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Poster abstracts

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Genetic variation in the Mexican species of *Rhamdia* using allozymic data

Twenty *Rhamdia guatemalensis* samples from South Mexican populations were examined as well as two of *R. parryi*, and three of *R. laticauda* with starch gel electrophoresis. Twenty-four loci were analysed as being all polymorphic. UPGMA and Wagner methods arrived at congruent clusterings with identical groups. The first grouping which showed two diagnostic loci, included the two samples of *R. parryi.* These samples which were clearly discriminated from the rest of the samples also showed high differentiation between them ($D=0{\cdot}37$). Samples of *R. laticauda* were also clustered in an independent group. High genetic distances, and one exclusive allele supported this group as a different species. The third group was composed of all samples of *R. guatemalensis* which were divided clearly in two subsets: the first included samples from the Atlantic slope, and the second mostly samples from the Pacific versant.

Baric, S. & Sturmbauer, C. (*Department of Zoology, University of Innsbruck, Austria*).

Comparative analysis of genetic differentiation in populations of *Tropheus* demonstrate a drop in water level of Lake Tanganyika in the very recent past

The most variable segment of the mitochondrial control region were sequenced from several isolated populations of the genus *Tropheus* from different localities of Lake Tanganyika. Populations from opposite shores situated at shallow border sections of the lake basins were closely related to each other. Individuals from the eastern and western shoreline differed by a minimum of 1–2 point mutations in the very north and south of the lake; identical genotypes among individuals from the eastern and the western shorelines were found in the lake's central region. Since *Tropheus* is strictly confined to rock habitats and is unable to cross larger distances of open water, the observed complete DNA sequence identity in the mitochondrial control region can be explained only by a dramatic drop of the lake level, forming a continuous band of shallow rock habitats across the lake. The consistently low amount of genetic variation suggests that this event must have happened more recently than indicated by geology-based estimations, probably around or even less than 10 000 years ago. Populations of several other stenotopic rock cichlids must have also been affected similarly.

Beeching, S. C. (*Department of Biology, Slippery Rock University, Slippery Rock, PA 16057, U.S.A.*).

Male mate choice and female aggression in the convict cichlid

Male mate choice in *Cichlasoma nigrofasciatum* was investigated using a three-way choice apparatus in the laboratory. Males did not exhibit selectivity on the basis of

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female colour, but were found to prefer larger females. Male mate choice in convict cichlids increases male reproductive success, since larger females are generally more fecund. Analysis of the temporal dynamics of male mate choice in the three-way choice apparatus reveals that males continue to consort with the smaller females when available. Thus the female–female aggression observed in the laboratory may benefit females by limiting their loss of male parental investment to other, unpaired females.

Breden, F., Wu, S. S. T. & Taylor, J. (*Department of Biological Sciences, Simon Fraser University, Burnaby, BC V5A 1S6*).

A population phylogeny of sexually selected characters in the Trinidad guppy

Data from four microsatellite loci (variation in length of repeat flanking sequence), mitochondrial D-loop, and allozyme loci were combined to examine the phylogeography of 16 populations studied extensively for variation in female preference and attractive male characters. Initial results show that these characters have most likely evolved independently in populations, and that upstream sites (high coloration/high female preference) have been colonized from corresponding downstream sites within streams.

Chifamba, P. C. (*University Lake Kariba Research Station, P.O. Box 46, Kariba, Zimbabwe*).

Spatial and seasonal fluctuations in body size and condition of *Limnothrissa miodon* in Lake Kariba

The body length and weight of the sardine *L. miodon* was analysed to determine seasonal and spatial variation and the condition and size distribution of fish in the commercial catches. Samples were taken at fortnightly intervals from the commercial catches in the Sanyati basin between 1986 and 1997. To assess spatial variation, samples from 14 sites along the length of Lake Kariba were taken using a small commercial lift net between 1989 and 1991. There were spatial, seasonal and year-to-year variations in the size and condition of the sardines. Spatial differences in condition were related to spatial variation in zooplankton abundance and water transparency. Recruitment periods were established from the changes in the size of small fish in the fishery and changes in mean fish length. Recruitment varied seasonally with the least recruitment levels between September and November. Based on the age of fish at recruitment this period of least recruitment coincided with the winter months where low winter temperatures could affect survival of juvenile fish.

Costa, Fabio E. S. (*Unesp/Departamento de Zoologia, Av. 24-A n. 1515, Bela Vista 13506-900, Rio Claro, SP, Brazil*) & Braga, F. M. de S. (*Unesp/Caunesp, Av. 24-A n. 1515, Bela Vista 13506-900, Rio Claro, SP, Brazil*).

The yellowfin tuna fishery of Santos longliners, Brazil

The total annual catches, and the monthly averages of catches of *Thunnus albacares* caught by longliners settled in Santos in 1971–1995 were analysed according to weight. The yellowfin total catch in Brazil is around 3500 t year^{-1} (10% of total yellowfin caught catch in the West Atlantic, 4% of the total Atlantic catch). The Santos' fleet catches correspond to about 10% of the total yellowfin caught by longliners in Brazil. The annual total catch of yellowfin by Santos' fleet decayed from 615 t in 1979 (90% of total catch) to 75 t in 1995 (5% of total catch). The main catches of yellowfin happen in hot months (September to April), and in cold waters months, albacore's and bigeye's catches prevail. The annual average catch per unit effort (cpue) of yellowfin decreased from 48 in 1972 to 3·1 kg 100 hooks^{-1} in 1991, and 3·3 kg 100 hooks^{-1} in 1995. The largest values of monthly cpue occurs in November and December (20 kg 100 hooks^{-1}), and the smallest in months of cold waters, April–May (6 kg 100 hooks^{-1}). Finally, comparing cpue of the

two fishing gears for yellowfin, it is observed that the efficiency of superficial longline is significantly superior ($P<0{\cdot}01$) when compared to Japanese longline, showing a catch efficiency of between 4.5 and 20 times better than the regular.

de Merona, B. *[ORSTOM, B.P. 165, 97323, Cayenne Cedex, France (French Guiana)]* & Rankin de Merona, J. (*INPA, C.P. 478, 69011, Manaus, AM, Brazil*).

Resource partitioning in fish assemblage from the Amazon floodplain

Between 1986 and 1988, fish were collected bimonthly by gillnets in a floodplain lake of about 100 km^2. Of 136 species registered, 87, representing more than 99% of the total number of specimens captured were analysed for stomach content. A cluster analysis allowed the identification of nine feeding guilds, some of them containing a large number of species. The overall overlap value in the assemblage was low, showing the efficiency of food partionning. However, mean intra-guild overlap value was high and other resource partitionning mechanism is expected to occur. Confidence analysis of habitat partitioning showed that some guilds exhibited a restricted distribution while others occupied the whole space sometimes with horizontal displacements between habitats. It is concluded that space partitioning is also an important mechanism for coexistence of species in these very rich communities, and time partitioning is investigated about.

do Amaral, M. F., Aranha, J. M. R. & de Menezes, M. S. (*Departamento de Zoologia, Universidade Federal do Parana, CP 19020, CEP 81531-990, Curitiba, Parana, Brazil*).

Age and growth of *Pimelodella pappenheimi* (Siluriformes, Pimelodidae) from an Atlantic forest stream in southern Brazil

Pimelodella pappenheimi were collected from September 1995 to February 1997 from das Pombas stream (southern Brazil), a coastal stream susceptible to the flash floods. Total length and weight were measured, as were the otoliths. The Ford–Walford transformation showed that the data were adjusted to a line with $r^2=0{\cdot}9735$ and it allowed the von Bertallanffy expression use. The pale ring formation is annual, and it occurs between the summer and the autumn. It was coincident with the end of the reproductive period. The biggest collected fish had 15 cm of total length which corresponds to about 4 years old. It is found that this species grows in length according to $L_t=15{\cdot}86(1-e^{-0{\cdot}57(t+0{\cdot}1551)})$ and in weight according to $W_t=24{\cdot}23(1-e^{-0{\cdot}57(t+0{\cdot}1551)})^{3{\cdot}12}$. The increase in length is faster until year 2 of life, whereas the increase in weight is more notable between years 1 and 4.

Du Feu, T. & Omorinkoba, W. [*Nigerian-German (GTZ) Kainji Lake Fisheries Promotion Project, c/o Deutsche Botschaft Lagos, Nigeria, Postfach 1148, 53001 Bonn, Germany*].

The fishery of Kainji Lake, Nigeria: its present status

Annual fish yield estimates in Kainji Lake peaked at 28 639 t during 1970, then declined to 4500 t in 1978. Recent studies of the fishery by the Nigerian–German (GTZ) Kainji Lake Fisheries Promotion Project estimate that there are now 7623 canoes with 5772 fishing entrepreneurs and 7136 fishing assistants operating. Yield estimates from a gear based catch assessment survey by the project gave a total fish yield of 28 753 t in 1997. The increase in yield is due to the diversification of fishing methods, and in particular, the development of a large beach seine fishery targeting the clupeid stocks, which contributed 39% of the 1997 yield. Other fisheries include the gillnet fishery

(contributing 26%), the cast-net fishery (12%), the trap fishery (12%), the drift-net fishery (6%) and the longline fishery (5%). The large array of fishing methods and mesh sizes used target almost all species on the lake. Because of the small mesh sizes most fish caught on the lake are juveniles from the first year cohorts. Since reaching a peak of 38 246 t in 1996 the fish yield has declined due to a fall in the beach seine catch. There has also been a steady decline in gear ownership by the fishing entrepreneurs since 1993.

Dulvy, N., Reynolds, J. & Metcalfe, J. (*University of East Anglia, Norwich, Norfolk, U.K.*).

Predicting vulnerability to exploitation by linking life histories to population dynamics

This study found that population trends (declines and increases) of five skate species can be predicted by the maximum size of each species. Such data are easy to obtain and provide a reasonable surrogate measure of a species life history. This approach could be applied to other fisheries where life-history data are limited, e.g. tropical reef fisheries.

Evans, J. & Matthews, I. (*School of Environmental Sciences, University of St Andrews, Bute Building, St Andrews, KY16 9TS, Scotland*).

Does male sexual behaviour reliably signal sexual fertility in guppies?

Past work has uncovered a positive association between a male guppy's mating behaviour (sigmoid displays and gonopodial thrusting) and the size of his ejaculate. This study tested if this relationship is maintained throughout the reproductive lifespan of the male, in order to establish whether the male courtship activity can reliably signal fertility. The study is on-going and preliminary results are presented.

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A biodiversity reference centre in Ghana for West African fresh and brackish water fish

Fish is a most appropriate commodity for which to establish a sub-regional centre for scientific study. It is proposed that such a centre established for West Africa in collaboration with the international community and institutions in developed countries, would concentrate efforts at one location in this sub-region. The main objectives of this project are: to build and maintain in Ghana, a biodiversity reference centre for West African fresh and brackish water fishes, through collaborative research and training programs; to train West African scientists in fish systematics and biodiversity research approaches and to apply of the acquired knowledge to conservation and sustainable exploitation strategies; to establish a long-term collaboration between advanced countries institutions and the proposed new centre, for its establishment, further development and provision of research, training and information services to the sub-region; to encourage studies on the conservation and sustainable use of fish as a major resource of the

sub-region; to enhance biodiversity knowledge to the sustainable development of wild and cultured fishes; and to develop and establish local, national and sub-regional networks, among African regional institutions for joint study on fish biodiversity and on the conservation and sustainable exploitation of fish resources. The first joint mission has been held on the Bia basin (Côte d'Ivoire/Ghana). The results and the data collected are presented in this poster.

Genner, M. J., Turner, G. F. (*Division of Biodiversity and Ecology, School of Biological Sciences, University of Southampton, Southampton, SO16 7PX, U.K.*), Barker, S. (*Biomedical Mass Spectrometry Unit, The Dental School, Framlington Place, University of Newcastle, Newcastle Upon Tyne, NE2 4HH, U.K.*) & Hawkins, S. J. (*Division of Biodiversity and Ecology, School of Biological Sciences, University of Southampton, Southampton, SO16 7PX, U.K.*).

Niche partitioning among Lake Malawi cichlids? Evidence from stable isotope signatures

It is still unknown how so many ecologically similar species can coexist in Lake Malawi. Most previous studies have concluded that coexistence is achieved through fine-scale division of habitat and food resources. Using a combination of stable isotope and stomach content analysis this study examined whether any true dietary segregation takes place between three sympatric rocky shore cichlids of the *Pseudotropheus* (Maylandia) subgenus at Nkhata Bay, on the north-western shores of the lake. These species are almost indistinguishable anatomically, but differ in body coloration. All three species feed upon both epilithic algae and plankton. Carbon and nitrogen isotope ratios were used as tracers of diet because they represent an accumulation of the isotopic signatures of food over a period of weeks to years. The results demonstrated that there was considerable interspecific overlap of isotopic signatures and stomach contents. However, many differences were statistically significant in pair-wise comparisons. It is concluded that there are real long-term differences between the foraging strategies of the three species, but on a day-to-day basis there is little or no true dietary segregation. Dietary segregation may not be necessary for their coexistence.

Goodwin, N. B. (*School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ, U.K.*), Balshine-Earn, S. (*KLIVV, A-1160 Savoyenstrasse 1A, Vienna, Austria*) & Reynolds, J. D. (*School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ, U.K.*).

Evolutionary transitions in parental care in cichlid fishes

This study examined evidence for evolutionary pathways among forms of parental care. This hypothesis and others were tested by evolutionary changes between parental care states were constructed and a composite phylogeny based on morphological and molecular evidence was used to trace two sets of characters: form of care (substrate guarding and mouthbrooding) and sex of care giver (biparental, female only, and male only). The evidence suggested the hypothesis that mouthbrooding evolved from ancestral substrate guarding, with 10–14 transitions and zero to three reversals. The data also support the hypothesized transitions in sex of care giver, with uniparent one female care having arisen from biparental care 21–29 times, with zero to nine reversals. Male-only care evolved independently from biparental once, and once from female care. These transitions in parental care characters are the most numerous reported for any family of vertebrates and provide the first quantitative support for models and hypotheses of parental care evolution.

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Mitochondrial phylogeny of the tropheini, an endemic lineage of rock cichlids in Tanganyika

A total of 1300 base pairs was sequenced, including a segment of the mitochondrial cytochrome b and the complete control region of nine genera and 21 species presently assigned to the Tanganyikan tribe Tropheini. In agreement with a previous study, *Cyphotilapia frontosa* forms a separate and ancient Tanganyikan lineage. The genus *Gnathochromis* was resolved paraphyletically in that *G. pfefferi* was identified as a member of the Tropheini, while *G. permaxillaris* appears to be a member of the Limnochromini. Further, *Ctenochromis hoorii* was also resolved within the Tropheini. Most surprisingly, however, the morphologically well-defined genera *Petrochromis* and *Tropheus* were resolved paraphyletically, suggesting that specialization to unicellular or filamentous algae must have evolved more than once within the *Tropheini*.

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Annotated species lists for coral reef fish throughout Belize (Central America): the current status

The Coral Cay Conservation survey programme in Belize has generated extensive fish species lists for many areas of the country. This study presents the current status of fish species lists from the Bacalar Chico Marine Reserve, South Water Cay Marine Reserve, Sapodilla Cays Marine Reserve and from Turneffe Atoll and the Snake Cays. New species records for Belize include the toadfish (*Sanopus splendidus*) which was observed at Turneffe Atoll although it was previously thought to be restricted to Cozumel, Mexico. Each species list has been annotated where possible with details of the species' abundance, ecology (such as habitat association) and distribution. A total list for the whole of Belize is also presented including notes on species occurring outside the five main survey sites. This study also compares the species lists from the five areas examined and highlights the importance of accurate species lists for aiding the management and design of new marine protected areas. Finally, the conservation of reef fish diversity within Belize's network of marine reserves is discussed.

Idid, M. & Carvalho, G. R. (*Molecular Ecology & Fisheries Genetics Laboratory, University of Hull, HU6 7RX, Hull, U.K.*).

Phylogenetics of Lake Malawi cichlids: molecular support for classifications by Malaysian patterns

The species flock of cichlid fishes in Lake Malawi represents one of the most extreme examples of adaptive radiation and explosive speciation. This species assemblage is the

most speciose and diverse, morphologically, ecologically and behaviourally among vertebrates. Although they exhibit an abundance of morphological homoplasies, their evolutionary relationships can sufficiently be reconstructed by implementing molecular phylogenetic approaches. With improvements in DNA sequence analyses in molecular systematics, attempts to reconstruct phylogenetic trees of the Lake Malawi cichlids are currently being made. These phylogenetic trees are based on complete mtDNA sequences of the control region (D-loop) and the mitochondrially encoded ND2 gene. Results pertaining to the information about ancestral lineages of the flock, sequence divergence of the various lineages and their life histories are presented. Comparisons are made to ascertain the relative efficiency of the two chosen regions in resolving the cichlid phylogenies. Apart from the general phylogeny of the Lake Malawi flock, the phylogenetic affinities of two pelagic cichlid genera, *Rhamphochromis* and *Diplotaxodon*, are also being analysed.

Jolley, T., Neiland, A. E. & Carrier, S. (*Centre for the Economics and Management of Aquatic Resources, University of Portsmouth, Locksway Road, Portsmouth PO4 8JF, Hants, U.K.*).

Changes in the fish stock composition of the wetlands of the Lake Chad Basin: a multi-disciplinary analysis

Over the last 40 years, the Lake Chad Basin has experienced significant fluctuations in climatic and environmental conditions including, as a result of the Sahelian droughts of 1972–1974 and 1982–1984, the lacustrine area being reduced from 20 000 km^2 (1960 level) to 2000 km^2 (present day). Using catch data from surveys undertaken of local fisheries, it has been possible to document the changes in fish stock composition in the Lake Chad Basin which have taken place since 1960. Overall, there has been a decline in lacustrine fish types (e.g. *Lates* and *Hydrocynus*) and an emergence of swampland fish types (e.g. ' Tilapia ' and Clarias). The relationship between environmental change and fish stock composition in the Lake Chad Basin will be examined in this paper as a central theme. However, our research has also shown that fish stock composition (as reflected by catch composition, albeit imperfectly) has been affected by important changes in the fisheries since 1960 including an overall intensification of fishing effort, the use of modern gears, the increased commercialisation of the fish trade and changes in the management of the fisheries. The paper concludes with a discussion of the relationship between the key factors identified and their impact on fish stock composition in the region.

Kuusipalo, L. (*University of Joensuu, Department of Biology, PL 111, 80101 Joensuu, Finland*).

Fatty acids of the muscle in endemic cichlids of Lake Malawi

The composition of 73 fatty acids was studied in the red muscle tissue surrounding the upper lateral line in nine species of Malawian cichlids. Total lipid selection and concentration of Lake Malawi cichlids clearly discriminated species from different niches. Species from the same environment had similar lipids: in pelagic area (*Oreochromis* and *Copadichromis*) in benthic (*Aulonocara* and *Chilotilapia*), and in rocky habitats (*Pseudotropheus* and *Cynotilapia*). Variation in lipid content implies, that species are differentiated from each other by their food consumption, behaviour and habitat. Based on different fatty acid concentration of muscles, it seems highly probable that the ecological niches of studied species are firmly established and stable.

Lament, J. J. (*Department of Biology, University of Miami, P.O. Box 249118, Coral Gables, FL 33124-0421, U.S.A.*).

Growth differences between introduced populations of *Cichlasoma urophthalmus* based on otolith mass

This study compared somatic growth rates in populations of *Cichlasoma urophthalmus* from an ecologically diverse range of habitats using otolith mass as a correlate of age. The fish from the cypress population grew faster than those from mangrove and sawgrass populations, which did not differ from each other. Analysis of otolith mass–frequency distributions revealed that maximum otolith mass in cypress forest fish was lower than the other populations, which indicated the absence of old, slow-growing fish. The cypress forest growth rate was higher even when the older mangrove and sawgrass fish were removed from the comparison. Thus this difference in age composition did not explain inter-habitat variation in growth rate. Differences in geographic proximity, hydrology, water temperature, salinity, length–frequency distributions were also inconsistent with variation in growth rate. Two explanations are offered for the faster cypress forest growth rate: less intra-specific competition or lower investment in gonads. Median otolith mass of the cypress forest population was significantly lower for the first 4 months compared with the latter 8 months of sampling, which was interpreted as evidence of an overall increase in age and suggests a more recent population origin. The peak of gonadosomatic index was lower in the cypress forest population, indicating lower gonad investment. Thus cypress forest fish may be employing a different life-history strategy, with reduced gonad investment and faster somatic growth.

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Aspects of reproduction and nourishment of *Cichla* cf. *ocellaris* on the Pantanal of Mato Grosso, Brazil

Cichla cf. *ocellaris* had a good condition factor and higher levels of visceral fat during the wet months and accordingly there was a higher frequency of fish with ripe gonads in this period. Spent gonads were observed on December to March, at the end of the wet season. Forty-nine species belonging to 18 families of teleostei fishes were identified in the stomach contents of *C.* cf. *ocellaris*. *Cichla* cf. *ocellaris* is a specialist piscivore fish, feeding on several species of fish and the Pantanal ecosystem offers several species of preys for it. In the Pantanal there are many marginal lagoons, and these connect with rivers during the rainy season. *Cichla* cf. *ocellaris* goes to these lagoons for reproduction and nourishment purposes.

Mannini, P. (*HIFI, University of Hull, Hull, HU6 7RX, U.K.*) & Craig, J. F. (*ICLARM, Africa and West Asia Region, P.O. Box 2416, Cairo, Egypt*).

Spatial and temporal distribution of *Lates stappersii* in relation to its diet in Lake Tanganyika

The results of two whole lake surveys, in June and November–December 1995, carried out as part of the FAO/FINNIDA Lake Tanganyika research project are presented. The concentration of the centropomid *Lates stappersii*, the clupeid *Stolothrissa tanganicae*, and for shrimps in particular the atyid *Limnocaridina parvula* showed distinct temporal and spatial heterogeneity although biomass of *L. stappersii* and *L. parvula* tended to be greatest in the central and southern parts of the lake and that of *S. tanganicae* greatest in the north. Shrimps and *S. tanganicae* were the most important prey items of the centropomid. The distribution of prey items was reflected in the diet of the predator as

shown by its stomach content. In June *S. tanganicae*, clupeid larvae and copepods were the main items in the diet of *L. stappersii* in the northern part of the lake while in the south the diet was almost exclusively composed of shrimps. In November–December prey items were much more varied. Overall, in June shrimps were the commonest prey but in November–December *S. tanganicae* predominated. In June the catch per unit effort (cpue) of *L. stappersii* was positively correlated with the concentration of shrimps and with the number of shrimps in their stomachs. *Lates stappersii* abundance was also related to the number of *S. tanganicae* in their stomachs but not to the cpue of the clupeid. The spatial and temporal changes found in the diet of *L. stappersii* by the whole lake surveys were similar to those observed for fish caught by the commercial fisheries at Kigoma and Mpulungu. The study highlights the importance of shrimps as prey for the top predator in Lake Tanganyika, a predator which is a valuable source of protein and income for the lake inhabitants.

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Genetic variation and phylogenetic relationships of populations of the genus *Profundulus* Hubbs 1924 from Mexico using allozymic data

Twenty-five *Profundulus* samples were examined with starch gel electrophoresis from South Mexican populations which occur in rivers localized between the Balsas and Grijalva-Usumacinta river basins. UPGMA and maximum likelihood trees (based on genotype frequencies) revealed four main groups. The first grouping showed two diagnostic loci and high genetic distances with respect to other samples of the genus *Profundulus*. This group was proposed to contain *P. oaxacae* since it included samples from central Atoyac basin, and one sample from the Mixteco–Balsas basin. The second clade comprised samples of springs in the high lands of the Mixteca region belonging to the Atoyac and Balsas basins. Genetic distances, and one diagnostic locus supported this group as a different taxon. The third group was composed by samples from the Pacific slope of the Tehuantepec Isthmus, which are conferible to *P. punctatus*. Interestingly, one sample from the Sierra Madre de Oaxaca springs (Tehuantepec river drainage) showed one diagnostic locus and a high genetic distance with respect to the rest of the samples included in this group. In contrast, the morphologically well-defined species *P. labialis* from the Grijalva-Usumacinta basin showed only a moderated genetic distance with respect to the *P. punctatus* group. The also heterogeneous fourth group included Pacific samples from rivers localized between the Balsas and Coyul basins and a sample from low Atoyac basin. Despite samples from Balsas, Pichuacan and Quetzala basins were well differentiated within this group, all were assigned to *P. balsanus*. Allozymic results showed that separation of the genus *Profundulus* into two subgenera is artificial. The samples from South Mexico studied here, which were formerly adscribed to *P. punctatus*, can be separated into, at least, five different species: *P. punctatus*, *P. oaxacae*, *P. balsanus*, and two other undescribed species. The species *P. labialis* which inhabits the basin of Grijalva-Usumacinta in the Atlantic slope is related to *P. punctatus*.

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Assessment and management of the demersal fishery in the British Indian Ocean Territory (Chagos Archipelago)

This paper presents an analysis of the available research and fishery data from the bank-reef fishery on the Chagos Archipelago and draws conclusions on the management

of the fishery to meet the specified objectives of the BIOT authorities. The primary management objective is conservation, whilst permitting Mauritian mothership-dory hook and line fishing ventures to fish as they have done previously. In recent years the fishery has yielded catches of around 300 t year^{-1} comprised mostly of lethrinids (60% of the catch or more), which are targeted in shallow water (30–50 m) on the banks. Whilst there are presently no indications of overfishing, fishing effort, although sporadic, is not low. The strong habitat association of exploited demersal species, and patchy nature of suitable habitat within banks fished means that there is a real danger of localised depletion, which this paper examines. Being a targeted fishery for predatory species, there is the potential for depletion of the most vulnerable species, such as serranids. Whilst this may be acceptable from a commercial fishery point of view, this needs to be balanced against the conservation aims of management. Careful monitoring of the inshore fishery is therefore a priority of the BIOT Authorities, and management objectives and instruments are annually reviewed. Existing management instruments are described.

Merigoux, S. (*Université Lyon 1, ESA CNRS 5023, Laboratoire d'Ecologie des Eau Douces et des Grandes Flewes, 69622 Villeurbanne, France*).

Predicting diversity of juvenile neotropical fish communities

The species richness of communities should largely depend on habitat variability and/or on habitat. The power of habitat variability and habitat state has been used to predict the diversity of juvenile neotropical fish communities in creeks of a river floodplain. It was not possible to demonstrate clear patterns of richness in relation to temporal and spatial habitat variability (if excluding habitat state variables), regardless of the grouping of sites (up- and downstream sites differed in temporal variability patterns). Step-wise multiple regression explained 36% of the variability in species richness for all data and at best 47% for all taxonomic units at upstream sites with temporal and spatial habitat variability and habitat state (bank length, mean width, mean water level before fishing and/or water turbidity). Monte Carlo simulations predicted blindly 31% (all data) and at best 37% (all upstream taxa) of the observed variability in species richness from these model types. This limited precision should be primarily related to the fact that rare species produced most of the richness patterns in the creeks. The prediction of these species is generally difficult for various reasons and a problem relevant in many ecosystem types. Therefore, ecology needs new metrics for community diversity that are easier to predict than species richness. Such metrics should consider functional diversity and focus on species traits.

Niedermayr, K., Barić, S. & Sturmbauer, C. (*Department of Zoology and Limnology, University of Innsbruck, A-6020 Innsbruck, Austria*).

Mitochondrial phylogeny of the *Neolamprologus brichardi* species complex and their phylogeography along the shores of Lake Tanganyika

A 450-bp segment of the mitochondrial control region of species and populations of *Neolamprologus sarvoryi*, *N. brichardi* and *N. pulcher* and various other lacustrine species of the Lamprologini was sequenced to clarify their position within the Lamprologini and to provide a phylogeny of lamprologine species with brood care helpers. The phylogeny demonstrates monophyletic evolution of the recruitment of brood care helpers and suggests that the *N. brichardi–pulcher* complex represents an ancient lineage within the Lamprologini.

Oliveira, R. F., Carneiro, L. A., Borges, R. A. & Canario, A. V. M. (*Unidade de Investigacao em Eco-etologia, Instituto Superior de Psicologia Applicada, R. Jardim Tabaco 44, 1100 Lisboa, Portugal and Centro de Ciencias do Mar, Universidade do Algarva, Campo de Gambelas, 8000 Faro, Portugal*).

Androgens and social behaviour in a cichlid fish, *Oreochromis mossambicus*

The relationship between androgen levels and social behaviours of males of the cichlid fish *Oreochromis mossambicus* (Peters) was investigated. Firstly, males were kept socially isolated for a week prior to placing them together in groups of only males. Urinary androgen (testosterone and 11-ketotestosterone) levels immediately after social isolation were not correlated to a dominance index obtained after male–male interactions in the newly formed groups. In contrast the dominance index obtained immediately after groups formation was a good predictor of androgen levels measured after male–male interactions. Secondly, receptive females were introduced in tanks of isolated males and the pair was followed for 6 h. Although male androgen levels measured prior to the introduction of the females were not correlated to their behavioural (agonistic and sexual) response towards the female, behavioural indices were good predictors of 11-ketotestosterone levels at the end of the trial. In a third experiment, the relationship between aromatase activity in the brain, social status and sexual behaviour was investigated. Brain aromatase activity was not correlated to any of the social behaviours measured but there was a variation in the enzyme activity with sex and gonadosomatic index. These results suggest a short-term social modulation of androgen levels both by male–male and by male–female interactions. Unlike in higher vertebrates, androgen-dependent activation of male social behaviours in cichlid fishes appears not to be controlled by brain aromatase activity.

Pilling, G. M., Kirkwood, G. P. (*RRAG, Imperial College, 8 Prince's Gardens, London, SW7 1NA, U.K.*) & Mees, C. C. (*MRAG Ltd, 47 Prince's Gate, London, SW7 2QA, U.K.*).

Simulating density dependence growth in a tropical reef fish—potential effects on yield and management

This study examines the likely effects of different types of possible density-dependent growth on the length structure and yield effort curves of simulated populations of the tropical lutjanids *Pristipomoides filamentosus* and *Aprion virescens*, and the lethrinid *Lethrinus mahsena*. The potential impacts of density dependent growth on stock assessments are then investigated to determine whether accounting for density-dependent growth is important to achieve management goals.

Pet-Soede, L., van Densen, W. & Machiels, M. (*Department of Fish Culture & Fisheries, WAU, P.O. Box 338, 6700 AH Wageningen, The Netherlands*).

Developments in fish stocks and fisheries off SW Sulawesi, Indonesia. Do we all perceive the same?

A condition for co- or community-based management of small-scale fisheries is that resource users, fisheries officers, biologists and managers have a similar perception of the state of the stocks. It is hypothesized that the perception of a downward trend in the stocks is biased by the use of fishing trips as the standard unit of effort, and obscured by the large variance, experienced by the resource users especially, around a trend in catch per unit effort. It is found that managers, fishermen and biologists perceive developments in the stocks better when information on species and size structure of the catch is evaluated as well.

Ponwith, B. J., Winemiller, K. O. & Neill, W. H. (*Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843-2258, U.S.A.*).

Ecology of tarpon snook (*Centropomus pectinatis*) in a Central American estuary

Over an 11-month period, *Centropomus pectinatus* was common throughout the Tortuguero estuary, comprising 29 and 4% of gillnet and bagseine catches, respectively. Data showed fluctuating sex ratios, spawning seasonality, and emigration of specific size classes from the study area. Length–frequency histograms revealed that the lower 17% of the size range of mature fish was comprised solely of males and the upper 21% of the size range was comprised solely of females, providing circumstantial evidence of protandric hermaphroditism. Higher condition factors in females than in same-sized large males and in smaller males than in same-sized immature fish imply that condition factors are correlated with maturation and sex change. Protandry tends to be selected for in fish species that have random mating (i.e. no sexual selection) and female fecundity increasing with body size throughout life, characteristics that *C. pectinatus* would seem to exhibit. If *C. pectinatus* proves to be a protandric hermaphrodite, this reproductive strategy must be considered when establishing management regimes for exploited populations.

Pritchard, V. & Butlin, R. (*Department of Biology, University of Leeds, Leeds, LS2 9JT, U.K.*).

The zebrafish as a model for the genetics of ethological isolation?

The process of speciation remains poorly understood. In particular, little is known about the precise role that mate choice might play in the creation of barriers to gene flow. A full understanding of this process requires identification of the genetic basis of behavioural traits involved. The zebrafish, *Danio rerio*, which may be a suitable species for use in such research, is currently an important model in developmental biology, and its genome is now well characterized. Although the genetics and development of the zebrafish have been studied extensively, this study aims to discover whether traits and preferences involved in mate choice can be easily documented and whether there is sufficient variability within the species for genetic analysis to be possible. Body shape and colour pattern are being investigated using image analysis techniques. Preferences for such morphological features are being examined using mate choice experiments. Establishment of 25 sib-half sib lines from one population allow the inheritance of these traits and preferences to be examined.

Queiroz, H. L. (*School of Environmental and Evolutionary Biology, Bute Building, St Andrews University, St Andrews, Fife, KY16 9TS, Scotland*).

Growth and sexual maturation of female Pirarucu, *Arapaima gigas*: tools for conservation and management of an Amazonian fish

A provisional growth curve for Pirarucu *Arapaima gigas* was constructed based on more than 1200 examined individuals. Also determined was the size/age of sexual maturation and first reproduction of pirarucu females. In the sample of ovaries, gonadal development phases were identified, and the frequency distribution of mature ovaries for each size category of females was plotted. The size of sexual maturation and first reproduction event (defined as the one from which 50% or more of the female sub-population was sexually mature) was estimated around 160 cm of total length, or about 5 years old. Ova counts showed that fertility increased with female body size (from 27 000 to 65 000), and the frequency distribution of ova diameters in pre and post-spawning ovaries indicated that pirarucu females are partial spawners. This have

important implications for the stock assessment of the species in Mamirauá. All results support not only the local management and sustainable use of this resource, but also the conservation efforts and protection of *A. gigas* in the Brazilian Amazon.

Queiroz, H. L. (*School of Environmental and Evolutionary Biology, Bute Building, St Andrews University, St Andrews, Fife, KY16 9TS, Scotland*).

Sexual selection and parental investment in a unique Amazonian fish: the aruanã, *Osteoglosumm bicihrrosum*

At Mamirauá Reserve, in the flooded forest of the Brazilian Amazon, from 1994 to 1996, more than 200 adult *Osteoglossum bicirrhosum* (Osteoglossidae), or aruanã, and their offspring were collected and examined. The breeding season (from December to March) was very much linked to fluctuations of the water level and the timing of the floods. Female fertility averaged around 209 mature ova. Males are mouth breeders, and guard an average of about 170 fertilized eggs and larvae in their mouths for 3–6 weeks. Larger males care for bigger broods. Some evidence is presented to support the hypothesis of mate selection by females. Apparently females prefer bigger and heavier males, but other traits are yet to be tested. Parental investment among males seems to be restricted to parental care, while females make a larger investment. Loss of body mass among females during the breeding season is severe, and the gonadosomatic index may reach 0·053 just before spawning.

Salzburger, W. & Sturmbauer, C. (*Department of Zoology and Limnology, University of Innsbruck, Technikertsrasse 25, A-6020 Innsbruck, Austria*).

Comparative phylogenetic analysis of Lake Tanganyika cichlids using different mitochondrial gene segments

The phylogenetic relationships among the major Tanganyikan lineages of cichlid fishes were analysed using three different mitochondrial gene segments. A segment of the cytochrome b gene, the variable and the conserved section of the control region using the same set of taxa, was tested for the influence of different selective constraints, and the influence of weighting regimes for each gene segment on the outcome of the phylogenetic analysis. Two data sets were analysed: one set with two representatives each from each of the Tanganyikan tribes, and the second selected species of the tribe Lamprologini. It is shown that inferring appropriate weights for each gene segment, according to their patterns of variation, does have a major influence on the outcome of the phylogenetic analysis, and that the control region, albeit its rapid evolutionary rate, is a powerful tool to resolve even more distantly related groups.

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Genetic diversity of *Notropis* and related genera in South Mexico

Genetic variation among populations of the Mexican species of *Notropis* has been analysed using allozymic electrophoresis data. Morphological, allozymic and sequence data were highly congruent. Using cytochrome b sequence data and *Phoxinus* as

outgroup taxon, it was found that Mexican *Notropis* species form a monophyletic group. A putative new species of *Notropis* was found in an endorheic stream localized close to the headwaters of the Mixteco-Balsas, Atoyac-Verde, and Papaloapan rivers in Oaxaca. This new species showed distinctive morphological characters. Cytochrome b sequence data supported a close relationship of this species to *N. imeldae*. *N. imeldae* populations showed higher genetic distances than those of *N. moralesi* and *N. boucardi* when allozymic data was analysed. Allozymic data showed also that species typical of each river basin also occurred in headwaters of adjacent river basins. These results suggest ancient connections among the headwaters of the Mixteco-Balsas, Atoyac-Verde, and Papaloapan rivers.

Takeuti, D. de F., Verani, J. R., Aranha, J. M. R. & Menezes, M. S. de. (*Departamento de Zoologia, Universidade Federal do Paraná, CP 19020, CEP 81531-990, Curitiba, Paraná, Brazil*).

Population structure and condition factor of *Pseudotothyris obtusa* (Loricariidae, Hypoptopomatinae) from three coastal streams in southern Brazil

Population structure features and the condition factor of *Pseudotothyris obtusa* were compared between three coastal streams in southern Brazil (Mergulhao, Colônia Pereira and Ribeirao) which belong to different drainage basins. The climatic conditions are similar in these areas, but differences in the depth, the substrate type and the edge vegetation were registered in the three streams. The size amplitude was the same for the Mergulhao and Colônia Pereira streams whereas there was no large size class in the Ribeirao stream. The intermediate and larger size classes were preponderant in the Mergulhao and the Colônia Pereira streams. On the other hand, the smaller and intermediate classes prevailed in the Ribeirao stream. Females prevailed in larger size classes and reached larger lengths than males in all streams, which suggests a different growth rate between the sexes. The values of condition factors were different in the three streams, indicating better condition and higher weight values in fishes from the Mergulhao and the Colônia Pereira streams. These differences may reflect the distinct environmental conditions between streams.

Tan, H. H., Ng, H. H. & Ng, P. K. L. (*School of Biological Sciences, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260*).

The catfishes (Teleostei: Siluriformes) of Central Sumatra

The freshwater and estuarine catfishes of central Sumatra (here defined as consisting of the Batang Hari, Indragiri, Kampar and Rokan drainages) are reported on the basis of literature records, material from earlier collections deposited in museums, as well as recent collections made in the Batang Hari and Indragiri basins over the last three years. About 75 species in 10 families are recorded from central Sumatra. One new species of *Nanobagrus* is described. *Akysis macronema*, a species not collected since its original description by Bleeker in 1860 is redescribed on the basis of fresh specimens. Observations on the feeding habits of the poorly known silurid species *Ceratoglanis scleronema* and *Hemisilurus moolenburghi* are provided. The taxonomy of commercially important species is also highlighted, and the identity of one of the most commercially important bagrids in central Sumatra, *Hemibagrus fortis*, is clarified (previously confused with *H. nemurus*). The catfish fisheries in central Sumatra (for food and collection for the aquarium trade) is also discussed.

Taylor, M. I., Turner, G. F., Robinson, R. L. (*Division of Biodiversity and Ecology, University of Southampton, Bassett Crescent East, Southampton, SO16 7PX, U.K.*) & Stauffer, J. R. Jr (*School of Forest Resources, Pennsylvania State University, U.S.A.*).

Sexual selection, parasites and bower height shown in an African bower-building cichlid from Lake Malawi, Africa

Correlates of courtship and spawning success were studied in a maternal mouth-brooding lekking cichlid fish from Lake Malawi, Africa. Females preferred to breed with males which constructed sand bowers. Males which had been observed to mate with females were found to have significantly heavier gonads and a significantly lower number of liver cestode parasites than unsuccessful males. There was also a significant positive correlation between the number of liver cestode parasites and the proportional difference between the maximum and minimum heights of the bower platform above the surrounding substrate. It is suggested that this measure of skew in bower platform heights is analogous to fluctuating asymmetry in anatomical traits. This study is the first quantitative evidence of a relationship between the structure of an extended phenotypic character (sand bowers) and male parasite load. The results are consistent with 'good genes' mechanisms of sexual selection, which predict that secondary sexual ornaments may reliably reveal a male's resistance to parasites.

Tibbetts, I. R. & Carsledine, L. (*Zoology Department, School of Marine Science, The University of Queensland, Qld 407Z, Australia*).

When is a herbivore not a herbivore: lessons from a Hemiramphid

Dietary analysis and stable isotope signatures *Hyporariphus regulans ardelio* collagen and muscle and dominant food items were used to determine their trophic status. Seagrass (*Zostera capricornii*) comprised 94% of the diet of fish greater than 100 mm (L_S) and stable isotope ratios indicated that *Z. capricornii* is the primary carbin source and animal prey (*Temora turbinata*) the principal nitrogen source for this halfbeak. The alimentary morphology of *H. regulans ardelio* is indicative of the carnivory, whereas examination of their gut contents indicates herbivory and stable isotope analysis indicates omnivory. These findings illustrate the imprecisions of the current use of ' herbivore '. Herbivory, omnivory and carnivory are appropriate descriptions of what a fish eats. This study proposes the parallel Greek roots, phytotrophic, pantotrophic and kreatoptrophic to communicate the importance of different food categories to an animal's nutrient status. In this regard the Greek trophos is clearly superior to the Latin voro.

Turner, G. F. & Robinson, R. L. (*School of Biological Sciences, University of Southampton, SO16 7PX, U.K.*).

Biodiversity of Lake Malawi pelagic cichlid fishes

Recent developments in the study of the dominant genera of Lake Malawi, *Rhamphochromis* and *Diplotaxodon*, are summarized, including their taxonomy, distribution and exploitation by artisanal and commercial fisheries. The evolution of these species is also of considerable interest, as it is difficult to conceive of habitat barriers which could lead to allopatric speciation among such pelagic taxa. Molecular phylogenetic studies appear to indicate that the pelagic cichlid genera are monophyletic within the Malawian cichlidae, which makes it unlikely that they have arisen by repeated invasions of the pelagic zone by inshore-living species. Some species are unlikely to be vulnerable to overfishing, as they spend their entire life cycles offshore or over rock reefs. Others however, appear to be more vulnerable, being confined to the principal trawling areas or having nursery areas on sandy beaches.

Tutui, S. L. S. (*Unesp—Av. 24-A n. 1515, Bela Vista—13506-900 Rio Claro—SP, Brazil; Fishery Institute of São Paulo State, Av Bartolomeu de Gusmão n. 192, 11030-906 Santos, SP, Brazil*), Tiago, G. G. & Silva, A. O. A. (*Fishery Institute of São Paulo State, Av Bartolomeu de Gusmão n. 192, 11030-906 Santos, SP, Brazil*).

Experimental and prospective fishery with bottom longline on the south-east coast of Brazil

A total of 275 251 hooks in 260 fishery operations was cast between 19°07′ S and 27°56° S latitudes and at 70–500 m depth from April 1994 to March 1995. Teleostei represented 83·11% of the catches. *Epinephelus*, *Helicolenus*, *Lopholatilus*, *Pseudopercis* and *Urophycis* represented 91.45% of the group catch. The elasmobranchs composed 16·51% and of these, the genus *Heptranchias*, *Mustelus*, *Scyliorhynus* and *Squalus* represented 94·65% of the group catch. There were also crustacean *Rochinia* spp. (0·21%) and accidental catches of birds (0·17%). The objective of this work is the study of the economic viability of the bottom longline in Brazilian sea waters, because these, catches analysis was made by category of target species, and the bycatch. The catches in individual numbers and in weight categories were respectively: 0·024 individuals hook^{-1} and 0.295 kg hook^{-1} for groupers; 0·0096 individuals hook^{-1} and 0.037 kg hook^{-1} for sand perch; 0.041 individuals hook^{-1} and 0.142 kg hook^{-1} for tilefish; 0.105 individuals hook^{-1} and 0.050 kg hook^{-1} for by-catches. The operation cost was U.S.$ 0.58 hook^{-1} and the net profit U.S.$ 0.78 hook^{-1}. The study shows a profitable fishery, and, also, the need for regulation in fishing effort on the target species due to the high susceptibility of these species to overfishing.

van Zwieten, P. A. M. (*Pomona 208 6708 CH Wageningen, The Netherlands; Fish Culture and Fisheries Group, Wageningen Institute of Animal Science, Agricultural University, P.O. Box 338, 6700 AH Wageningen, The Netherlands*), Machiels, M. A. M. & van Densen, W. L. T. (*Fish Culture and Fisheries Group, Wageningen Institute of Animal Science, Agricultural University, P.O. Box 338, 6700 AH Wageningen, The Netherlands*).

Species change in a heavily fished African lake: the case of Mweru–Luapula, Zambia

This study attempted to explain the impact of fishing on the species in Lake Mweru. Catch per unit of effort (cpue, kg 100 m^{-2} of gillnet night^{-1}) has declined from 12 in 1955 to 1.5 at present. The largest drop occurred between 1963 and 1967 and coincided with the massive introduction of synthetic fibres in the artisanal and subsistence fisheries. Gill nets now constitute the predominant gear in the lake, and mesh-sizes have decreased while the number of nets has increased. There is also some light fishing for chisense (*Microthrissa moeruensis*). Declines in cpue coincide with or immediately follow prolonged periods of low water levels. During such periods large parts of the swamps and of the Luapula floodplain south of the lake dry out. A decline in 1959 was reversed with the rising water level, but ones since 1963 appear to have been irreversible. Experimental gillnet surveys conducted at the lake in 1970–1972, 1982–1985 and 1994–1997 have shown changes in abundance in two groups of species: Schilbeidae (two species), Synodontidae (four) and Mormyridae (nine) declined in relative biomass and large Clariidae (two) and Bagridae (two) also in length; Cichlidae (four species, all targets of the gillnet fishery) and Alestidae (two) fluctuate in abundance. In an allotrophic riverine lake where production is partly dependent on nutrient pulses brought in with the floods, species change is considered unlikely to result from mere increases in fishing effort. Generally, in such lakes, susceptibility to increased effort is thought to be low, the recovery potential rapid, the ratio of fishing mortality to total mortality low and the yield potential high but

variable. The observation that some groups have disappeared as a result of fishing pressure indicates that such generalizes are not applicable to all species.

Videler, H., Geertjes, G. J. & Videler, J. J. (*Department of Marine Biology, Groningen University, P.O. Box 14, 9750 AA Haren, The Netherlands*).

Novel antibiotics from parrot-fish pyjamas

This study searched for glycoproteins and their potential batericidal properties in the pyjamas of the queen parrotfish (*Scarus vetula*). It was found that the mucous cocoon is an extensive di-sulphate bonded network consisting exclusively of small glyco-proteins of about 21 kDa apparant molecular weight. N-terminal amino acid sequencing resulted in an unique sequence of the first 25 amino acids. Sonicated samples of mucus inhibit growth of *Escherichia coli*, strains lilly and 8623, *Micrococcus luteus*, *Aeromonas hydrophila* and *Vibrio anguilarium*. The dialysed new protein (pyjamicine) had an antibiotic effect on *Micrococcus luteus* and *Aeromonas hydrophila*.

Volckaert, F. A. M., Hellemans, B. (*Katholieke Universiteit Leuven, Zoological Institute, Naamsestraat 59, B-3000 Leuven, Belgium*) & Legendre, M. (*ORSTOM, Jakarta 12540, Indonesia*).

The genetic variability of some catfishes of the genus *Pangasius* and *Clarias* in SE Asia as measured with DNA microsatellites

Ten species-specific DNA microsatellites were developed for the catfishes *Clarias batrachus* and *Pangasius hypophthalmus* by means of a gDNA bank enriched for di- and tetranucleotides. Several of these markers, as well as markers previously developed specifically for *C. gariepinus*, were applicable (i.e. observing a high level of genetic variability) in related species of the genus *Clarias* and *Pangasius*. A significant level of genetic variability was observed in catfish populations collected in the field or by sampling alive in fish markets from the Mekong Delta (Vietnam) and Java Island (Indonesia), apart from the reported taxonomic diversity. Estimates of family and genetic variability point to well-structured populations with the typical features of freshwater fish populations.

Wakeford, R. C., Kirkwood, G. P. (*Renewable Resources Assessment Group, Imperial College, 8 Prince's Gardens, London, SW7 1NA U.K.*) & Mees, C. C. (*Marine Resources Assessment Group Ltd, 47 Prince's Gate, London, SW7 2QA U.K.*).

Developing management strategies for the domestic fishery of the Seychelles

The level of fishing within the inshore region of the Seychelles means a form of regulation is now required in order to sustain present catch levels and conserve the future biological status of the resource. This research aims to develop and evaluate a number of alternative management strategies for the domestic fishery. An existing research framework has been adapted to collect information on the biological, technical, economic and socioeconomic attributes of the domestic fishery. This framework forms the basis of a preliminary institutional analysis of the domestic fishery and provides specific information on the decision-making arrangements of the fishers. The latter will be used to help predict the behaviour of fishers in response to different management strategies. These data will be combined to develop a bio-socioeconomic simulation model of the fishery, which will be used to investigate the likely outcomes from new management strategies (e.g. maximum employment, sustainability of the resource base). The results of this study can then be used to develop guidelines for a management plan of the domestic fishery.

Zardoya, R. & Doadrio, I. (*Museo Nacional de Ciencias Naturales, José Gutiérrez Abascal, 2, 28006 Madrid, Spain*).

Phylogenetic relationships of Greek cyprinids based on cytochrome b sequence data

The complete sequence of the mitochondrial cytochrome b gene was determined in 55 cyprinid species from Greece. Most variability among sequences was detected in third codon positions. The inferred molecular phylogeny was highly congruent with previous phylogenies based on osteological characters. The phylogenetic relationships among Greek cyprinids based on cytochrome b sequence data supported the traditional division of the Cyprinidae into two subfamilies: Cyprininae and Leuciscinae. The barbin lineages form a monophyletic group with *Cyprinus* and *Carassius* as sister group species. Within the barbin subset, two major clades could be recognized; one comprising most of the Greek barbels; the other containing *Barbus graecus* and *Barbus albanicus*. The former clade appears to be related with Central European Barbus, the latter to Iberian Barbus. Within Leuciscinae, several monophyletic groups could be distinguised. As shown in barbels, most Leucisicinae are related to Central European species, but some showed greater affinities to Iberian species. Cytochrome b evidence support a biogeographical division of Greece into two main regions: the north-eastern region which includes cyprinid fauna that show strong affinities with Central European species; and the south-western region inhabited almost entirely by endemisms related to Mediterranean species.