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On the brink – investigating biodiversity in endangered crater lakes of the Amber Mountains National Park (Madagascar)

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ABSTRACT

1. Madagascar's biodiversity is vanishing at an alarming pace. The documentation of this loss has so far focused on terrestrial habitats and organisms. Eight volcanic crater lakes in the Amber Mountains National Park (Northern Madagascar) and surroundings were investigated for the first time to describe limnological conditions and aquatic biodiversity. Seven of the lakes were affected by deforestation/logging and fish introduction and only one lake was assumed to have remained in pristine condition. In the deeper lakes (> 5 m) steep physico-chemical gradients and anoxic hypolimnia were observed.
2. Algae, hydrozoans, nematodes, rotifers, annelids, copepods, cladocerans, ostracods, and mites were identified to genus or species level. The majority were taxa with a cosmopolitan or tropicopolitan distribution. The highest number of afrotropical and endemic species were recorded within the crustaceans.
3. Multivariate analysis of species communities revealed significant differences between lakes in deforested and forested catchments. Introduced alien fish had no detectable effect on species assemblages.
4. Illegal harvest of timber was observed within the National Park and drug plantations are less than 1 km away from the last pristine crater lake. If deforestation continues at the current rate, which is likely under the prevailing political situation, the last undisturbed lake communities may be altered in the near future.
5. There is an urgent need for taxonomic research to assess the biodiversity of algae and micrometazoa. Highest priority should be given to pristine freshwater ecosystems within protected areas.

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KEY WORDS: algae; alien species; biogeography; deforestation; invertebrates; island; lake; taxonomy

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INTRODUCTION

The island of Madagascar is among the top hotspots for biodiversity conservation worldwide (Myers *et al.*, 2000; Ganzhorn *et al.*, 2008; Vieites *et al.*, 2009). More than 90% of all plants, 100% of native amphibian and mammal species, 92% of reptiles and 44% of birds occur nowhere else. This high level of endemism predominantly results from radiation of African founder individuals arriving during the Cenozoic (65.5 Ma to present) and from relict species radiating after the island separated from the African mainland (183–158 Ma), Antarctica (130 Ma), and India (96–65 Ma; Vences *et al.*, 2009).

Besides an extraordinary diversity in terrestrial organisms, Madagascar has also been recognized as a global hotspot of freshwater biodiversity (Groombridge and Jenkins, 1998). In the last two decades of the 20th century the number of newly described species of aquatic insects and fish had increased exponentially (Benstead *et al.*, 2003). However, owing to incomplete species inventories and taxonomic difficulties, the degree of endemism in small planktonic and benthic organisms is difficult to assess. There is evidence for endemism especially for copepods (Dussart, 1982), but also for some freshwater algae (e.g. desmids (West and West, 1895; Bourrelly and Couté, 1991; Coesel, 2002) and benthic diatoms (Metzeltin and Lange – Bertalot, 2002)).

Taxonomic research on Malagasy freshwater algae and micrometazoa is still scarce. There are no systematic species inventories available and current knowledge is based on random samples mostly covering specific groups of organisms from different habitats. First surveys of the Malagasy freshwater algal flora were provided by West and West (1895), Fritsch (1914), Manguin (1941), Bourrelly and Leboime (1946) and Bourrelly and Manguin (1949). More detailed algological investigations are available for diatoms (Spaulding and Kociolek, 1998a, b; Metzeltin and Lange – Bertalot, 2002), desmids (Bourrelly and Couté, 1991; Coesel, 2002) and chrysophytes (Hansen, 1996). Taxonomic research on micrometazoa was conducted predominantly until the 1960s (DeGuerne and Richard, 1893; Brehm, 1930, 1948; Kiefer, 1930). Most studies were based on samples taken by the director of the Institut des recherches scientifiques de Madagascar, Renauld Paulian, who sent the material to various taxonomists (Rotifera: Berzins, 1960, 1973, 1982; Harpacticoida: Chappuis, 1952, 1954, 1956; Calanoida: Brehm, 1951, 1952a, b, c, 1953, 1954; Cyclopoida: Lindberg, 1951a, b, 1952, 1953; Kiefer 1952, 1954, 1955; Cladocera: Brehm, 1953). Brehm (1960) gave an account of freshwater Crustacea collected during the Austrian Madagascar expedition in 1958. After this period of intensive taxonomic work on freshwater micrometazoa few publications appeared (Dussart, 1982; Segers, 1992; Fiers, 2002).

Madagascar's biological richness is threatened by massive habitat destruction. Forty per cent of rainforest cover was lost between 1950 and 2000 (Harper *et al.*, 2007; Wikipedia, 2012). Deforestation currently continues at a rate of about 0.5% per year (57 000 ha; Mongabay, 2011). Although the country possesses 46 legally protected areas covering almost 1.7 million hectares (2.89% of total territory), habitat destruction still proceeds at an alarming pace. A peak in illegal logging was observed during the political turmoil in 2009. Schuurman and Lowry (2009) spoke of a 'Madagascar rosewood massacre', because 625 containers of hardwood worth approximately US $ 130 million illegally left the country in 2009. Most of the trees were felled in protected mountain reserves in Northern Madagascar (Marojeji, Masoala, and Amber Mountains). During sampling in May 2009 the illegal harvest of rosewood and palisander (*Dalbergia* spp.) was witnessed on several occasions.

Deforestation not only changes terrestrial habitats but causes increased sediment delivery and nutrient input into rivers and lakes and hence alters physico-chemical conditions, species composition and trophic interactions in aquatic habitats as well (Benstead *et al.*, 2003). Loss of forest cover has already caused a shift from persistent to intermittent flow in the streams draining the northern and eastern slopes of the Amber Mountains and the Tsaratanana Massif (Raxworthy *et al.*, 2008).

Following habitat destruction, invasive species are regarded as the second leading cause of species extinction and endangerment worldwide (Sala *et al.*, 2000). A number of alien fish species have been stocked in pristine Malagasy fresh waters causing severe changes to entire ecosystems and being detrimental to various groups of animals (Canonico *et al.*, 2005). For instance, there is a strong correlation between the introduction of exotic fish and the decline of native fish in Madagascar (Reinthal and Stiassny, 1991; Sparks and Stiassny, 2003), but no information is available about their impact on plankton and benthos communities in Malagasy lake ecosystems.

Finally, the warming trends reported for Madagascar equal or exceed global averages (Raxworthy *et al*., 2008). A drier climate will accelerate the destruction of montane rainforests in the Amber Mountains National Park. At its lower level the thinning of the protective canopy exposes the forest to sunlight and drying wind thereby increasing the risk of wildfires.

Benstead *et al*. (2003) defined three major objectives to conserve the remaining Malagasy freshwater biodiversity: (1) Survey efforts have to be directed at remote regions that have no inventories for freshwater biota. (2) Systematic and ecological studies of poorly known taxonomic groups must be undertaken. (3) Top conservation priority should be given to intact freshwater ecosystems that are situated within protected areas.

Today, only a few pristine volcanic crater lakes on the entire island remain surrounded by primary rainforest (Schabetsberger *et al*., 2009a). The two largest clusters of crater lakes are within or near the borders of the volcanic massifs of the Amber Mountains and the Tsaratanana (Bemanevika area) National Parks in Northern Madagascar. The Bemanevika lakes were found to be the last refuge for only a few individuals of the Madagascar pochard, a duck proclaimed extinct and rediscovered in 2006 (TWSG News, 2006), but the catchment already exhibits fragmented pockets of rainforest near the lakes. A single isolated crater lake in the Makira protected area, Lake Amparihibe, also appeared to be pristine (Schabetsberger *et al*., 2009a). It was reached by a 1-day boat journey and a 3-day march through rainforest. Nevertheless, the illegal harvest of hardwood trees was witnessed more than half way along the trail. These last examples of undisturbed lentic species communities, which have persisted before and since the arrival of man on Madagascar approximately 2300 years ago (Burney *et al*., 2004), should therefore be given high priority in future conservation measures.

The aim of this study was a preliminary limnological characterization of lakes in the Amber Mountains National Park and its surroundings. Preliminary species lists of planktonic and benthic organisms are presented and the impact of deforestation and stocking with alien fish species on freshwater communities is analysed. The samples were collected during a single expedition mounted during times of political unrest and increasing illegal timber harvest within the Amber Mountains National Park (Schuurman and Lowry, 2009; personal observations). Although we were unable to collect replicate samples and measure nutrient chemistry, these first baseline data are provided to support future conservation efforts.

STUDY AREA

The Amber Mountains are a large stratovulcano in northern Madagascar (*c*. 2500 km^2). Radiometric ages of lavas range from 12.1 ± 0.2 Ma (^{40}Ar-^{39}Ar) in the north west to 0.83 ± 0.02 Ma (^{40}K/^{40}Ar) in the central part, suggesting that the volcanism was active from at least the middle Miocene. The massif is formed by 'hundreds of lava flows, plugs, spatter cones, tuff rings, pyroclastic flows, and pyroclastic fall deposits' (Cucciniello *et al*., 2011 and references therein). Several lakes fill tuff rings that represent the youngest volcanic activity of the complex.

In 1958 the French Colonial Forces established the first Malagasy National Park in the Amber Mountains massif. Today the Park protects 18 200 ha of mid-altitude montane rainforest lying at altitudes ranging from 850–1475 m. Five volcanic crater lakes are situated within (here numbered (1–3); (7)), or at the edge of the forest (8), while three lakes at lower altitude (4–6) are outside the park and are surrounded by savannah (Figures 1, 2; Table 1). Lake Manonja (7) remains the only unstocked lake surrounded by primary rainforest, whereas the savannah has already reached the southern shore of Lake Fantany (8). Also, 'khat' (*Catha edulis* – a drug common in East Africa) plantations are closing in on Lake Manonja and are now less than 1 km away.

During French occupation, a forest station operated at the park entrance near Joffreville (A. Randimbison, personal communication). From there black bass (*Micropterus salmoides*) and carp (*Cyprinus carpio*) were introduced into three out of five lakes in the centre of the park (Mahasarika (1), Malio (2), Taranta (3)). In addition, tilapia (*Tilapia rendalli*) and mosquitofish (*Gambusia affinis*) are found today in the lake closest to the park entrance (Mahasarika (1)). The lakes surrounded by savannah (Mahery (4), Antagnavo (6), and Antagnavo ely (5)) contain tilapias together with endemic cichlids and are inhabited by crocodiles (*Crocodylus niloticus*).

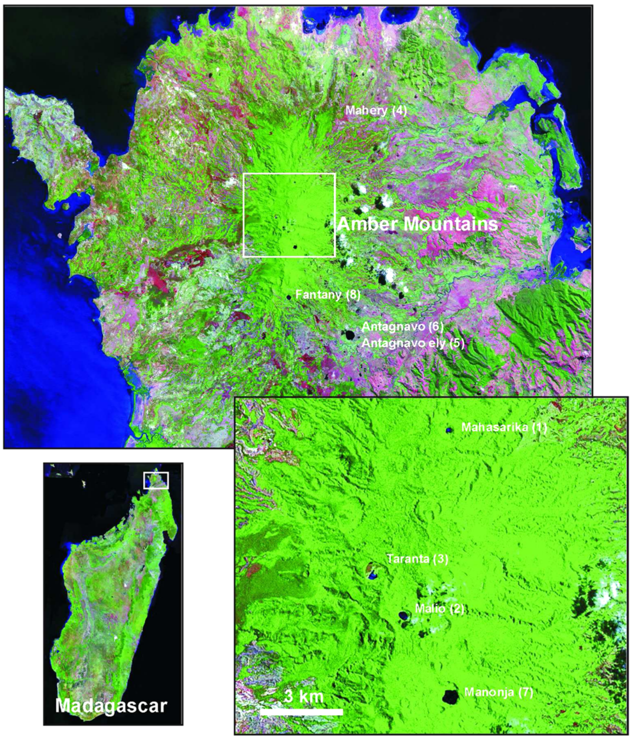

Figure 1. Location of the sampling sites in the Amber Mountains National Park and surroundings (green: forested (lakes 1, 2, 3, 7, 8); red: savannah (4, 5, 6)).

METHODS

Field work lasted from 16 to 23 May 2009 during the beginning of the dry season. The savannah lakes were sampled only from the shoreline or the outflow (Lake Antagnavo), because of the danger of crocodiles. In the other lakes the maximum depth was measured from an inflatable dinghy with a portable gauge. Depth-specific water samples were collected at the deepest point with a Schindler-Patalas trap and profiles of temperature (thermometer within trap), pH, conductivity (Hanna Combo electrode), and oxygen (Hach HQ 40d) were measured. Integrated qualitative plankton samples were taken with a 30 μm plankton net by retrieving the net from near bottom layers or throwing out the net from the shore. In addition, samples were collected in different littoral habitats (sediment, macrophytes). All samples were filtered through a 30 μm net and preserved in 4% formaldehyde. Quantitative phytoplankton samples were collected from the water surface at the deepest point in lakes Mahasarika, Malio and Taranta (200 mL unfiltered lake water) and at three different depths in lakes Manonja (1, 5, 9 m depth) and Fantany (1, 7, 15 m) and preserved with Lugol's solution.

In the laboratory Lugol-preserved phytoplankton samples were analysed following recommendations for counting and biovolume calculations using the Utermöhl technique (Rott, 1981). Species were determined from Lugol and formaldehyde-preserved plankton samples (algae in general: E. Rott; Zygnematophyceae: R. Lenzenweger and E. Rott). Zooplankton and zoobenthos samples were stained with Rose Bengal, sorted under a stereo microscope and determined to genus or species (hydrozoans: R.D. Campbell; nematodes: W. Traunspurger; rotifers: R. Schabetsberger; annelids: S. Gaviria; cladocerans: A. Kotov; copepods: F. Fiers; ostracods: C. Meisch; mites: S. Mahunka).

Species assemblages were analysed with non-linear multidimensional scaling (NMDS; Kruskal, 1964) using presence/absence data of all taxa occurring in more than one lake (103 out of 276 taxa, mean 21.5 ± 15.3 SD) and the Kulczynski index (Faith *et al.*, 1987; Legendre and Legendre, 1998) as a measure of dissimilarity. Using the same index, an agglomerative hierarchical clustering of the data was computed (Kaufman and Rousseeuw, 1990). Ordination diagrams and fitted environmental vectors, as well as clustering solutions, indicated a strong pattern related to conductivity. Subsequently an Analysis of Variance Using Distance Matrices (Anderson, 2001; McArdle and Anderson, 2001) was applied to test the null hypothesis of no relationship between species assemblages and conductivity. All computations were coded in R (R Development Core Team, 2011) using base packages plus the vegan library (Oksanen *et al.*, 2011).

RESULTS

Description of lakes

Data on physical conditions and algae are presented in Figures 3 and 4.

Mahasarika (1, Figure 2(a))

The 4.8 m deep crater lake is oversaturated with oxygen down to 4 m depth. A strong gradient in pH and high total algal biomass result from a bloom of *Monoraphidium contortum*, *Microcystis wesenbergii*, *Cylindrocystis* sp., and *Cosmarium* sp. It is said that the lake feeds the water supply for the town of Antsiranana (Diego-Suarez; A. Amba, personal communication), although to

Figure 2. Photographs of the lakes in the Amber Mountains National Park and surroundings.

our knowledge there are no hydrological studies available to confirm this.

Malio (2, Figure 2(b))

The highest lake within the National Park was saturated with oxygen throughout the 4 m deep water column. Weak gradients in all parameters indicated frequent mixing of the shallow lake. Phytoplankton biomass was dominated by Cyanobacteria (*Cyanodictyon* sp., *Microcystis pulverea*, *Microcystis* sp.) and Dinophyceae (*Peridinium volzii*).

Taranta (3, Figure 2(c))

The lake is only 0.9 m deep and well oxygenated. Phytoplankton was dominated by Zygenematophyceae (*Cosmarium pygmaeum*), Chlorophyceae (*Coelastrum sphaericum*) and Dinophyceae (*Peridiniopsis elpatiewskyi*).

Mahery (4, Figure 2(d))

Several small islands indicate a shallow depth of the lake (probably < 3 m). The near-shore water is characterized by comparatively higher conductivity

Table 1. Description of lakes in the Amber Mountains National Park, Madagascar (*indicates native fish species)

Lake Number	Malagasy Name	Foreign Name	Sampling Date	Altitude (m)	Max.Length (m)	Max. Depth (m)	Temp. (°C)	Cond. (µS cm^{-1})	pH	Oxygen (mg L^{-1})	Oxygen (% sat)	Fish
1	Mahasarika	Petit Lac	16.05.2009	1060	280	4.8	24.6	28	9.28	8.24	115	*Tilapia rendalli*, *Cyprinus carpio*, *Micropterus salmoides*, *Gambusia affinis*
2	Malio	Grand Lac	16.05.2009	1335	360	4.0	20.6	31	8.41	7.97	105	*Cyprinus carpio*, *Micropterus salmoides*
3.	Taranta	Maudit	18.05.2009	1250	720	0.9	19.8	56	8.22	8.09	103	*Cyprinus carpio*, *Micropterus salmoides*
4	Mahery	Mahery	19.05.2009	364	765	Shallow	26.1	218	6.87	-	-	*Tilapia rendalli*, *Paratilapia* sp.*
5	Antagnavo ely	Sacré small	20.05.2009	348	190	2.5	25.9	202	7.16	-	-	*Tilapia rendalli*, *Paratilapia* sp.*, *Ptychochromis* sp.*
6	Antagnavo	Sacré	20.05.2009	367	1660	?	26.1	231	8.74			*Tilapia rendalli*, *Paratilapia* sp.*, *Ptychochromis sp.**
7	Manonja	Texier	22.05.2009	1034	630	25	22.7	61	9.01	8.72	113	no introduced fish, eels*
8	Fantany	Fantany	23.05.2009	810	780	32	25.4	75	9.06	8.01	108	no introduced fish, eels*?

and slightly acidic conditions within a dense belt of the non-native water hyacinth *Eichhornia crassipes*.

Antagnavo ely (5, Figure 2(e))

The small crater lake in the south east of Lake Antagnavo is also surrounded by floating carpets of *E. crassipes*. Similar to Lake Mahery, surface conductivity was > 200 µS cm^{-1} and pH was just above neutral.

Antagnavo (6, Figure 2(f))

The water in the outflow was characterized by high pH and conductivity (Table 1). Crocodiles are fed regularly in ritual ceremonies.

Manonja (7, Figure 2(g))

Lake Manonja is the most pristine freshwater ecosystem in the Amber Mountains National Park. The protected crater lake is 25 m deep and exhibited steep physico-chemical gradients. Beyond 15 m depth the water was anoxic. A phytoplankton bloom resulted in high pH values in shallow water. The algal community was dominated by Cyanobacteria (*Anabaena* sp., *Cyanodictyon* sp.). So far the lake has not been stocked with alien fish and is said to contain large numbers of native eels (*Anguilla* sp.; A. Amba, personal communication). Plantations of 'khat' (*Catha edulis*) are only an hour's walk away from the lake and numerous felled rosewood trees were seen in the area.

Fantany (8, Figure 2(h))

The deepest lake in the Amber Mountains National Park (32 m) is situated at the border between rainforest and savannah. Similar to Lake Manonja, steep physico-chemical gradients were found and the water was anoxic beyond 15 m depth. Phytoplankton was dominated by Cyanobacteria (*Microcystis pulverea*; *M. wesenbergii*, *Cyanothece* sp.), Bacillariophyceae (*Synedra* sp.) and Dinophyceae (*Peridiniopsis elpatiewskyi*). According to information from local people crocodiles have been introduced into the lake, but so far no fish have been stocked. The illegal harvest of hardwood was witnessed near the lake.

Species assemblages

In total, 142 algal, 1 hydrozoan, 23 nematode, 56 rotifer, 12 annelid, 15 copepod, 16 cladoceran, 8 ostracod, and 3 mite taxa were recorded

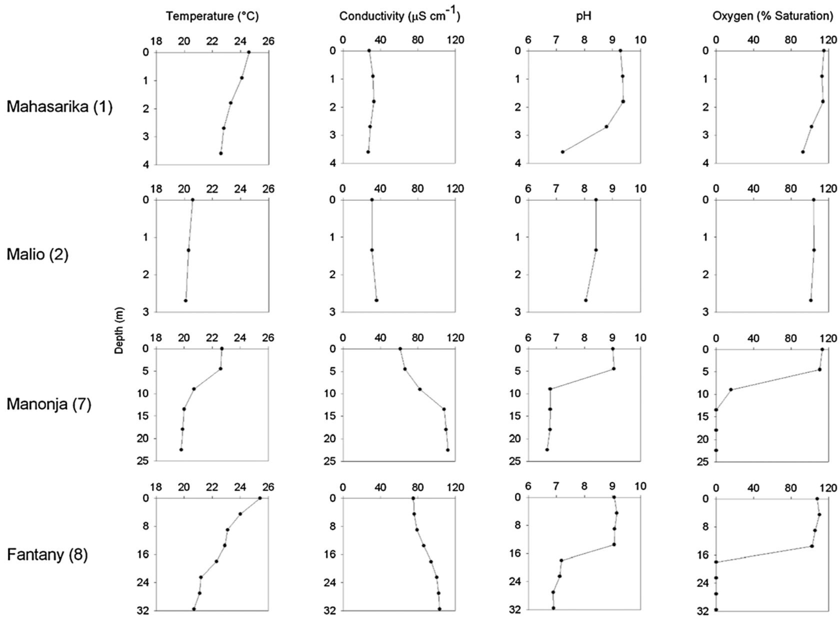

Figure 3. Depth profiles of temperature, conductivity, pH, and oxygen in four lakes of the Amber Mountains National Park.

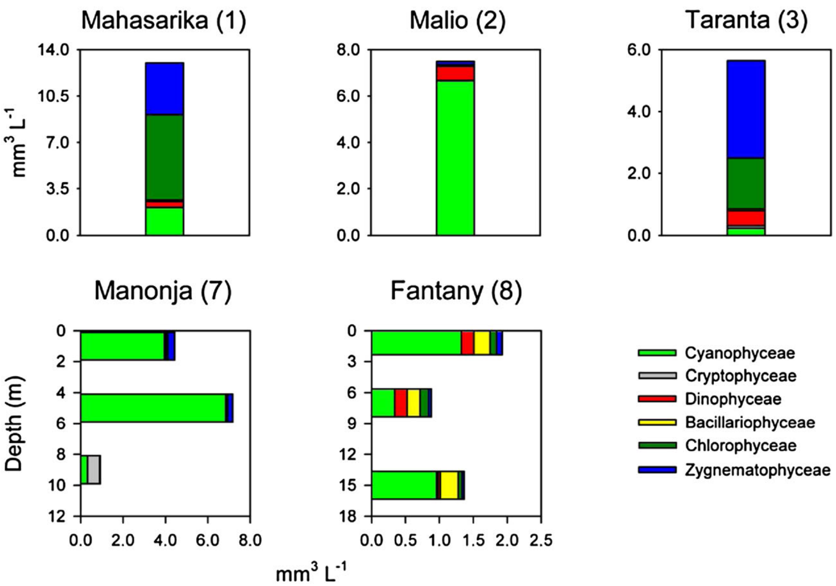

Figure 4. Phytoplankton biomass (mm^3 L^{-1}) at 0.5 m depth in shallow lakes (top panels) and at three different depths in the deeper lakes (> 5 m, bottom panels) within the Amber Mountains National Park.

(Appendix). The highest species richness was observed in the belt of water hyacinth of Lake Mahery (4) (Figure 5). Crustacean species exhibited a lower proportion of cosmopolitan or widely distributed taxa than the other groups of organisms. Truly endemic morpho-species (3) were predominantly found within the copepods and they were restricted to lakes within the park boundaries (Appendix).

Ordinations and clustering solutions clearly corroborate differences in species assemblages with regard to conductivity and surrounding vegetation (Figure 6). Conductivity was significantly related to vegetation (one-way ANOVA, $F_{1,6}$: 152, *P*: <0.0001) with mean 50.2 µS cm^{-1} ± 20.2 SD for forest and 217 µS cm^{-1} ± 14.5 for savannah environments. Analysis of Variance Using Distance Matrices confirmed that conductivity is non-randomly related to species patterns and explains roughly one-third of the variability in the species matrix (R-squared: 0.34, $F_{1,6}$: 3.05, *P*: 0.003, *P*-values obtained by 999 permutations). The same holds true for surrounding vegetation (2-level factor: forest and savannah) when used as predictor variable (R-squared: 0.33, $F_{1,6}$: 2.98, *P*: 0.016, 999 permutations). The effect of introduced fish on species assemblages and richness was also tested. Analysis of Variance was applied using Distance Matrices and one-way ANOVA of log-transformed species richness. Only spurious relationships were found.

Ordination of lake communities (Figure 6(a)) shows a distinct pattern with regard to conductivity. Likewise, items display a clear group structure when ordination scores are labelled according to the surrounding environment. Independent cluster analyses (Figure 6(b)) corroborate the validity of the ordination configuration. In addition, clustering analyses suggest a hierarchical structure in the data, embedding the three savannah lakes in a group with two forest lakes of intermediate (7) and low conductivity (2).

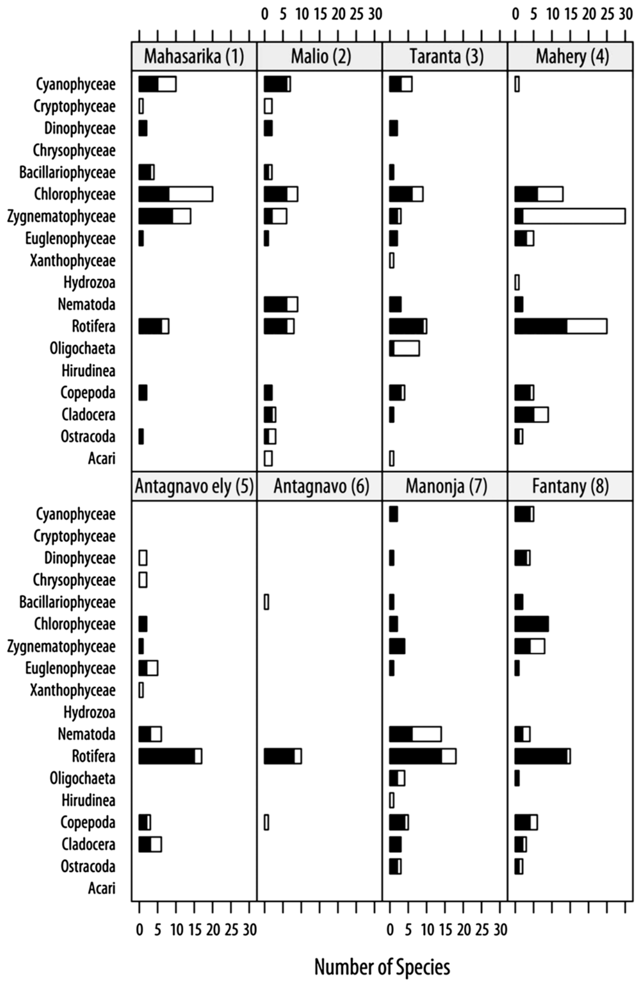

Figure 5. Total number of species grouped at higher taxonomic level (Appendix). The stack bars give the number of species occurring in more than one lake (solid black) and the fraction of species encountered only within the named lake (white).

DISCUSSION

Species communities differed between lakes situated in forested compared with deforested catchments. In turn forest cover was strongly correlated with water conductivity, being four times higher in lowland lakes surrounded by savannah. Increased sediment input through soil erosion probably leads to changes in algal and micrometazoan communities (Lott *et al.*, 1994; Alin *et al.*, 2002), although single sampling cannot provide conclusive evidence. Deforestation proceeded from the lowlands around Lake Antagnavo (6) towards the foothills of the Amber Mountains within the last millennium (Burney *et al.*, 2004) and has now reached Lake Fantany (8). We hypothesize that sediment cores would reveal clear changes in species communities after the arrival of humans, that are not paralleled in the forest lakes. In this respect the lakes would be promising targets for palaeolimnological research.

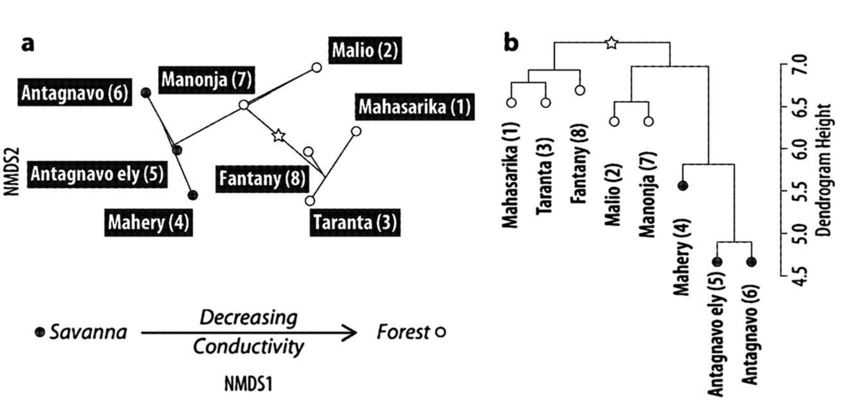

Figure 6. Ordination diagram and cluster dendrogram based on the Kulczynski index computed with presence/absence data. a: NMDS Ordination (stress: 7.85) with sample sites connected by a cluster dendrogram. The star denotes the root of the dendrogram (see b.). The fit of conductivity onto the ordination is shown as a symbolic arrow (R-squared: 0.91, P: 0.002, p-values based on 999 permutations). b: Agglomerative Nesting Clustering (agglomerative coefficient: 0.15) with tips coded according to the surrounding vegetation.

Owing to their sheltered position and nutrient-rich volcanic bedrock, all deeper crater lakes within the park exhibited strong physico-chemical gradients, anoxic hypolimnia and phytoplankton blooms. The highest epilimnetic algal biomass was recorded in the lake with four introduced alien fish species. This might have resulted from the absence of larger crustacean grazers because of size-selective fish predation. Unfortunately quantitative phytoplankton samples from lowland lakes were lost.

No significant differences were detected between species assemblages of the stocked and the two unstocked lakes. The effects of fish were probably masked by more prominent factors such as forest cover. In the highest lake of the National Park introduced fish coexisted with the only endemic calanoid copepod species *Tropodiaptomus madagascariensis*. This is different from the results obtained from a high-altitude lake of similar size and depth, where native calanoids were eliminated within a decade after stocking (Schabetsberger *et al*., 2009b; see also Knapp *et al*., 2001). Either the lake was stocked fairly recently by carrying fish from the lower lakes uphill, or the copepod can tolerate size-selective fish predation. However, we still postulate that palaeolimnological work would reveal changes within the species communities after fish introduction, especially as the introduced cyprinids, tilapias, and mosquitofish prey on different trophic levels from detritus to algae to insect larvae (Zambrano *et al*., 1999; Fishbase, 2012).

Deforestation and introduction of alien species does not necessarily result in a decrease in species richness. For example, the large belt of *Eichhornia* in Lake Mahery (4) probably decreases the pH to slightly acidic conditions through CO_2 accumulation (Rai and Munshi, 1979), enabling the development of a rich desmid flora surpassing any other sampling site in its diversity. However, the high proportion of taxa that were recorded only once suggests that the single preliminary survey does not warrant a comparison of overall species richness between lakes, especially as the largest crater lake could only be sampled in the outflow.

Similar to other isolated crater lakes on Madagascar, islands of Oceania and in West Africa (Schabetsberger *et al*., 2004, 2009a, c), a large proportion of species were cosmopolitans or widely distributed taxa. Only within the crustaceans did tropicopolitan and afrotropical faunal elements predominate. The Mozambique Channel may not be a barrier for the transport of their propagules with wind, rain and water birds. Truly endemic species were predominantly found within the copepods, which seem to have limited dispersal abilities (Schabetsberger *et al*., 2009c).

On the other hand there is growing evidence that many freshwater algal and micrometazoan morpho-species are actually complexes of cryptic species with more restricted distributions (Gómez *et al*., 2002; Fawley *et al*., 2004; Belyaeva and Taylor, 2009). In addition, some species that could only be determined to genus level may be new endemic taxa. Hence, remote lakes on islands may still harbour comparatively higher proportions of genetically isolated lineages of microorganisms (Schröder and Walsh, 2007). With several species of higher plants and animals on the brink of extinction in Madagascar, conserving potentially undescribed planktonic and benthic organisms has low priority. At present the lakes attract international conservation efforts only if 'flagship' bird species occur (e.g. the Madagascar pochard, *Aythya innotata* (TWSG News, 2006)). With the current state of knowledge it is impossible to understand distribution patterns and the full degree of endemicity in Malagasy freshwater organisms.

Conserving the lakes and their catchments from further deterioration is difficult. The Amber Mountains and their lakes are protected as an internationally recognized National Park, which is the highest status of protection in Madagascar. However, the raiding of the forests is highly organized and well funded, as 1 m^3 of rosewood yields US$ 3000 (Wikipedia, 2012). Encampments of loggers may invite the introduction of alien fish into the last unstocked lake. The eradication of alien fish populations by intensive gill netting and seining (Knapp and Matthews, 1998) might help temporarily to restore more natural conditions in the shallow, already stocked lakes and could be achieved with comparatively little funding. However, as long as some precious timber can leave the country, the remaining forests will be steadily depleted and the impact on lake ecosystems will increase.

The protection of National Parks from illegal timber harvest is difficult and requires frequent controls of armed rangers, which is unrealistic under the current political situation. Owing to international pressure timber exports were banned in 2010 (Bohannon, 2010), but on 18 January 2012 Madagascar's Minister of the Environment has re-authorized the export of 'all categories of natural forest-sourced primary products' (Mongabay, 2012).

Only international loans financing conservation efforts in Madagascar coupled with political pressure may ease the current situation, although it is likely only to slow down the depletion until the trees finally become too scarce to be harvested economically. Subsequently, slash-and-burn agriculture, tree cutting, honey extraction, and bushmeat hunting will commence within the degraded catchments. By then, the Amber Mountains lake communities will resemble those from lowland areas.

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APPENDIX

Freshwater algae, Hydrozoa, Nematoda, Rotifera, Annelida, Copepoda, Cladocera, Ostracoda, and Acari found in the eight lakes of the Amber Mountains National Park (1–8, Table 1) and surroundings and their known distribution (afrotrop. = afrotropical; austral. = Australian; circumtrop. = circumtropical; cosm. = cosmopolitan; holarct. = holarctic; nearct. = nearctic; neotrop. = neotropical; orient. = oriental; palaearct. = palaearctic; tropicopol. = tropicopolitan). Circumtropical: distribution predominantly between the Tropics of Cancer (23°27' N) and Capricorn (23°27′ S); Tropicopolitan: distribution throughout the tropical and subtropical zone (up to app. 34° N and S), but at higher latitudes, if local temperature regimes permit

Group	Species Names	Lake Number	Biogeography
Cyanophyceae	*Anabaena* sp.	1,2,7,	
Cyanophyceae	*Aphanocapsa delicatissima* W. West & G.S. West, 1912	1,3,	cosm.
Cyanophyceae	*Chroococcus limneticus* Lemmermann, 1898	3,	cosm.
Cyanophyceae	*Chroococcus* sp.	1,	
Cyanophyceae	*Cyanodictyon* sp.	2,7,	
Cyanophyceae	*Cyanothece* sp.	2,8,	
Cyanophyceae	*Cylindrospermopsis africana* Komárek & Kling, 1991	1,	afrotrop.?
Cyanophyceae	*Geitlerinema splendidum* (Greville) Anagnostidis, 1989	4,	cosm.
Cyanophyceae	*Merismopedia tenuissima* Lemmermann, 1898	1,	cosm.
Cyanophyceae	*Microcystis aeruginosa* (Kützing) Kützing, 1846	1,2,8	cosm.
Cyanophyceae	*Microcystis comperei* Komárek, 1984	1,	
Cyanophyceae	*Microcystis protocystis* Crow, 1932	8,	circumtrop.
Cyanophyceae	*Microcystis pulverea* (Wood) Forti, 1907	2,8,	cosm.
Cyanophyceae	*Microcystis wesenbergii* (Komárek) Komárek, 1968	1,3,8,	cosm.
Cyanophyceae	*Microcystis* sp.	1,	
Cyanophyceae	*Oscillatoria* sp.	3,	
Cyanophyceae	*Planktolyngbya limnetica* (Lemmermann) J. Komárková-Legnerová & G. Cronberg, 1992	1,2,3,8,	cosm.
Cyanophyceae	*Planktolyngbya undulata* Komárek & Kling, 1991	3,	afrotrop.
Cyanophyceae	*Radiocystis* sp.	2,	
Cryptophyceae	*Chroomonas acuta* Utermöhl, 1925	2,	cosm.
Cryptophyceae	*Cryptomonas tetrapyrenoidosa* Skuja, 1948	2,	cosm.?
Cryptophyceae	*Cryptomonas* sp.	1,	
Dinophyceae	*Gymnodinium* sp.	5,	
Dinophyceae	*Peridiniopsis elpatiewskyi* (Ostenfeld) Bourrelly, 1968	1,3,8,	cosm.?
Dinophyceae	*Peridinium* cf. *pusillum* (Pénard) Lemmermann, 1901	8,	cosm.?
Dinophyceae	*Peridinium volzii* var. *cinctiforme* M.Lefèvre, 1932	2,7,	endemic?
Dinophyceae	*Peridinium* sp. 1	2,3,8,	
Dinophyceae	*Peridinium* sp. 2	1,8,	
Dinophyceae	*Wolozynskia* sp.	5,	
Chrysophyceae	*Mallomonas* sp.	5,	
Chrysophyceae	*Spiniferomonas* sp.	5,	
Bacillariophyceae	*Aulacoseira ambigua* (Grunow) Simonsen, 1979	1,2,8,	cosm.
Bacillariophyceae	*Aulacoseira granulata* (Ehrenberg) Simonsen, 1979	1,3,7,	cosm.
Bacillariophyceae	*Cyclotella meneghiniana* Kützing, 1844	2,	cosm.
Bacillariophyceae	*Cyclotella* sp.	1,	
Bacillariophyceae	*Surirella* sp.	6,	
Bacillariophyceae	*Synedra* sp.	1,8,	
Chlorophyceae	*Ankistrodesmus bernardii* Komárek, 1983	4,	circumtrop.
Chlorophyceae	*Asterococcus* sp.	4,	
Chlorophyceae	*Botryococcus* sp.	2,3,7,	
Chlorophyceae	*Chlamydomonas* sp.	1,	
Chlorophyceae	*Chlorolobion (Ankistrodesmus) braunii* (Nägeli) Komárek, 1979	4,	cosm.

(*Continues*)

(Continued)

Group	Species Names	Lake Number	Biogeography
Chlorophyceae	*Chlorotetraedron incus* (Teiling) Komárek & Kovácik, 1985	1,3,	cosm.
Chlorophyceae	*Coelastrum indicum* W.B. Turner, 1892	4,	tropicopol.
Chlorophyceae	*Coelastrum pulchrum* Schmidle, 1892	1,	
Chlorophyceae	*Coelastrum proboscideum* Bohlin in Wittrock & Nordstedt, 1896	1,	cosm.
Chlorophyceae	*Coelastrum reticulatum* (P.A. Dangeard) Senn, 1899	4,	cosm.
Chlorophyceae	*Coelastrum reticulatum* var. *cubanum* Komárek, 1975	3,8,	circumtrop.
Chlorophyceae	*Coelastrum sphaericum* Nägeli, 1849	3,	cosm.
Chlorophyceae	*Coenococcus* sp.	4,7,8,	
Chlorophyceae	*Crucigenia tetrapedia* W. West & G.S. West, 1902	2,	cosm.
Chlorophyceae	*Dictyosphaerium tetrachotomum* var. *fallax* Komárek, 1983	3,	circumtrop.
Chlorophyceae	*Dictyosphaerium* sp. 1	4,8,	
Chlorophyceae	*Dictyosphaerium* sp. 2	1,	
Chlorophyceae	*Golenkinia* sp.	1,	
Chlorophyceae	*Kirchneriella dianae* (Bohlin) Comas Gonzalez, 1980	1,3,4,	tropicopol.
Chlorophyceae	*Lagerheimia longiseta* (Lemmermann) Printz, 1914	1,	cosm.?
Chlorophyceae	*Lauterborniella* sp.	1,	
Chlorophyceae	*Monoraphidium contortum* (Thuret) Komàrková-Legnerová, 1969	1,2,8,	cosm.
Chlorophyceae	*Oocystis borgei* J.Snow, 1903	2,	cosm.
Chlorophyceae	*Oocystis* sp.	4,8,	
Chlorophyceae	*Pandorina morum* (O.F. Müller) Bory de Saint-Vincent, 1824	4,	cosm.
Chlorophyceae	*Pediastrum duplex* Meyen, 1829	1,2,5,	cosm.
Chlorophyceae	*Pediastrum duplex* var. *echinatum* C.C. Jao, 1947	1,	cosm.?
Chlorophyceae	*Pediastrum simplex* Meyen, 1829	3,	cosm.
Chlorophyceae	*Pediastrum tetras* (Ehrenberg) Ralfs, 1844	1,2,4,8,	cosm.
Chlorophyceae	*Pseudodictyosphaerium elegans* (Bachmann) Hindák, 1988	4,5,	cosm.
Chlorophyceae	*Scenedesmus acuminatus* (Lagerheim) Chodat, 1902	1,2,	cosm.
Chlorophyceae	*Scenedesmus armatus* (R. Chodat) R. Chodat, 1913	1,	
Chlorophyceae	*Scenedesmus brasiliensis* Bohlin, 1897	2,	cosm.
Chlorophyceae	*Scenedesmus opoliensis* P.G. Richter, 1897	2,3,	cosm.
Chlorophyceae	*Scenedesmus tropicus* W.B. Crow, 1923	1,	tropicopol.
Chlorophyceae	*Scenedesmus* sp. 1	3,8,	
Chlorophyceae	*Scenedesmus* sp. 2	1,	
Chlorophyceae	*Scourfieldia* sp.	1,8,	
Chlorophyceae	*Sorastrum* sp.	4,	
Chlorophyceae	*Tetraedron minimum* (A.Braun) Hansgirg, 1888	1,8,	cosm.
Chlorophyceae	*Tetrastrum staurogeniaeforme* (Schröder) Lemmermann, 1900	1,7,	cosm.?
Zygnematophyceae	*Bambusina brebissonii* Kützing, 1945	4,	cosm.
Zygnematophyceae	*Closterium dianae* var. *arcuatum* (Brébisson ex Ralfs) Rabenhorst, 1868	2,	cosm.
Zygnematophyceae	*Closterium ehrenbergii* Meneghini ex Ralfs, 1848	4,	cosm.
Zygnematophyceae	*Closterium lineatum* Ehrenberg ex Ralfs, 1848	4,	cosm.
Zygnematophyceae	*Closterium parvulum* Nägeli, 1849	4,	cosm.
Zygnematophyceae	*Closterium ralfsii* Brébisson ex. Brébisson in Ralfs, 1848	4,	cosm.
Zygnematophyceae	*Closterium setaceum* Ehrenberg ex Ralfs, 1848	4,	cosm.
Zygnematophyceae	*Cosmarium binum* Nordstedt in Wittrock & Nordstedt, 1880	4,	cosm.
Zygnematophyceae	*Cosmarium contractum* var. *minutum* (Delponte) Coesel, 1989	1, 4, 8,	cosm.
Zygnematophyceae	*Cosmarium depressum* (Nägeli) P.Lundell, 1871	1,	cosm.
Zygnematophyceae	*Cosmarium nudum* (W.B. Turner) Gutwinski, 1902	4,	tropicopol.
Zygnematophyceae	*Cosmarium pygmaeum* W.Archer, 1864	3,8,	cosm.
Zygnematophyceae	*Cosmarium quadrum* var. *sublatum* (Nordstedt) W. West & G.S. West, 1912	4,	cosm.
Zygnematophyceae	*Cosmarium* spyridion W. West & G.S. West, 1895	1,4,	endemic?
Zygnematophyceae	*Cosmarium* sp. 2	2,	
Zygnematophyceae	*Cosmarium* sp. 3	4,	endemic?
Zygnematophyceae	*Cylindrocystis* sp.	1,2,	
Zygnematophyceae	*Euastrum didelta* Ralfs ex Ralfs, 1848	4	cosm.
Zygnematophyceae	*Euastrum elegans* var. *madagascariense* W. West & G.S. West, 1895	4	cosm.?
Zygnematophyceae	*Euastrum humerosum Ralfs, 1848*	4	cosm.
Zygnematophyceae	*Euastrum praemorsum* (Nordstedt) Schmidle, 1898	4,	cosm.
Zygnematophyceae	*Euastrum* sp.	1,4,5,	
Zygnematophyceae	*Gonatozygon* sp.	4,	
Zygnematophyceae	*Micrasterias anomale* Turner, 1892	4,	tropicopol.
Zygnematophyceae	*Micrasterias crux-melitensis* (Ehrenberg) Hassall ex Ralfs, 1848	4,	cosm.
Zygnematophyceae	*Micrasterias decemdentata* (Nägeli) W.Archer, 1861	4,	cosm.
Zygnematophyceae	*Micrasterias truncata* var. *africana* F.E. Fritsch & M.F. Rich, 1924	4,	tropicopol.
Zygnematophyceae	*Mougeotia* sp.	4,	
Zygnematophyceae	*Pleurotaenium ehrenbergii* (Brébisson ex Ralfs) Delponte, 1878	4,	cosm.

(*Continues*)

(Continued)

Group	Species Names	Lake Number	Biogeography
Zygnematophyceae	*Pleurotaenium ovatum* Nordstedt, 1877	4,	tropicopol.
Zygnematophyceae	*Pleurotaenium trabecula* var. *rectum* (Delponte) W. West & G.S. West, 1904	4,	cosm.
Zygnematophyceae	*Staurastrum brachiatum* Ralfs ex Ralfs, 1848	8,	cosm.
Zygnematophyceae	*Staurastrum ceylanicum* W. West & G.S. West, 1902	2,	orient.
Zygnematophyceae	*Staurastrum ellipticum* West, 1892	8,	cosm.
Zygnematophyceae	*Staurastrum gracile* var. *coronulatum* Boldt, 1885	8,	cosm.
Zygnematophyceae	*Staurastrum inflexum* Brébisson, 1856	4,	cosm.
Zygnematophyceae	*Staurastrum johnsonii* W. West & G.S. West, 1896	1,	cosm.
Zygnematophyceae	*Staurastrum leptocladum* Nordstedt, 1869	4,	tropicopol.
Zygnematophyceae	*Staurastrum muticum* Brébisson ex Ralfs, 1848	2,7,	cosm.
Zygnematophyceae	*Staurastrum orbiculare* var. *ralfsii* W. West & G.S. West, 1912	4,	cosm.
Zygnematophyceae	*Staurastrum sebaldi* var. *ornatum* Nordstedt, 1873	8,	cosm.
Zygnematophyceae	*Staurastrum* sp. 1	1,8,	
Zygnematophyceae	*Staurastrum* sp. 2	1,7,	
Zygnematophyceae	*Staurastrum* sp. 3	2,	
Zygnematophyceae	*Staurastrum* sp. 4	1,7,	
Zygnematophyceae	*Staurastrum* sp. 5	1,	
Zygnematophyceae	*Staurastrum subavicula* (West) W. West & G.S. West, 1894	4,	cosm.
Zygnematophyceae	*Staurastrum tetracerum* Ralfs ex Ralfs, 1848	1,3,8,	cosm.
Zygnematophyceae	*Staurodesmus dejectus* (Brébisson) Teiling, 1967	1,	cosm.
Zygnematophyceae	*Staurodesmus* sp. 1	3,	
Zygnematophyceae	*Staurodesmus* sp. 2	1,	
Euglenophyceae	*Euglena* sp. 1	5,	
Euglenophyceae	*Euglena* sp. 2	4,5,	
Euglenophyceae	*Euglena* acus (O.F.Müller) Ehrenberg, 1830	5,	
Euglenophyceae	*Phacus curvicauda* Svirenko, 1915	3,4,	cosm.
Euglenophyceae	*Phacus* sp.	5,	
Euglenophyceae	*Strombomonas* sp.	4,	
Euglenophyceae	*Trachelomonas horrida* Palmer, 1905	4,	cosm.
Euglenophyceae	*Trachelomonas volvocina* Ehrenberg, 1833	1,2,	cosm.
Euglenophyceae	*Trachelomonas* sp.	3,4,5,7,8,	
Xanthophyceae	*Goniochloris fallax* Fott, 1960	5,	cosm.?
Xanthophyceae	*Trochiscia* sp.	3,	
Hydrozoa	*Hydra viridissima* Pallas, 1766	4,	cosm.
Nematoda	*Achromadora micoletzkyi* Stefanski, 1915	7,	cosm.
Nematoda	*Crocodorylaimus flavomaculatus* (Linstow, 1876)	2,3,4,5,7,8,	cosm.
Nematoda	*Cryptonchus* sp.	2,	
Nematoda	*Dorylaimus* cf. *stagnalis* Dujardin, 1845	7,	cosm.
Nematoda	*Eumonhystera* cf. *gerlachi* (Meyl, 1954)	5,	Europe
Nematoda	*Ironus ignavus* Bastian, 1865	7,	cosm.
Nematoda	*Ironus tenuicaudatus* De Man, 1876	2,7,8,	palaearct., afrotrop., orient.
Nematoda	*Mesodoryilaimus* cf. *subtiloides* (Paetzold, 1958)	2,5,7,	Europe
Nematoda	*Mesodorylaimus* sp. 1	2,	
Nematoda	*Mesodorylaimus* sp. 2	2,	
Nematoda	*Monhystera* cf. *paludicola* De Man, 1881	8,	cosm.
Nematoda	*Monhystrella* cf. *paramacrura* (Meyl, 1953)	7,	palaearct., afrotrop., orient.
Nematoda	*Mononchus* cf. *aquaticus* Coetzee, 1968	8,	cosm.
Nematoda	*Mylonchulus lacustris* (Cobb, 1915)	2,3,7,	palaearct., afrotrop., orient., nearct., neotrop.
Nematoda	*Neoactinolaimus duplicidentatus* (Andrássy, 1968)	2,3,7,	palaearct., afrotrop.
Nematoda	*Neotobrilus longus* (Leidy, 1852)	7,	palaearct., afrotrop., orient., nearct., neotrop.
Nematoda	*Oncholaimus* cf. *oxyuris* Ditlevsen, 1911	7,	brackish water
Nematoda	*Plectus* cf. *pusillus* Cobb, 1893	7,	palaearct., afrotrop., austral., nearct., neotrop.
Nematoda	*Prodorylaimus* sp.	7,	
Nematoda	*Rhabdolaimus aquaticus* De Man, 1880	2,	cosm.
Nematoda	*Rhabdolaimus terrestris* De Man, 1880	5,	cosm.
Nematoda	Species 1	5,	
Nematoda	*Tobrilus helveticus* (Hofmänner, 1914)	2,4,5,7,	palaearct.
Rotifera	*Anuraeopsis fissa* Gosse, 1851	1,5,6,8,	cosm.
Rotifera	*Anuraeopsis navicula* Rousselet, 1911	2,3,8,	cosm.
Rotifera	*Asplanchna* cf. *brightwellii* Gosse, 1850	3,	cosm.
Rotifera	*Brachionus angularis* Gosse, 1851	1,3,8,	cosm.
Rotifera	*Brachionus falcatus* Zacharias, 1898	1,2,5,6,7,8,	cosm.
Rotifera	*Brachionus quadridentatus* Hermann, 1783	3,7,8,	cosm.
Rotifera	*Cephalodella* sp.	8,	

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Group	Species Names	Lake Number	Biogeography
Rotifera	*Colurella* sp.	7,	
Rotifera	*Conochilus* sp.	7,	
Rotifera	*Dicranophorus tegillus* Harring & Myers, 1928	4,	nearc., orient.
Rotifera	*Epiphanes* cf. *clavulata* (Ehrenberg, 1831)	5,	cosm.
Rotifera	*Euchlanis* sp.	4,	
Rotifera	*Filinia opoliensis* (Zacharias, 1898)	7,8,	cosm.
Rotifera	*Lepadella (H.) ehrenbergi* (Perty, 1850)	7,	cosm.
Rotifera	*Hexarthra intermedia* Wiszniewski, 1929	1,5,7,8,	cosm.
Rotifera	*Keratella procurva* (Thorpe, 1891)	6,7,	cosm.? (excl. nearct.)
Rotifera	*Keratella valga* (Ehrenberg, 1834)	2,8,	cosm.
Rotifera	*Lecane curvicornis* (Murray, 1913)	4,5,	cosm.
Rotifera	*Lecane bulla* (Gosse, 1851)	4,5,7,8,	cosm.
Rotifera	*Lecane aculeate* (Jakubski, 1912)	3,4,5,6,	cosm.
Rotifera	*Lecane closterocerca* (Schmarda, 1859)	5,7,	cosm.
Rotifera	*Lecane furcata* (Murray, 1913)	4,7,8,	cosm.
Rotifera	*Lecane hamata* (Stokes, 1896)	4,5,6,7,	cosm.
Rotifera	*Lecane hornemanni* (Ehrenberg, 1834)	2,3,	cosm.
Rotifera	*Lecane inermis* (Bryce, 1892)	3,4,5,7,	cosm.
Rotifera	*Lecane inopinata* Harring & Myers, 1926	7,	cosm.
Rotifera	*Lecane luna* (Müller, 1776)	4,8,	cosm.
Rotifera	*Lecane lunaris* (Ehrenberg, 1832)	2,	cosm.
Rotifera	*Lecane nana* (Murray, 1913)	4,	cosm.
Rotifera	*Lecane pyriformis* (Daday, 1905)	4,6,7,	cosm.
Rotifera	*Lecane quadridentata* Ehrenberg, 1830	4,	cosm.
Rotifera	*Lecane* cf. *ruttneri* Hauer, 1938	6,	afrotr., orient., neotr.
Rotifera	*Lecane signifera* (Voigt, 1902)	4,	cosm.
Rotifera	*Lecane thienemanni* (Hauer, 1938)	6,	afrotrop., orient., austr., neotr.
Rotifera	*Lecane unquitata* (Fadeew, 1925)	4,7,	eastern hemisphere
Rotifera	*Lecane* spp.	4,	
Rotifera	*Lepadella patella* (Müller, 1773)	2,4,7,	cosm.
Rotifera	*Lepadella* sp.	5,	
Rotifera	*Lepadella quinquecostata* (Lucks, 1912)	4,	cosm.
Rotifera	*Macrochaetus collinsii* (Gosse, 1867)	4,	cosm.
Rotifera	*Mytilina ventralis* (Ehrenberg, 1832)	4,7,	cosm.
Rotifera	*Mytilina* sp.	4,	
Rotifera	*Platyias leloupi* Gillard, 1957	4,5,	pres. cosm. (excl. palaearct.)
Rotifera	*Polyarthra indica* Segers & Babu, 1999	5,6,	afrotrop., orient., pacific
Rotifera	*Polyarthra vulgaris* Carlin, 1943	1,3,	cosm.
Rotifera	*Polyarthra* sp.	4,5,	
Rotifera	*Scaridium* sp.	4,	
Rotifera	*Testudinella incisa* (Ternetz, 1892)	3,8,	cosm.
Rotifera	*Testudinella patina* (Hermann, 1783)	4,5,8,	cosm.
Rotifera	*Trichocerca* cf. *pusilla* (Jennings, 1903)	1,3,	cosm.
Rotifera	*Trichocerca chattoni* (De Beauchamp, 1907)	1,	cosm.
Rotifera	*Trichocerca* cf. *rattus* (Müller, 1776)	5,6,	cosm.
Rotifera	*Trichocerca similis* (Wierzejski, 1893)	1,	cosm.
Rotifera	*Trichocerca tigris* (Müller, 1786)	4,	cosm.
Rotifera	*Trichocerca* sp.	2,5,8,	
Rotifera	*Trichotria tetractis* (Ehrenberg, 1830)	2,	cosm.
Oligochaeta	*Dero (Aulophorus) hymanae* Naidu, 1962	3,	Southern India
Oligochaeta	*Chaetogaster crystallinus* Vejdovsky, 1883	7,	palaearct., afrotrop., orient., nearct.
Oligochaeta	*Nais africana* Brinkhurst, 1966	7,8,	afrotrop.
Oligochaeta	*Nais pseudoobtusa* Piguet, 1906	3,	palaearct., afrotrop., orient., nearct., neotrop.
Oligochaeta	*Nais simplex* Piguet, 1906	3,7,	palaearct., afrotrop., orient., nearct.
Oligochaeta	*Nais* sp. 1	3,	endemic?
Oligochaeta	*Nais* sp. 2	3,	
Oligochaeta	*Nais* sp. 3	3,	
Oligochaeta	*Pristina aequiseta* Bourne, 1891	3,	cosm.
Oligochaeta	*Pristina proboscidea* Beddard, 1896	7,	palaearct., orient., austral., neotrop.
Oligochaeta	*Vejdovskyella comata* (Vejdovsky, 1883)	3,	palaearct., afrotrop., orient., nearct.
Hirudinea	*Alboglossiphonia heteroclita* (Linnaeus, 1761)	7,	palaearct., nearct.
Copepoda	*Elaphoidella bidens* (Schmeil, 1894)	3,8,	cosm.
Copepoda	*Elaphoidella grandidieri* Guerne & Richard, 1893	3,	afrotrop., orient., pacific, neotr.
Copepoda	*Elaphoidella* sp.	4,8,	
Copepoda	*Epactophanes richardi* Mrazek, 1893	7,	cosm.
Copepoda	*Cryptocyclops linjanticus* (Kiefer, 1928)	4,5,	afrotrop., orient., holarct. (aralo-caspian and mediterranean)

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Group	Species Names	Lake Number	Biogeography
Copepoda	*Ectocyclops hirsutus* (Kiefer, 1930)	4,	afrotrop.
Copepoda	*Mesocyclops insulensis* Dussart, 1982	8,	endemic
Copepoda	*Mesocyclops pilosus* (Kiefer,1930)	1,2,3,7,8,	endemic
Copepoda	*Microcyclops* cf. *varicans* (Sars, 1863)	3,4,5,7,	cosm.
Copepoda	*Paracyclops* sp.	7,8,	Genus cosmopolitan
Copepoda	*Thermocyclops* cf. *crassus* (Fischer, 1853)	5,	cosm.
Copepoda	*Thermocyclops decipiens* (Kiefer, 1929)	1,4,	cosm.
Copepoda	*Thermocyclops neglectus* (Sars, 1909)	6,	afrotrop.
Copepoda	*Tropocyclops* cf. *tenellus* (Sars, 1909) sensu Lindberg (1952)	8,	afrotrop., endemic?
Copepoda	*Tropodiaptomus (Anadiaptomus) madagascariensis poseidon* Brehm, 1952	2,7,	endemic
Cladocera	*Alona cambouei* Guerne & Richard, 1893	4,7,	circumtrop., eastern hemisphere
Cladocera	*Alona guttata* Sars, 1862	8,	cosm., species group
Cladocera	*Anthalona harti harti* Van Damme, Sinev & Dumont, 2011	4,7,	afrotrop.
Cladocera	*Ceriodaphnia cornuta* Sars, 1885	2,4,	tropicopol.
Cladocera	*Ceriodaphnia laticaudata* P.E. Müller, 1867	4,	cosm.
Cladocera	*Chydorus sphaericus* (O.F. Müller, 1785)	4,	cosm., species group
Cladocera	*Daphnia laevis* Birge, 1879	2,7,8,	tropicopol.; North, South America and Africa only
Cladocera	*Dunhevedia serrata* Daday, 1898	4,5,	tropicopol.
Cladocera	*Euryalona orientalis* (Daday, 1898)	4,	tropicopol.
Cladocera	*Ilyocryptus spinifer* Herrik, 1882	5,8,	tropicopol.
Cladocera	*Karualona socotrana* Dumont & Silva-Briano, 2000	5,	afrotrop., Sokotra
Cladocera	*Kurzia longirostris* (Daday, 1898)	5,	circumtrop., eastern hemisphere
Cladocera	*Leberis diaphanus* (King, 1853)	2,	circumtrop., eastern hemisphere
Cladocera	*Macrothrix spinosa* King, 1853	3,4,5,	tropicopol.
Cladocera	*Moinodaphnia macleayi* (King, 1853)	4,	torpicopol.
Cladocera	*Notoalona globulosa* (Daday, 1898)	5,	circumtrop.
Ostracoda	*Cryptocandona* sp.	2,	palaearct., introduced?
Ostracoda	*Cypretta* cf. *seurati* Gauthier, 1929	4,	palaerct., neotrop., orient., pacific
Ostracoda	*Cypria* cf. *lenticularis* G.W. Müller, 1898	7,	afrotrop.
Ostracoda	Cyprididae *Gen.* sp.	8,	
Ostracoda	*Gomphocythere obtusata* Sars, 1910	7,8,	afrotrop.
Ostracoda	*Nealecypris obtusa* (Klie, 1933)	1,4,	afrotrop.
Ostracoda	*Potamocypris* sp.	2,	
Ostracoda	*Zonocypris costata* (Vávra, 1897)	2,7,	palaearct., afrotrop.
Acari	*Tactocepheus* cf. *velatus* (Michael, 1880)	2,	cosm.
Acari	*Trhypochtoniellus longisetus* (Berlese) f. *setosus* Willmann, 1928	2,	cosm.
Acari	*Punctoribates* sp.	3,	