect of Natural and Sexual Selection During Speciation
10.10-10.40	**Coffee break**

Oral session, Chair: Christian Albrecht

10.40-11.05	**Michael Matschiner**: A Phylogenomic Perspective on Teleost Evolution and Cichlid Diversification
11.05-11.30	**Frank Riedel**: Evolution of the Mega-Lake Palaeo-Makgadikgadi (Kalahari, Botswana) During the Last 100 ka
11.30-11.55	**Bert Van Bocxlaer**: Adaptive Morphological Divergence in an Ongoing Radiation of *Lanistes* Gastropods from Lake Malawi
11.55-12.20	**Roland Schultheiß**: Adaptive and Non-Adaptive Components of Diversification in An Endemic Gastropod Group in Lake Malawi
12.20-13.30	**Lunch break**

Oral session, Chair: Daisy Wowor

13.30-13.55	**Katzuki Nakai**: Recent Declining Trends in Indigenous Fish Diversity in Lake Biwa, Japan, and Efforts Towards Recovery
13.55-14.20	**Jusri Nilawati**: Endemic Fish Fauna from Sulawesi Ancient Lakes and Threats of Habitat Loss
14.20-14.45	**S.H. Nasution**: Ornamental Shrimp: An Economic Alternative for People Around Ancient Lake Towuti, South Sulawesi
14.45-15.10	**D. Hoese**: Evolution And Speciation Of Gobioid Fishes In Ancient Lakes Of New Guinea And Sulawesi
15.10-15.40	**Coffee break**

Oral session, Chair: Tom Wilke

15.15-17.00	Closing discussion
17.00-18.00	Poster removal and conference photo

Farewell dinner

18.00-18.30	Entertainment
18.30-19.00	Speech - President of SIAL, Tom Wilke
19.00-22.00	Dinner

Do Lake Characteristics Explain Biodiversity and Endemism?

C. Albrecht

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Abstract

Ancient lakes are usually perceived as more or less long-lived lakes that are often associated with both high species numbers and endemicity in various systematic groups. Many papers have dealt with the evolution of individual taxa in mostly single ancient lakes, providing possible answers to the seemingly simple question behind the sheer number of taxa: What are the shared driving forces in ancient lake biodiversity? In this context it is often challenging to distinguish between environmental drivers of evolutionary change and biotic interactions. Here, we have chosen gastropods, one of the few suitable taxa with world-wide occurrence in lakes, to focus on non-biological factors of lakes that provide conditions for, and are potentially involved in diversification patterns such as speciation, extinction and/or immigration.

An extensive dataset of various physical, chemical, and ecological parameters, as well as gastropod biodiversity and endemicity has been compiled for 58 world-wide lakes. Geologically, these range from very young to extremely old and include all lake types, size classes, and altitudinal and latitudinal positions. Multivariate regression tree analysis was used to identify hierarchically ordered explanatory variables that characterize and cluster lakes with a certain degree of species richness and endemicity.

Our analyses revealed that of all the factors age (pre-Eemian lakes i.e. older than 130.000 years) has the highest explanatory power to distinguish between relatively species/endemic rich and poor lakes. In both, young and old lakes, size-related variables are significant in predicting gastropod diversity. Furthermore, in old lakes, depth of a given lake is an important variable in explaining and predicting species richness and endemicity.

The results are discussed in the context of evolution and age and stability of lakes. Given our results, it becomes clear that many more lakes with a considerable amount of biodiversity, qualify as long-lived lakes. These lakes should not be dismissed in ancient lake research on topics such as speciation, extinction, radiations, reservoir functioning or eco-insularity.

Preliminary Study of Atyid Shrimps of Lake Lindu, Sulawesi Indonesia

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Abstract

Lake Lindu is located in the central highlands of Sulawesi at 982 m a.s.l. This tectonic lake is found in a strict-slip fault, the Palu-Koro Fault originally formed from three joined plates, i.e. Pacific, Indoaustralia and Eurasia. The age of the lake has been estimated between 1.6 – 5.3 mya, based on analysis of molluscs from a small island in the lake. So far there is only one species of atyid shrimps found in the lake, i.e. *Caridina linduensis*. The specimens of this species was encountered for the first time by M.M Sarasin during the 1901-1903 Sulawesi Expedition. This species was described by J. Roux in 1904. Since then there was no study on crustaceans conducted on this lake till the mid of 2011. Investigation during three field trips in July, August and November 2011 revealed that there are two other endemic new species of atyid shrimps in the Lake Lindu system. *Caridina* sp. A and *Caridina* sp. B, two yet undescribed species, are found in different habitats. The first species is riverine while the latter is lacustrine. The three endemic species have different morphological characters and also have different habitat preferences. *Caridina linduensis* has a long rostrum with an egg diameter of 0.9 – 1.0 mm. This species prefers stagnant water and is found on a mixture of muddy or sandy substrat with leave litter, or roots of macrophytes. *Caridina* sp. A has a short rostrum with an egg diameter of 1.0 – 1.5 mm. This species prefers clean streams with slow to moderate running water. This first new species is found on several habitats, i.e. gravels and boulders, leave litter, roots of macrophytes. *Caridina* sp B has a medium length rostrum with an egg diameter of 0.9 – 1.1 mm. This second new species is only found on roots of macrophytes in slow running water. Their distribution in the lake system is provided.

Phylogenetic Diversity of Cyanomyoviruses Associated with the Endemic Freshwater Sponge *Lubomirskia baicalensis*

T.V. Butina, **O.V. Kaluzhnaya** & S.A. Potapov

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Poster abstract

Cyanophages are the viruses that infect cyanobacteria and, as well as their hosts, ubiquitous in marine and freshwater environments. Sponges are usually associated with various microorganisms, including cyanobacteria; therefore the cyanophages could play an important role in sponge community. All cyanophages described to date are tailed phages belonging to the families Myoviridae, Podoviridae, and Siphoviridae, and the majority of isolated marine cyanophages are myoviruses. In our study we analyzed the molecular diversity of cyanomyoviruses in sponge *Lubomirskia baicalensis* by targeting the structural g20 gene of cyanophages. Simultaneously, the analysis of cyanobacterial diversity based on 16S rRNA sequences was performed with cyanobacteria-specific primers, CYA106F and CYA781R. In April 2010 the samples of the freshwater sponge *L. baicalensis* and water (as a control) were collected at the depth of 15 m in southern basin of Lake Baikal. The sample was rinsed three times and then thoroughly shaken in sterile water. The water extract was sequentially filtered through polycarbonate filters (Millipore) with diameter of 1.2, 0.45 and 0.2 μm and used as DNA template for PCR analysis of g20 genes of cyanophages. For cyanobacteria analysis DNA from sponge tissue was extracted using a RIBO-sorb kit (InterLabService). The purified g20 and 16S rRNA PCR products were cloned and analyzed by automatic sequencer Beckman Coulter CEQ8800. In total 32 and 31 clones of g20 gene were sequenced from the samples of sponge and water, respectively. Our studies demonstrate the presence and high diversity of cyanomyoviruses both in sponge *Lubomirskia baicalensis* and in water of Lake Baikal. BLAST analysis revealed that the closed similarity to sequences obtained showed those from marine cyanophages isolated from bacteria of genera *Synechococcus* and *Prochlorococcus,* and the g20 clones from marine and freshwater environments. The analysis of bacterial 16S rRNA gene sequences in sponge also revealed the diversity of cyanobacteria of genus *Synechococcus*. Phylogenetic analysis clearly showed that the majority of g20 clones from sponge formed several separate clusters. Thus, our study revealed the presence of diverse and specific community of cyanomyoviruses associated with the endemic freshwater sponge *Lubomirskia baicalensis*.

The study was supported by RFBR grants: 10-04-01613 and 11-04-92220.

Molecular Clock Analyses in Freshwater Gastropods (*Radix* spp.) Suggest the Existence of an Ancient Lake on the Tibetan Plateau

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Poster abstract

A total of at least three ancient tectonic lakes are described from China, lakes Dianchi, Erhai, and Fuxian Hu. Remarkably all of them are located on the Yunnan Plateau (south-western China) at an average elevation of 2000-2500 m a.s.l. A previous study based on phylogeographic analyses of freshwater gastropods (*Radix* spp.) raised the question whether there are also ancient lakes on the Tibetan Plateau, a high-mountain plateau on average twice as high as the Yunnan Plateau. It is assumed that the colonization of the Tibetan Plateau by *Radix* lineages started during the Pleistocene or even during the Pliocene. We studied *Radix* populations in one lake on the eastern Tibetan Plateau (Lake Dongi Tsona) in order to estimate the onset of diversification, and hence, to estimate the minimum age of the lake. Populations of *Radix* spp. were sampled at 14 different locations including sites directly on the lakeshore as well as sites in the catchment area of the lake system. For the molecular clock analyses, we utilized nucleotide DNA sequences of the mitochondrial cytochrome *c* oxidase I (COI) gene. The analyses of a 148 sequences data set revealed two major results. Firstly there are more *Radix* clades in the lake as well as in the catchment area than previously known. In the lake, there are one major endemic clade and at least two previously unknown widespread lineages. Secondly the most recent common ancestor of the endemic *Radix* clade is significantly older than the Last Glacial Maximum approximately 0.02 My ago. Preliminary estimates for the initial diversification of endemic *Radix* clade resulted in 0.35 My with an 95% HDP interval of 0.16-0.58 My. These preliminary age estimations of the onset of diversification of *Radix* within the lake indicate that there is at least one ancient lake on the Tibetan Plateau, i.e. Lake Dongi Tsona. Our findings are discussed in the context of existent and potential ancient lakes in Asia and worldwide. Further studies will aim at investigating population structures of the endemic *Radix* group based on other genetic marker systems such as microsatellites. This will potentially shed more light on the population dynamics during the last millennia in ancient Lake Dongi Tsona.

Potential of Changes in Phytoplankton Composition and Abundances to Predict Cholera Outbreaks at Lake Tanganyika

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Abstract

Cholera is one of the deadliest diseases in Africa. Outbreaks reappeared in the area of the African Rift in the late 1970's when strong signals of climate changes were noted. The African Great Lakes are suspected of playing a role as reservoir of the cholera bacteria while human infection and movement propagate the disease inland (Bompangue et al. 2008). In the past a link between cholera, phytoplankton blooms and copepods was demonstrated in Asia. The interdisciplinary CHOLTIC project studies the possible link between Cholera outbreaks and climate change at Lake Tanganyika, which could be useful to develop an early warning method. Changes in algal community structure were already documented in Lake Tanganyika: the cyanobacteria-chrysophytes-chlorophytes community of 1975 (Hecky & Kling 1981) was replaced by a cyanobacteria-chlorophytes-diatom community as observed at the beginning of the 21th century (Verburg et al. 2003, Cocquyt & Vyverman 2005). In the context of the CHOLTIC project changes in phytoplankton composition and abundances will be investigated during a 3 year monitoring based on a weekly sampling at Uvira (DR Congo) in the north and at Mpulungu (Zambia) in the south of Lake Tanganyika. Preliminary results of the phytoplankton analyses, following the Uthermöhl method, are discussed. Special attention will go to the dominant phytoplankton species in the actual plankton. Attention will also be paid to real floristic changes compared to the investigation of the 1975 as documented in the literature.

Molecular Exploration of the Baikalian Amphipod Radiation

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Abstract

The fauna of the Siberian Lake Baikal contains seven endemic families of amphipods, exhibiting a stunning variation of life forms, often unique in this crustacean order. These include, for instance, mysidiform planktonic (Macrohectopodidae), ectoparasitic (Pachyschesidae) and giant processiferous nectobenthic taxa (Acanthogammarinae). A previous study by MacDonald et al. (2005) showed that most of the families are nested within the widespread Holarctic genus Gammarus of Gammaridae, making Gammarus and Gammaridae paraphyletic, and comprise at least two independent lines of diversification. We explored the phylogeny of Baikalian amphipods further in an extended taxonomic data set and from sequences of four nuclear and one mtDNA gene, totaling 3100 bp with emphasis on the most diverse family Acanthogammaridae. The data now encompass all the seven families, all six subfamilies of Acanthogammaridae and 26 acanthogammarid genera, most of which have not been previously assessed. They reveal a progressive radiation in Lake Baikal, which is based on three major independent evolutionary lines stemming from the extant Gammarus, and represented by the endemic families Baicalogammaridae, Micruropodidae and Acanthogammaridae. The other four families originated from within the latter two: Macrohectopodidae from the micruropodids; Eulimnogammaridae, Pallaseidae and the parasitic Pachyschesidae from the acanthogammarids. Still even the Eulimnogammaridae and Pallaseidae appear as polyphyletic assemblages within the major acanthogammarid radiation, and so do some of the previously recognized subfamilies of Acanthogammaridae itself. Moreover, one of the current acanthogammarid subfamilies indeed belongs to the micruropodid radiation. The Baikalian amphipod diversity seems to have arisen in a process of progressive evolution of morphological groups (taxa) from within other groups, and could be characterized as sequential paraphyly. A serious systematic revision is required.

The Biogeochemistry of Lake Matano, Malili Lakes, Indonesia

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Abstract

Lake Matano in Indonesia is part of the Malili Lake system that is located on the southeastern peninsula of Sulawesi Island, Indonesia. This lake system was formed by a horst and graben depression, and is the eight deepest lake in the world (600m). Although its age remains speculative at between 1-4 million years in age, it is clearly ancient and has been consistently stratified by a weak thermal and salinity gradient. The catchment surrounding the lake is comprised predominantly of ophiolitic rock and weathered lateritic soils (iron-rich) which contribute to the high (40–60 %) iron (hydr)oxide concentrations in the lake sediments. This combination of iron rich sediments and stratification has the led the development of the basin into one that can be termed as ferruginous and therefore analogous to the Earth's early oceans.

Although studied intensively the biogeochemistry of this system remains somewhat enigmatic as each biologically (P) and redox active elements (C, N, Fe, Mn, Cr) have clear connections to microbiological driven cycling in the lake and are stratified by depth. For example carbon cycling in the lake appears to be driven by a very active methane cycle in the anoxic zone followed by consumption via novel methanotrophic activity in the oxic/anoxic transition zone coupled to Fe and Mn cycling. These same cycles (Fe, Mn) appear to be important drivers of P availability (ultraoligotrophic surface waters with extreme C:P ratios) and Cr (and other trace elements) cycling and are also tied to anoxygenic photosynthetic processes. The work presented will provide a holistic framework for how these cycles are interconnected, the potential energy and biomass generated through these processes and its impact on supporting biomass at higher trophic levels.

Biodiversity of Cyanobacteria in Biofilms from Lake Baikal

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Abstract

Lake Baikal is a unique ancient freshwater ecosystem with particular hydrological and hydrochemical regime. Despite many years of observations, its benthic microbial community has been insufficiently studied. This work was aimed at studying cyanobacterial communities of biofilms forming on different substrates in Lake Baikal. Lately, special attention has been given to study of natural biofilms, as they play an important role in ecosystems, biotechnology and medicine. Complex studies of biofilms in Lake Baikal have not been carried out before. Rocks that form the basis of the coastal zone of Lake Baikal (marble, granite, and amphibolite) were chosen as experimental substrates, the stainless steel and natural stones from the littoral zone in the vicinity of the experiment served as control substrates. Cyanobacterial communities were studied by the complex of methods: light microscopy, SEM, and pyrosequencing of 16S rRNA gene. The structure and morphology of biofilms were studied by microscopy, as well as the dominant cyanobacterial species complexes were identified. The species compositions of rocky substrate communities were similar (dominant species *Rivularia rufescens* and *Tolypothrix limbata*) and differed from the community of the artificial substrate (dominant species *Chamaesiphon fuscus* and *Heteroleibleinia pusilla*) and the near-bottom water (dominant species *Cyanobium* sp.). A total 34560 reads with average length of 430 bp were retrieved from pyrosequencing of PCR amplicons. Three bacterial phyla (Cyanobacteria, Proteobacteria and Bacteroidetes) dominated in different ratios in the composition of biofilm communities. Cyanobacteria were the major constituent on marble and steel, but not on granite, amphibolite, and the control substrate. Cyanobacterial communities on marble and steel were the most diverse in the number of detected phylotypes and calculated values of species richness. Granite and amphibolite communities of cyanobacteria were less rich, minimal diversity was detected on the control substrate and in the near-bottom water. The most abundant genotypes belonged to the dominant species identified by microscopy. In addition, rare phylotypes of cyanobacteria were found.

The work was supported by Integration Programme No. 96 (Limnological Institute SB RAS).

Origin, Limnology and Evolutionary History of the Ancient Lakes of Sulawesi, Indonesia

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Abstract

Sulawesi Island is one of the most unique island systems in the world. The 'K' shaped island was primarily formed during the Miocene-Pliocene as a result of the collision of the northwestward moving Australian plate with Sundaland. The complex juxtaposition processes of the various crustal fragments involved resulted in the formation of faults such as Palu-Koro and Matano transversing the central mountains of the island as it continues to rotate counter clockwise. Sulawesi's two ancient lake systems, Lake Poso and the five lakes of the Malili system, essentially owe their origin to these faulting processes. The Malili system with the three larger lakes Matano, Mahalona and Towuti comprises the only hydrologically connected ancient lakes in the world that drain a water shed comprised mostly of ultra-mafic rocks. This water shed imposes a different water chemistry compared with most other lakes, and it is hypothesized that the chemical regime of the lakes provides a strong resistance to the colonization of the lakes by many cosmopolitan species resulting in the Malili lakes having the highest percent endemism of diatoms, and limiting the number of successful invasions. The iron rich waters have the capacity to regulate nutrient availability and thus the lakes have the lowest primary production measured for tropical lakes. Competition for food has been hypothesized to be a major force driving speciation in the lakes highly diverse and endemic fauna. All species flocks have arisen in situ in the process of adaptive radiation, and trophic specialization i.e., adaptations of the feeding apparatus to different substrates or prey, seems to have been the major factor driving diversification. Hybridization is a widespread phenomenon, especially in snails and fishes, where it is suspected of promoting adaptive divergence. A conspicuous and frequently flamboyant body colouration is also common to all taxa, and may contribute to diversification processes. Species number differs widely between groups, ranging from 8 species (crabs) to 53 (snails) for all lakes. No species is shared between Lake Poso and the Malili lakes, and even within the Malili system, very few taxa occur in all five lakes, the vast majority is endemic to one or two lakes only. Some species have very restricted distribution ranges that are frequently coupled with very specific habitat requirements. The most extreme case is found in shrimps, where a recently described species exclusively dwells on a yet undescribed freshwater sponge species, the first record of such an association in freshwater. The Sulawesi lakes provide unique opportunities for studying processes of speciation and adaptation in natural replicates within and between several taxa. The lakes' unique fauna is increasingly threatened by Human action, though, and appreciable efforts should be made now to preserve this aquatic biodiversity hotspot in Wallacea.

The Role of Niche-Based vs. Neutral Processes in Shaping Gastropod Communities in Ancient Lake Ohrid

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Abstract

Community composition is mainly caused by the interplay of: (I) niche-based processes, driven by species interactions or environmental factors and (II) neutral processes such as speciation and extinction. The investigation of such processes is typically facilitated by utilizing systems with well-defined physio-geographical boundaries and a high rate of endemicity such as ancient lakes. The European ancient Lake Ohrid is of early Pleistocene or Pliocene origin and was formed in a large flat region of karstic limestone. An analysis of gastropod communities of Lake Ohrid already showed that specific species compositions are mainly dictated by niche processes with additional evidence for the existence of neutral processes. Now, with robust phylogenetic hypotheses of almost all gastropod species available, we here aim at (I) identifying directly the individual effect of speciation on species composition within individual sampling sites and (II) developing a scenario of speciation combined with migration into newly developing areas of the lake. Such a scenario would allow us to infer bathymetrical regions within the lake where communities are phylogenetically overdispersed, that is, they are assemblages of species which are only distantly related to each other. In these areas, colonization would be the dominant mechanism compared to purely evolutionary processes, typically resulting in phylogenetic clustering (i.e., assemblages of closely related species). Phylogenetic overdispersion might be mainly found in deeper parts of Lake Ohrid, which are, in theory, more affected by niche-based processes (e.g., multiple and independent colonization of stable niches by species with similar environmental requirements but few speciation events). In contrast, communities in upper parts of the lake might be mainly affected by neutral processes (e.g., intra-habitat speciation, but few immigration events). In future studies, these scenario will also be tested on a horizontal scale (e.g., lake proper vs. water shed) in order to obtain a general understanding of evolutionary and limnological processes in Lake Ohrid in space and time.

A Biological Invasion into the Caspian Sea: The Case of the Bivalve *Mytilopsis leucophaeata*

K.C.M. Heiler [1], P.V. von Oheimb [1], N. Nahavandi [2] & C. Albrecht [1]

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Abstract

It has been proposed that anthropogenically unaffected ancient lakes have a relatively high resistance to biological invasions. The Caspian Sea, however, is strongly impacted by water pollution and fishing activities, making this ecosystem vulnerable for species invasions. A species that has recently invaded the Caspian Sea is the dreissenid brackish water bivalve *Mytilopsis leucophaeata*. This bivalve is native to the southeastern coast of North America. Prior to the Caspian Sea, it had invaded parts of North and South America as well as of Europe. The first record in Europe was made already in 1835 in the harbor of Antwerp (Belgium). Since then it has been recorded in various brackish water areas at the North Sea, Baltic Sea, Atlantic Ocean and Mediterranean Sea. In 2002 *M. leucophaeata* was observed in the Black Sea basin and we finally found it in the Caspian Sea in 2009. Two potential invasion corridors into the Caspian Sea have been suggested: from the Black Sea basin via the Volga-Don Canal, or from the Baltic Sea via canals and the Volga River.

As *M. leucophaeata* is known as ecosystem engineer and a highly competitive benthic species, it may pose a serious threat to the native fauna of the Caspian Sea in general and to the endemic Caspian dreissenid species in particular. Hitherto, *M. leucophaeata* was found only at the southern coast of the Caspian Sea. However, given the high colonization success of this bivalve in other regions, it is likely that it will also spread to other parts of the Caspian Sea. Therefore, future monitoring activities in the Caspian Sea should take this bivalve species into account.

Ecological Speciation in Ancient Lake Matano: The Species Flock of "Roundfin" Sailfin Silversides

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Abstract

Ancient Lake Matano in Sulawesi (Indonesia) harbors an endemic species flock of sailfin silversides (Atheriniformes: Telmatherinidae: Telmatherina). This flock consists of two major clades, "sharpfins" and "roundfins", characterized among other characters by fin shapes. The three morphospecies of roundfins are characterized by substantial, but incomplete, reproductive isolation, morphological traits such as body size and shapes of head and body, and distinct patterns of habitat use. In contrast to morphology, conspicuous male colour polymorphisms occurring in all three morphospecies are not associated to genetic divergence. Here, we present data on roundfin feeding mechanics and trophic ecology, and show that morphospecies-specific traits are consistent with functional adaptation following different modes of feeding specialization. We also find significant intersexual adaptation in feeding traits, reflecting sex-specific composition of stomach contents. Taken together, our findings are consistent with speciation in sympatry following ecological selection pressure, and suggest that sexual dimorphism may further increase complexity in evolving adaptive radiations.

Evolution And Speciation Of Gobioid Fishes In Ancient Lakes Of New Guinea And Sulawesi

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Abstract

Ancient Lakes of New Guinea and Sulawesi are characterised by the presence of endemic gobioid and other fish species and often mini-species flocks. Fish taxonomists are increasingly find examples of highly specialized genera phylogenetically falling within an existing generalized genus, often upsetting the traditional classification. Ancient lakes offer a unique opportunity to study a geologically recent expansion of a group into a new environment where major changes in morphology have been documented in many fish groups. A number of gobioid genera normally found in rivers have invaded lake environments, often showing major anatomical differences from riverine species. Two genera are particularly common in ancient lakes. The eleotrid genus *Mogurnda* is confined to Australia and New Guinea. Normally only a single species is found in a single river system. However in Lake Kutubu in Papua New Guinea, 8 species coexist, developing a variety of body forms distinct from the riverine species. Most other species in the lake are also endemics and many have developed similar body forms, particularly the development of a hump head. A number of features appear in various lakes in related species, such as large spots on the side of the body and large head. Species of *Glossogobius* found in Lakes in New Guinea and Sulawesi have developed a variety of different specialisations and life styles. Species in different lakes are derived from the same or different ancestral forms. Separating the species into distinct genera based in degree of dissimilarity would not reflect phylogenetic relationships.

Back To Tanganyika – Migration Between "Closed" Systems

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Abstract

The cichlid species flocks of the East African Great Lakes are thought to each have evolved independently and to date no species is known to be shared between the different lake faunas (apart from the otherwise widely distributed *Tilapia rendalli*). Thus leaving these systems to appear somewhat closed and limited in their genetic diversity.

Genetic and morphological analysis of a haplochromine species (*Astatotilapia* cf *stappersi*) recently recorded from the southern most affluents of Lake Tanganyika suggests an origin from within the Lake Victoria/Kivusuper flock. *Astatotilapia stappersi* (Poll, 1943) described from the Malagarasi in Tanzania, is indistinguishable from the present species suggesting an ancient spread of riverine species out of the Lake Victoria/Kivu drainage into river and lake systems such as Lake Tanganyika and the Malagarasi and Rukwa systems. Several different migration scenarios are discussed with respect to geology and phylogenetic relations to other haplochromines of the region.

I suggest a never before reported migration of cichlid species originating from one of the three large species flocks, to another. Such migrations might be very rare events facilitated by special environmental conditions only and might not be likely or even possible in other lake systems. Nevertheless, they could represent a novel mechanism for the input of new genetic diversity in ancient lake systems such as Lake Tanganyika.

Notes on Radula and Shell Morphology, and Habitat Preferences of the Endemic Freshwater Snail Genus *Tylomelania* Sarasin & Sarasin, 1897 From Ancient Lake Poso, Sulawesi (Gastropoda: Cerithioidea: Pachychilidae)

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Abstract

The freshwater snail *Tylomelania* Sarasin & Sarasin, 1897 is an endemic genus for Sulawesi. These gastropods occur in rivers, but most are found in the ancient Malili lakes (Towuti, Mahalona, Matano, Lantoa, and Masapi) in South Sulawesi, and Lake Poso in Central Sulawesi. In Lake Poso, there are more than 12 species of *Tylomelania*, and four species are described in detail here. Based on a recent study on radula and shell morphology as well as habitat preferences four species are identified as *T. carbo*, *T. centaurus*, *T. kuli* and *T. toradjarum*. Each species has its specific habitat preferences. *T. centaurus* and *T. kuli* live in deeper water (about 2 – 4 meter) with sandy or muddy substrate, or are attached to wood, *T. toradjarum* is more common crawling in shallow areas (20 – 60 cm) with gravel and sandy substrate, while *T. carbo* is usually abundantly attached to rocks. The shape, the number of rows and the length of the radula are different between these species although occur syntopically. The radula of *T. carbo* is very long, with a single pointed elongated cusp on the central, lateral and marginal teeth. It is very different from *T. kuli* which has a shorter radula and smaller teeth compared to that of *T. centaurus* and *T. toradjarum.* The different morphology, shell size, sculpture and habitat preferences of these *Tylomelania* species from Lake Poso will be presented.

Study of the Taxonomy and Phylogeny of Deep-water Sponges of Lake Baikal by Molecular Methods

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Poster abstract

Lake Baikal is the deepest and the most ancient lake in the world, it's age estimated at 30 million years. Due to oxygen exchange Baikal is inhabitable at all depths up to the deepest point of 1647 m. An unusually big number of sponge species live in Lake Baikal in comparison to other lakes. According to present classifications 13 species and one subspecies from the family Lubomirskiidae, and five species from the family Spongillidae, are known from the Lake Baikal. Though sponges form the dominating biomass of the benthos of Baikal and play an important role in the ecology of the lake, the taxonomy of the Baikal sponges is complicated. The existing classification of Baikalian sponges was developed mainly on the basis of samples collected by scuba diving from depths up to 40 meters but the deep-water fauna of Baikal sponges remains poorly studied. In 2008-2009, expeditions in Baikal with use of the deep-water manned vehicles Mir-1 and Mir-2 were carried out. During dives between 120 - 1450 m unique samples of deep-water sponges were collected and their habitats studied. Species identifications were performed via morphological and molecular methods and their distribution to depths was studied. Scanning electron microscopy (SEM) identified collected samples as *Baikalospongia intermedia*, *B. intermedia profundalis*, *B. bacllifera*, *B. fungiformis*, *B. martinsoni*, *Swartschewskia papyracea* all from the family Lubomirskiidae. According to spicule morphology some specimens are representatives of undescribed Lubomirskiidae species. Several specimens were assigned to the family Spongillidae however species identification was not possible via SEM. Analysis of ribosomal internal transcribed spacer regions (ITS1 and ITS2) was also used to perform a species identification of 15 deep-water specimens and to study their phylogenetic relationships. All deep-water specimens were shown to belong to the Lubomirskiidae including those assigned to the family Spongillidae via morphology. Furthermore, nucleotide substitutions distinguish newly collected deep-water specimens from described species of Lubomirskiidae thereby supporting the existence of new undescribed species. Study of the deep-water fauna of the Baikal sponges will improve the systematics of freshwater sponges and will provide new data for understanding the origin and evolution of the endemic family Lubomirskiidae.

Contemplating Great Lakes of the Past and Future

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Abstract

Due to a recent ice age, Earth probably has more great lakes on its continents today than it has had throughout much of its history. The random walk of plate tectonics has arranged continents and oceans in a configuration that promotes the recurrence of major ice ages every ~100,000 years and relatively moist conditions over broad expanses of the terrestrial realm during the interglacials. (This has not been the case throughout most of Earth history.) The resultant array of freshwater and saline inland seas extends today from the tropics to the high latitudes and provides an opportunity to assess ecosystem processes in a broad range of lakes that display widely different basin morphologies, climate settings, hydrological budgets and ecosystem dynamics. This talk focuses on Lake Superior in North America and Lake Malawi in East Africa as examples that are dramatically different in origins, hydrological budgets, circulation dynamics, primary productivity, and biodiversity. The contrast sheds light on factors to be considered when envisioning the limnology of ancient lakes that are now represented by only their sedimentary remains in the geological record. Both lakes are warming measurably in response to greenhouse gas emissions from the burning of fossil fuel. Lake Malawi, unlike Lake Superior, is highly vulnerable to dropping below outlet level, due both to climate change and ambitious plans for expansion of irrigation in its drainage basin. This would have tragic consequences for the regional economy and lifestyle of people along its shores, and for the lake's rich and unique aquatic ecosystem.

A Comparison of the Genus *Diploneis* Cleve Between Lake Ohrid (Macedonia) and Lake Hövsgöl (Mongolia)

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Poster abstract

Diploneis Cleve is one of the few remaining diatom genera that is represented in both marine and fresh waters. The number of freshwater species is considerably lower than marine taxa; however, the number of *Diploneis* species documented in regional floras is usually low and dominated by a few, presumably widespread species. In contrast the species richness in ancient lakes like Ohrid (Macedonia), Baikal (Russia) and Hövsgöl (Mongolia), is reported to be higher, and characterized by widespread, endemic and relict species.

The scope of this study is to review and circumscribe the diversity of the genus *Diploneis* in Lake Ohrid and Lake Hövsgöl, and to determine the diversity and systematic similarities between these two lakes.The genus *Diploneis* in Lake Ohrid is represented with sixteen species including three potentially new species and one species with unclear taxonomical position. Preliminary observations from Lake Hövsgöl confirm the presence of widespread taxa and species that were recently described from other Mongolian lakes (*D. mongolica* Metzeltin, Lange-Bertalot & Nergui, *D. spectabilis* Metzeltin, Lange-Bertalot & Nergui, *D. linearielliptica* Metzeltin, Lange-Bertalot & Nergui, *D. heteromorphiforma* Metzeltin, Lange-Bertalot & Nergui). We document a preliminary total of 25 taxa for Lake Hövsgöl, but seven of these are so far not identified to the species level. Species that were found in both lakes were also documented and presumably represented widespread taxa [*D. krammeri* Lange-Bertalot & Reichardt, *D. oculata* (Brébisson) Cleve, *D. peterseni* Hustedt]. However, these two lakes are also considered to be rich in endemic, relict and rare species. From Lake Ohrid we present three relict taxa [*D. ostracodarum* (Pantocsek) Jurilj, *D. budayana* (Pantocsek) Jurilj and *D. praeclara* (Pantocsek) Cleve-Euler] and three new species (*D. vetusa*, *D. pulchra* and *D. rotunda*) that are potentially endemic for Lake Ohrid. From Lake Hövsgöl we documented seven species with unclear taxonomic position, potentially endemic for the lake. In previous observations on Lake Hövsgöl, there have been no data presented on endemic or relict *Diploneis* species. Because the diatom floras from regions surrounding these ancient lakes has not been well-studied, it is difficult to compare the extent of possible endemic, relict or shared taxa between these two ancient lakes.

Diversity of Baikalian Sponge Microbial Community and the Presents of Natural Product Genes

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Poster abstract

Sponges (phylum Porifera) – the filter feeders, accumulates in there body a variety of microorganisms. Unlike the marine sponges, bacterial communities of freshwater sponges currently are poorly investigated. At the same time, freshwater sponges (Porifera, Haplosclerida, and Spongillina) are represented by more than 150 species inhabiting the various freshwater bodies (lakes, rivers, brooks, bays, reservoirs, etc.). Lake Baikal, the oldest (25–30 Myr) and deepest (1637 m) lake on the earth, is characterized by a wide species diversity of sponges constituting the endemic family Lubomirskiidae. In present work phylogenetic analysis of the nucleotide sequences of 16S rRNA genes in the metagenomic community of *Lubomirskia baicalensis* (sample collected in April 2010) has revealed taxonomic diversity of bacteria associated with the endemic freshwater sponge. Fifty-four operational taxonomic units (OTUs) belonging to six bacterial phyla: Actinobacteria, Proteobacteria (class α-Proteobacteria and β-Proteobacteria), Verrucomicrobia, Bacteroidetes, Cyanobacteria, and Nitrospiracea have been identified. Actinobacteria, whose representatives are known as antibiotic producers, is the dominant phylum of the community (37%, 20 OTUs). All sequences detected shared the maximal homology with uncultured microorganisms from freshwater habitats. The wide diversity of bacteria closely coexisting with the Baikal sponge indicate the complex ecological relationships in the community formed under the unique conditions of Lake Baikal. Screening of metagenomic DNA of *L. baicalensis* microbial community revealed the presents of molecular systems involved in natural product synthesis – polyketide synthase genes (PKS). Cloning and sequencing of amplified products of the ketosynthase domain of PKS has revealed 15 fragments of PKS genes differ from each other's on 35%-65% by amino acid. All received sequences belong to the KS-domains identified for various groups of microorganisms: α-, β-, δ-Proteobacteria, Verrucomicrobia, Cyanobacteria, Chlorophyta. Some sequences were related to the genes which are taking part in biosynthesis of known metabolites: curacin A (CurI, CurJ), stigmatellin (StiC, StiG), nostophycin (NpnB), cryptophycins (CrpB). The homology of the found sequences with published in the genetic EMBL database varies within 50%-82% confirming the presence in fresh-water sponge community the genes for synthesis of the new, yet not investigated polyketide substances, possessing the biotechnological potential.

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Baikal Leeches: Historical Review and Further Perspectives of Study

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Abstract

Lake Baikal is the oldest (25-30 mya), the deepest (1637 m) and the largest (23,000 km3) repository of fresh water of the planet (20% of drinking water). The lake has a unique complex of living organisms (1550 animal species), which are adapted to a variety of environmental conditions and diversity of habitats from the interstitial zone to maximal depths. Despite the 200-year history of biological studies, Baikal is still full of "white spots", one of them is the fauna of parasitic annelids. Baikal leeches demonstrate a high level of biological diversity (11 genera) and endemism, both at the genus level and at the species level. These species are adapted to living in cold, clean, oxygenated water and feeding on Baikal endemic animals: bullheads, amphipods, and perhaps other groups. Modern approaches have been successfully applied to clarify the phylogeny of both European and North American leeches, whereas the evolutionary history and phylogeny of the unique Baikal fauna remain to be examined. The present study is the first serious attempt to fill the gaps in knowledge of the Baikal leech group, since previous results have been obtained incidentally and consist of fragmentary data. Thus, according to the last literary information 18 and 13 species was referred to Baikal in Kozova & Izmest'eva, 1998 and Timoshkin, 2001, respectively. Source of 1998 contains three leech species erroneously indicated to Baikal list. Source of 2001 does not specify composition of species. Analysis of both historical data and data of aimed sampling allow getting a refined checklist. Up to now 21 hirudinid species are recorded in Baikal, four of them are new taxa. Karyotype information demonstrates existence of *B. torquata* and *B. cottidarum*. The first results of molecular data reveal two forms belonging to Erpobdella. Representatives of this genus were not indicated to the lake before.

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Interacting Effect of Natural and Sexual Selection During Speciation

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Abstract

The spectacular diversity in sexually selected traits among animal taxa has inspired the hypothesis that divergent sexual selection can drive speciation. At the same time, evidence is accumulating for species divergence driven by ecological adaptation. These two hypotheses are not mutually exclusive: recent theory and data suggest that interactions between natural and sexual selection may be particularly powerful in generating species diversity. For example, sensory adaptation may pleiotropically affect mating preferences; and mate choice for locally adapted partners can accelerate niche divergence. In my talk, I will review the empirical evidence for these mechanisms and present some of my work on colour signal divergence in East-African cichlid fish. These studies illustrate how ecological heterogeneity can influence sexual communication and thereby the origin and maintenance of species boundaries.

Distribution and Growth of Endemic Butini Fish (*Glossogobius matanensis*) in Towuti Lake, South Sulawesi

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Abstract

A research on distribution and growth of endemic fish butini (G*lossogobius matanensis*) in Lake Towuti was conducted over 12 months using long line of various hook sizes and in various depths. The result of this study indicates that the Butini is distributed at various depths but mostly in 100 m depth. During the study 2,195 specimens of Butini were caught comprising 1,401 males and 794 females. In each depth the males tend to be more abundant than the females. Total length ranged from 14.5 to 46.2 cm. The Butini population has an infinity length (L_∞) equal to 46.62 cm, and a coefficient of growth (K) equal to 1.200 per year. The infinity length (L_∞) for both males and females are the same, while the growth coefficients of males and females were 0.950 and 0.820 respectively. The maximum size of males can be reached in five years and females can be reached in six years.

Species and Speciation in Ancient Lakes (SIAL) – A Review (Almost) 20 Years after Mont Rigi

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Abstract

In 1993, the first international conference on speciation in ancient lakes was held in the field station of Mont Rigi in the Haute Fagnes, Belgium. In 1994, the proceedings of this meeting were published in the *Archiv für Limnologie, Suppl*. and comprised an article entitled "Speciation in Ancient Lakes – 40 years after Brooks", which attempted to summarise progress made in the field since the seminal papers by Brooks on the same topic. A 1997 paper in TREE, using the same proceedings as a basis, summarised the importance of ancient lakes for general ecological and evolutionary research. The present keynote lecture for SIAL6 attempts to highlight progress made in the (almost) 2 decades since the 1994 AfL paper.

A first objective fact derived from a literature study is that the field has vastly expanded geographically and methodologically. Previously fairly unknown ancient lakes such as the Ohrid/Prespa basins in the Balkan and especially the Sulawesi lakes in Indonesia (host to the previous SIAL5 and the present SIAL6 meetings respectively) have received dedicated attention. Also the vast Caspian Sea has meanwhile been baptised 'ancient lake'. This does not mean that the 'traditional' ancient lakes Baikal and the three African lakes have been neglected, they continued to be investigated as before.

As could be expected, the general trend in evolutionary research with focus on genetic and recently also genomic methods has not been passed unnoticed in the field of SIAL studies, but it is encouraging to see that such novel methods are merged with more traditional morphological and biogeographical approaches. From a theoretical point of view, issues such as the relevance of hybridisation for speciation and the existence of cryptic (specific) diversity have received attention. The conservation of ancient lake habitats and related issues, such as the fact that ancient lakes might be drivers of regional biodiversity, have been key issues in ancient lakes studies.

Some model studies are highlighted and prospects for future research directions are proposed.

A Phylogenomic Perspective on Teleost Evolution and Cichlid Diversification

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Abstract

With over 26 000 living taxa, teleost fishes represent nearly half of the extant vertebrate diversity, and include a number of explosive radiations. Among these rapidly diversifying groups, the most species-rich radiations are those of cichlid fishes into as many as 2-3 000 closely related species. Whereas the bulk of the cichlid diversity occurs in the Great Lakes of East Africa, the family shows a Gondwanan distribution, and some of its non-African clades may well be considered raditions in their own right. Despite numerous phylogenetic investigations of the cichlid radiations, some key questions concerning their evolution have yet to be answered. Whether or not trans-oceanic dispersal contributed to cichlid biogeography remains debated, and it is not yet clear which parts of the cichlid phylogeny are truly exceptional in terms of diversification rates. Similarly, it remains to be shown whether Lake Tanganyika was colonized individually by the ancestors of multiple tribes, or by a single lineage.We here present a massive phylogenomic dataset that is designed to resolve those questions. This dataset contains nearly 600 cichlid species representing the global distribution of the family, and includes newly generated sequences for over 70 species in key positions of the phylogeny. Furthermore, we added over 600 teleost outgroup taxa, in order to fully cover the euteleostean and otocephalan diversity at least on the level of order, but extending to genus or species level for selected groups. This sampling scheme allows us to time-calibrate the resulting phylogeny on the basis of over 70 fossil constraints, and will further permit an extensive analysis of cichlid and background teleost speciation rates in order to infer events in the cichlid history that led to their exceptionally rapid diversification. Among the outgroup taxa, our dataset comprises Lake Baikal cottids, Lake Titicaca cyprinodontids, and Lake Matano telmatherinids in addition to Lake Tanganyika and Lake Malawi cichlids, and will thus shed light on the time of colonization for five ancient lakes. Preliminary results will be discussed.

Recent Declining Trends in Indigenous Fish Diversity in Lake Biwa, Japan, and Efforts Towards Recovery

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Abstract

Lake Biwa, Japan's only ancient lake, is situated in the center of Shiga Prefecture, and its watershed closely corresponds to the prefectural boundaries. Its surface area of ca 670 km^2 is great enough for it to be regarded as a "large lake" and the maximum depth of 104 m assures permanently cold water in the lake's deeper zone. Owing to the variety of habitats the lake provides, as well as its exceptional age, Lake Biwa harbors some 60 endemic taxa; however, a variety of anthropogenic influences have threatened the lake's biodiversity. The lake's fish fauna originally comprised ca. 50 indigenous species including 15 endemic ones. Unfortunately, most of them are now considered to require special attention for conservation: about half were listed in the most recent edition of the Japanese national Red List in 2007, and one-third were additionally included in the Shiga Prefectural Red Data Book in 2010. The Lake Biwa Museum and the Shiga Prefectural Fisheries Experiment Station have established captive breeding programs for species that are valuable for conservation or that serve as fisheries resources, respectively. In addition, the Museum administers a national project for re-introducing a critically endangered bitterling to the wild. In parallel with other anthropogenic factors, invasion and proliferation of certain alien species have seriously damaged the native fish community, especially in the littoral zone of the lake. The most deleterious event was the population explosion of largemouth bass *Micropterus salmoides* in the 1980s, followed by a marked increase in bluegill *Lepomis macrochirus* in the 1990s and after. In 1999, Shiga Prefecture began to intensify its cooperative efforts with the commercial fishing industry to control these invasive alien fishes, and in 2003 it established a new ordinance to prohibit the release of the alien fishes captured by recreational fishers. As a result, some 400 tons of alien fish have been removed annually from the lake. The estimated standing biomass of these invasive alien fishes has shown a downward trend over the past decade, and recent fisheries statistics suggest that a gradual recovery of indigenous fish, including endemic species, is taking place.

Ornamental Shrimp: An Economic Alternative for People Around Ancient Lake Towuti, South Sulawesi

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Abstract

Towuti is a tectonic-oligotrophic lake located in Malili Complex, South Sulawesi and has been designated as a recreation park. This lake is one of the ancient lakes in Sulawesi supporting life of many endemic species such as shrimps. The shrimps in the lake are commonly known as ornamental shrimps and endemic species. These shrimps have beautiful colors and shades, are economically high valuable, relatively small, with a length of only about 2-2.5 centimeters. The price of the ornamental shrimps is starting from Rp 700/individual for the fisherman, Rp. 3000/individual at the collecting point and ranges from Rp. 7,000-10,000/individual at retailers. The price of the shrimps is based on the species. To meet the market demand, the fishermen are completely relying on catches from nature. This activity can cause the reduction of the population size of the various ornamental shrimp species. The diversity of shrimps, especially those inhabiting rocks, wood and leave litter, should be protected because of their endemicity. There should be an effort to breed them to ensure the survival of the shrimps. The main problem related to the management of these endemic shrimps is lack of information concerning the endemic shrimp. The decrease of the shrimp populations is due to deforestation, sawdust pollution, and over fishing. Efforts to sustain the endemic shrimps should be conducted by all stakeholders: locals, central and local governments, researchers, as well as non government institutions. The governments together with stakeholders should help by facilitating the people with techniques of shrimp domestication and cultivation. Degradation of lake water quality should be minimized. Limitation of using fishing gears, harvesting time in the year, and collecting areas should be applied. Efforts to sustain the *Caridina* spp would create new jobs in shrimp culture and simultaneously support conservation.

Endemic Fish Fauna from Sulawesi Ancient Lakes and Threats of Habitat Loss

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Abstract

Lakes in Central Sulawesi are a hotspot for endemic freshwater fish in the Wallacea area. There are three main lake systems that received major interest from global biologists and conservationists, i.e. Malili Lakes Complex (Lakes Matano, Towuti, Mahalona, Lantoa, and Masapi), Lake Poso, and Lake Lindu. The lakes harbor a highly diverse endemic fish fauna. Recently, we noted 41 endemic fish from those lakes; 32 species in Malili Lakes Complex, 7 species in Lake Poso, and only one species in Lake Lindu. Three of those endemic species were already extinct, i.e. *Adrianichtys kruyti* and *Xenopoecilus poptae* from Lake Poso, and *Xenopoecilus sarasinorum* from Lake Lindu. The reasons for the endemic fish extinction are the introduction of alien fish, overexploitation, and the destruction of the habitat. In the future, land conversion for housing, logging, mining, road and dam constructions will enhance habitat loss and hence further decrease species diversity in this region. Ex-situ conservation and other management strategies to support the sustainable use of the lakes are urgently needed. Information on the endemic fish diversity and the uniqueness of these ancient lakes should be disseminated to local community, government, and other stakeholders.

Population Structure and Demographic History of *Gmelinoides fasciatus* (stebbing, 1899) from Lake Baikal and Angara River

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Abstract

Amphipod of Baikalian origin *G. fasciatus* is found not only in the lake but also in the basin of Angara River, the Lake's only outlet. In the middle of last century this species was introduced artificially in Volga River basin from, where it spreaded wide so that now it reaches Middle Europe. From evolutionary viewpoint *G. fasciatus* is the only species representing a long branch but still belonging to one of the Baikalian flock. In the lake it is subdivided into at least four continuously distributed populations with some boundaries unexplained by geographical reasons.Here we report the results of more detailed study of the South Western population and samples obtained from the Middle Angara River (ca. 1000 km North from the lake). Isolation-with-Migration model as implemented in program ima2 and migrate-n was applied to the data on the polymorphism of nucleotide sequences of the Folmer fragment of mitochondrial gene coxI. This approach allowed us to show that: South-Western population is subdivided into two non-perfectly reproductively isolated sub-populations separated from each other by the Angara River outlet; Well-dated event of the generation of the isolating barrier allowed us to determine precisely the mutation accumulation rate in coxI of *G. fasciatus*; The Angara population is separate entity from genetic point of view. Migration between this population and the SW population is highly asymmetrical with the major gene flow going downstream; The Angara population still retains significant genetic signal of it's paleo-contact with the population of the Middle Basin of Lake Baikal.Reconstruction of the demographic histories was carried out by means of BEAST software package. Comparison of data on *G. fasciatus* populations to any geological or climatic events demands further researches. However the South Western population showed sharp increase of number. It is related with restoration from the bottle neck caused by catastrophic formation of the Angara River outlet, which coincided with warm period after glaciation.

Testing for Ecomorphological Adaptation and Related Individual Fitness Consequences in Lake Matano's Incipient "Sharpfin" Sailfin Silversides Radiation

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Abstract

Mechanisms driving sympatric speciation remain only partially explored. Especially suitable for studying early stages of ecological adaptation and related genomic consequences are evolving radiations restricted to habitat islands. Theory predicts a selection-maintained "syngameon" phase in early stages of species-flock formation, with ecologically distinct but genetically weakly differentiated emerging species. The lack of complete reproductive isolation might lead to novel combination of traits under selection and thereby increase evolution of phenotypic diversity. Here, we test whether the incipient adaptive radiation of "sharpfin" sailfin silversides (Atheriniformes: Telmatherinidae: *Telmatherina*) endemic to the ancient graben-lake Matano in Central Sulawesi (Indonesia) fulfills predictions of a "syngameon" complex, with focus on individual fitness consequence of phenotypic variation. The comparatively small but phenotypically diverse species flock of sharpfins shows fine-scaled variation in traits relevant to foraging. Previous studies revealed ongoing geneflow among different *Telmatherin*a morphospecies, and demonstrated that individuals with character combinations intermediate to the morphospecies occur. We analyzed individual fitness consequences of ecomorphological phenotypic variation, based on fitness proxies and a comprehensive random sample of sharpfins taken from 154 locations distributed equally around Lake Matano' shoreline and genotyped the same fish using multilocus AFLP markers. Bringing these data together, we generated phenotypic and genotypic fitness landscapes of the whole sharpfin species flock. Combining both fitness landscapes we discuss the results in the light of the "syngameon" phase hypothesis of adaptive radiation.

New Data on Diversity of Freshwater Crabs from Sulawesi and the Sequential Succession of Colonization of the Ancient Lakes

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Abstract

Ancient lakes probably represent the most stable freshwater environment on Earth, with a species richness clearly exceeding that of younger and less stable limnic habitats. The biological colonization of these old lake systems in most cases must have occurred via the surrounding rivers. Reconstructing these colonization events may thus help to better understand evolutionary processes like subsequent adaptive radiations. Furthermore it allows us to depict one or several moments in time in which an ecological transition took place from a riverine ancestor to a lake inhabitant, potentially occupying new ecological niches. If the age of the corresponding ancient lake is known, reconstruction of colonization events can then aid to calibrate molecular clocks for the phylogeny of the respective freshwater-dependent taxa. Two ancient lake systems of Sulawesi (Malili lake system and Lake Poso) have been studied in terms of the taxonomy and phylogeny of freshwater crabs (Decapoda: Brachyura: Gecarcinucidae). Both systems have been colonized twice independently and in both systems we can find three ecological niches which are always occupied by different crab species: molluscivores, omnivores, detritivores. In a recent effort, we have obtained mtDNA sequences from crab populations inhabiting more than twenty river systems in Sulawesi to allow a better reconstruction of lake colonization events. The reconstructed phylogenetic trees confirm two independent colonization events for both ancient lake systems with a subsequent radiation. Furthermore they imply that the species which are today molluscivorous were the first to colonize, whereas omnivores and detritivores are derived from later colonization events and the outcome of radiations due to their monophyletic relationship. The significance of these results will be discussed.

Evolution of the Mega-Lake Palaeo-Makgadikgadi (Kalahari, Botswana) During the Last 100 ka

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Abstract

Lake Palaeo-Makgadikgadi was thought to be a centre of major evolutionary radiations during the Pleistocene. The (palaeo-) lake is centred on the Makgadikgadi Basin, the largest and deepest of five major fault-controlled lacustrine sub-basins within the Makgadikgadi-Okavango-Zambezi basin, a structural depression of the south-western branch of the East African Rift System. The origin of the lacustrine system may reach back to Pliocene times, but evidence for a large lake approximately 40,000-70,000 km2 is confined to the last ~300 ka. Seven so-called mega-lake phases have been inferred from the chronology of geomorphological features that are argued to reflect lakeshore features, but neither the duration or limnological parameters of mega-lake phases are reported. We present the first palaeolimnological data, based on fossil diatom assemblages from the western edge of the Makgadikgadi Basin, that infer salinity and pH for a mega-lake period during ca 105-75 ka. We further report stages of lake development at ca 46 ka and ca 37 ka, during the Last Glacial Maximum, during Heinrich Event 1 (17-16 ka) and during the Holocene, based on hydromorphological and palaeolimnological evidence. The data suggest from ca 46 ka to ca 16 ka the Makgadikgadi Basin was not interconnected with the lacustrine depressions of the Okavango-Zambezi Rift Zone. During that period the Makgadikgadi Basin did not receive water from the Okavango River but from the Palaeo-Boteti and the Palaeo-Nata Rivers located in the northern catchment or from the Okwa River located in the south-western catchment. The Okwa River was likely activated by a northward shift of the winter rainfall zone during the Last Glacial Maximum sustaining a high lake level for a period of ca 6 ka. During Heinrich Event 1 the lake probably desiccated abruptly and completely, which possibly triggered tectonic activity due to reduced loading of the crust. Higher lake levels were reached again during the Holocene before the lake desiccated in the middle of the last millennium. It is unlikely that major evolutionary radiations occurred during the last 100 ka because Lake Palaeo-Makgadikgadi fluctuated strongly and longer periods of relatively stable environmental conditions have been the exception.

The Origins of a Species Flock in Ancient Lake Matano, Sulawesi

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Abstract

Recent studies indicate that the planet is rapidly moving out of the relatively stable Holocene, a geological epoch during which humans have come to dominate and produce most of their epic achievements. The approaching new age is expected to be more tumultuous, highly variable and exhibit much lesspredictable conditions. This new epoch has been termed the Anthropocene because major changes to Earth's systems have been largely precipitated by the activities of a single species. Perhaps the most obvious indicator of these changes is the unprecedented rate of species loss over the last 250 years, a rate equal to or greater than that of the previous five mass extinctions experienced over Earth's history. In this light, studies on the natural history and evolution of species can beextremely useful in identifying not only the species and areas prone to species generation and high endemism, but also in determining key ecological, environmental and physiological mechanisms underlying the origin of new species in natural systems. Research on the early invading fauna of ancient lakescan not only clarify a broad understanding of the environmental history of the area(s), but (some may argue more importantly) also provide opportunities to gain insight into how species originate and adapt to changing environmental conditions. Here, we show that ancient Lake Matano in the highlands of Sulawesi, in the Indonesian Archipelago, is a system that allows for key hypotheses of adaptive radiation, adaptive divergence and ecological speciation to be tested in its endemic pisceancommunity. We show that research inthis system has resulted in substantial contributions to the understanding of the origin of species. Moreover, we demonstrate that its continued use in evolutionary and ecological studies will lead to a more complete and better understanding of how ecology shapes species and how species can, in turn, shape evolutionary trajectories.

Phylogenetic Insight into the Origins of Endemic Diatom Diversity

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Abstract

Benthic diatom communities in ancient lakes are morphologically diverse and reported to contain numerous endemic and relict taxa. High diversity in these long-lived systems is thought to be non-uniform in two ways. First, an ancient lake may be characterized by increased diversity of particular benthic diatom groups that are specific to that lake. And second a single diatom lineage can be diverse in multiple geographically distant lakes of different ages. The phylogenetic relationships of these endemics to one another and to widespread taxa are unknown. Their ages are similarly unknown but it has been suggested that they may be neo- or paleoendemic taxa. To investigate ancient lake endemic diversity, we use a lineage of diatoms referred to as "Robustoids" (Surirellaceae), from ancient Lake Ohrid. Seventeen species of Robustoids are considered endemic to Lake Ohrid. Using a time-calibrated phylogeny based on nuclear, chloroplast and mitochondrial markers, we assess the monophyly and divergence times of these endemics. The results indicate that endemic Lake Ohrid Robustoids are not a product of a single diversification event, but rather are a mixture of old and more recent colonizers that live in sympatry. Based on divergence times and phylogenetic relationships, Lake Ohrid has endemic species that can be defined as both neo- and paleoendemic taxa that are coexisting with younger endemic clades that potentially represent cases of intralacustrine speciation. Fine-scale genetic studies of these clades within Lake Ohrid, coupled with analyses of sediment cores and taxonomic investigations of fossil deposits will further elucidate the processes leading to the observed diversity of Lake Ohrid Robustoids. Our data argues that endemic diatom diversity in ancient lakes is temporally and geographically complex and assembled by the interplay of multiple processes including ancient and recent colonizations as well as intralacustrine speciation.

Lacustrine Scientific Drilling of Large Tropical Lakes

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Abstract

Only a decade ago, we thought the water balance of Quaternary tropical lakes marched to the beat of global ice volume and greenhouse gases, highlighted by widespread aridity during the Last Glacial Maximum 21,000 year BP. Starting in 2000, Lacustrine scientific drilling in South American and African lakes has highlighted the critical role that orbitally-forced migration of the Intertropical Convergence Zone plays in regulating continental moisture balance and lake level. For instance, megadroughts observed in Lake Malawi during Marine Isotope Stages 4, 5, and 6 document large, coupled changes in the monsoons, the Intertropical Convergence Zone, and the Hadley circulation forced directly by orbital precession, not ice volume. These studies have significantly advanced our understanding of meridional variations in tropical paleoclimate, and suggest the need for renewed investigation of the role of orbital forcing in determining the evolutionary rates and trajectories of lacustrine biota. However, we are still far from understanding long-term changes in equatorial regions, where mostly present-day rainfall variations are associated with the Walker Circulation. This is because we do not have long paleohydrologic records from the largest zone of deep atmospheric convection on Earth, the Indo-Pacific Warm Pool.

Over the course of four field seasons we have acquired over a thousand kilometers of seismic reflection data and 150 m of piston core from Lake Towuti, one of the largest lakes in Indonesia. Located in central Sulawesi, in the heart of the Indo-Pacific region, Towuti contains up to 150 m of stratified lacustrine sediment that chronicles mid- to late Pleistocene variations in the Indo-Pacific. Lake Towuti also has high rates of biological endemism and and is hosted in the East Sulawesi ophiolite, one of the three largest ophiolites on Earth. We are developing a new lake drilling program for Towuti, spearheaded by a collaborative US, Indonesian, German, Australian, and Canadian team to produce the first lacustrine scientific drilling project in SE Asia in Lake Towuti to understand the lake's long-term environmental and evolutionary history.

Evolution in Darwin's Dreamponds: The Adaptive Radiations of Cichlid Fishes in the East African Great Lakes

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Abstract

More than one and a half centuries after the publication of Charles R. Darwin's The Origin of Species, the identification of the processes governing the emergence of novel species remains a fundamental question to biology. Why is it that some groups have diversified in a seemingly explosive manner, while other lineages have remained unvaried over millions of years? And what are the external factors and environmental conditions that promote diversification? A key to these and related questions is the comparative study of exceptionally diverse yet relatively young species assemblages that have radiated in geographically well-defined areas, such as the Darwin's finches on the Galapagos archipelago, the Caribbean Anoles lizards or the cichlid fishes in the Great Lakes of East Africa. Lakes Tanganyika, Malawi, and Victoria are each teeming with a unique set of hundreds of endemic cichlid species, which are likely to have evolved in the last few millions to several thousands of years only. East Africa's cichlid species differ greatly in ecologically relevant, hence naturally selected, characters such as mouth morphology and body shape, but also in sexually selected traits such as coloration. One of the most fascinating aspects of cichlid evolution is the frequent occurrence of evolutionary parallelisms, which has led to the question whether selection alone is sufficient to produce these parallel morphologies, or whether a developmental or genetic bias has influenced the direction of diversification.

Adaptive and Non-Adaptive Components of Diversification in An Endemic Gastropod Group in Lake Malawi

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Abstract

The African Riftlake Malawi is among the deepest and oldest lakes in the world. Although it is reported to have reached deep-water conditions 4.5 million years ago, recent studies have shown that the lake's endemic species flocks are remarkably young and have not radiated before the Pleistocene. It is believed that the recovery from severe lake level low stands has triggered the onset of the modern radiations but the driving forces of these diversification processes are not yet understood. Here we employ an AFLP genome scan of the endemic species of the gastropod genus *Lanistes* to analyse two intertwined components during speciation: adaptive and non-adaptive processes. Utilizing Bayesian techniques for outlier detection, we isolated neutral loci (bearing signals of non-adaptive processes) from loci under divergent selection (bearing signals of adaptive processes) and test for (A) isolation by distance and (B) isolation by adaptation in our dataset.

Former studies have argued that shell shape of the endemic *Lanistes* species has evolved in adaptation to different selection pressures, e.g. wave action and predation. We use morphometric semi-landmark analyses on the shells of the specimens in the molecular dataset to explore ecological adaptation. Using partial Mantel tests we investigate the influence of geographic and morphometric distances on the genetic structure of the group. Our results indicate that the main driving force for diversification processes in this radiation is isolation by distance whereas isolation by adaptation has played a less conspicuous role thus far. There is a clear difference between populations from the northern shore and those from the southern area of the lake. We argue that geographical separation across the entire lake in the aftermath of Late Pleistocene lake level fluctuations played a dominant role during diversification while adaptive processes appear more locally confined to the southern region of the lake.

Radula Genes and Adaptive Radiation in the Freshwater Snail *Tylomelania* in Lake Towuti (Sulawesi)

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Poster abstract

The two ancient lake systems of Sulawesi, Lake Poso and the five Malili lakes (incl. Lake Towuti), are aquatic biodiversity hotspots in Southeast Asia. The species flock (c. 55 species) of the viviparous freshwater snail *Tylomelania* in these lakes have strikingly different radula forms; a strong correlation of radula form and substrate suggests that trophic specialization is a major factor in the adaptive radiation of this species. Particularly interesting is the pattern observed in the species *Tylomelania* sarasinorum, a widespread hard substrate dweller in the largest of Sulawesi's ancient lakes, Lake Towuti. While there is little variation in the shell, four distinct radula forms can be distinguished, two of which are dominant. At almost all sites, the species occurs on two substrates, rocks and wood, usually in shallow water down to c. -5 m. In gastropods, the radula (rasping tongue) is the key organ of the feeding apparatus. An understanding of the adaptation of the radula to different food sources or substrates relies on an understanding of radula ontogeny. The continuous replacement of teeth and the apparent ability to change tooth form abruptly, at least in some taxa, provide ideal conditions for studying the genetic basis of differences in tooth form, as the responsible genes are apparently expressed permanently, i.e. not just at one or a few early ontogenetic stages. Preliminary transcriptome sequencing results show differences between target and reference tissue (radula forming tissue vs. mantle edge). The transcriptome comparison of both target vs. reference tissue and between both radula morphs might reveal factors influencing radula formation (e.g. polymorphisms, expression levels) and thus playing a crucial role in radula evolution and adaptive radiation in this snail genus.

The Zooplankton of Sulawesi Reveal the Importance of Hybridization for Speciation in Plankton

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Abstract

The importance of hybridization for diversification in animal taxa has remained unclear for many decades, and even less clear is its role in the speciation of planktonic species. In this study, we investigate the importance of hybridization and geographic isolation for speciation in copepods using phylogenetic and population genetic analyses of mitochondrial and nuclear genes in the freshwater diaptomids of the ancient lakes of Sulawesi, Indonesia. We found two separate lake systems where hybridization plays an important evolutionary role. In Lake Tondano, the diaptomid population is of hybrid origin, possessing homogenous ribosomal genes but two highly divergent mitochondrial lineages. In the ancient Malili lakes, the diaptomid populations are also homogenous at nuclear loci, but show two highly divergent mitochondrial clades that are geographically restricted to single lakes, despite their hydrological connectivity. This indicates that unidirectional hybridization allows gene flow across the nuclear genome, but prevents the introgression of mitochondrial genomes into neighboring populations. We find that allopatric speciation in zooplankton dominates over large geographic scales, while at local scales, speciation processes are highly dynamic and influenced mainly by hybridization among neighboring populations. We suggest that hybridization between differentiated populations is a significant evolutionary force in freshwater plankton.

Adaptive Morphological Divergence in an Ongoing Radiation of *Lanistes* Gastropods from Lake Malawi

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Abstract

Ampullarid gastropods of the genus *Lanistes* have occupied the Malawi Basin since the Late Pliocene, but the molecular diversity in the extant, monophyletic group of *Lanistes* from Lake Malawi did not start to accumulate until approximately 600 ka. Yet, the mechanisms of diversification in the group are poorly understood. An AFLP genome scan indicated that the major divergence occurred between specimens from the North and the South, probably due to isolation by distance. The molecular differentiation in two groups, each occupying a subregion of the lake, coincides with consistent morphological differences. Within each subregion, considerable morphological variability exists, but the morphological and molecular differentiation correlate poorly. To obtain insight into the heritability of morphological variation, we subjected live-collected specimens of three *Lanistes* morphospecies ('*ovum*', '*solidus*' and '*nyassanus*'), regularly found in micro-sympatry in the South of Lake Malawi, to Common Garden Experiments. Shell shapes of the parent and F1 offspring populations were documented with semi-landmark morphometrics and were compared among parent-offspring couples and between morphospecies. Highly similar reaction norms from the parent to the F1 offspring were obtained in replicate experiments for the same morphospecies, suggesting that our study design was robust. Clustering using normal mixture models on the covariance structure of F1 offspring populations and statistical tests demonstrated that the morphological differences between two morphospecies pairs (*nyassanus-solidus*; *nyassanus-ovum*) remained in the F1 generation whereas the difference in the third morphospecies pair (*solidus-ovum*) disappeared at F1. Our results indicate that much of the morphological disparity within the *Lanistes* morphospecies from the South of Lake Malawi relates to inherited differences even though gene-flow between these morphospecies may occur. Our data hence indicate that some isolation by adaptation has occurred in *Lanistes* morphospecies in the South of Lake Malawi.

Freshwater Shrimp Species Flocks From the Ancient Lakes of Sulawesi, Indonesia: The Geography of Speciation

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Atyid freshwater shrimps are globally distributed and form an important part of freshwater ecosystems, particularly in the tropics and subtropics. The two ancient lake systems of the Indonesian island Sulawesi, Lake Poso and the Malili Lakes, host the largest radiations of freshwater shrimps worldwide (with currently 21 described and at least two yet undescribed species), all belonging to the most speciose genus *Caridina* (over 200 species) within the Atyidae. Both lake systems provide similar environmental conditions with locally heterogeneous habitats: Lake Poso is a single lake with less pronounced geographic structure than the Malili lake system with its five connected lakes. The spatial subdivison and the higher number of species in the Malili lakes (15 vs. 6 species in Lake Poso) make the system especially interesting for the study of geographic differentiation.

The phylogeographic patterns of the majority of the lacustrine species in the radiations were assessed. Both lake systems have been sampled comprehensively over several years, i.e. 137 localities altogether. A molecular phylogeny based on two standard genes (16S and COI) was reconstructed. A mismatch between molecules and morphology hinted towards cases of introgression or incomplete lineage sorting in some species. To analyse geographic differentiation, geographic data for each species was mapped onto the phylogeny. In addition, haplotype networks were constructed to assess intralacustrine geographic patterns. In general, the molecular phylogeny revealed that all species, with one exception, are endemic to the ancient lakes, always showing local endemism within one system or even single lakes. Species from the Malili lakes revealed more geographic differentiation than species from the solitary Lake Poso. In several species from the Malili lakes, geographically separated populations form distinct subclades, suggesting limited gene flow between these populations. In other cases, allopatrically occurring populations within species were found in separate clades that were not even sister groups to each other in the overall phylogeny. This suggests not only the existence of cryptic species but also of unrecorded endemism.

Interlacustrine Connectivity and Intralacustrine Divergence in *Paratherina* Sailfin Silversides from Sulawesi's Malili Lakes

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Abstract

Insular lacustrine endemic species by their very nature are at increased risk for extinction through habitat loss. Within the Malili Lakes system, some species are restricted to a single lake, representative of the entire species distribution; whereas other species distributions' span multiple lakes and habitats. In the latter, estimates of genetic diversity and population connectivity are important considerations for comprehensive conservation programs with respect to population replenishment, long-term stability, and sustainability. Using two species of *Paratherina* sailfin silversides, we provide evidence for both connectivity and structure between lakes Mahalona and Towuti in the Malili Lakes system, suggesting a complex relationship between dispersal and divergence within and among populations. We also provide evidence for ecological divergence between the two species within Lake Mahalona, which appears to parallel that of the *Telmatherina* radiation in nearby Lake Matano. Our work provides an example fine-scale divergence in Malili Lakes region, but also highlights the role of exogenous gene flow in the development novel lacustrine genetic signatures.

Old Lakes, Old Taxa?

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Abstract

Ancient lakes often contain a large number of endemic species. The evolutionary processes leading to high degrees of biodiversity, however, are still not well understood and controversially discussed. Two hypotheses have been proposed for the generation of endemic diversity in ancient lakes: (1) These water bodies function as sinks for extralimital relic species over long time periods, resulting in the accumulation of phylogenetically diverse assemblages ("reservoir function"), and (2) the lakes serve as sites for intralacustrine speciation ("cradle function"). Moreover, in case of intralacustrine speciation it often remains unclear whether the extant endemic species (a) evolved shortly after the lakes came into existence ("old taxa") or whether (b) they are considerably younger than the respective lake ("young taxa").

Based on comparative molecular clock analyses of invertebrate species flocks from several ancient lakes, it is demonstrated that the majority of taxa evolved through intralacustrine speciation. Moreover, the data show that most flocks are considerably younger than the actual lake, indicating that speciation processes started after an extended lag phase and/or the existence of strong bottle necks acting on endemic faunas.

This predominant pattern of "old lakes, young taxa" is discussed within the palaeolimnological context of the respective lakes as well as within the framework of the "law of extinction" proposed by Van Valen.

Author Index