Fish and More

3rd FishBase Mini Symposium

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FishBase Symposium: Fish and More

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When the now anonymous artist created the famous fresco known as the 'Little Fisherman from Thera (Santorini)' he could not imagine that after more than three thousands years his masterpiece would have, apart from its historic, cultural and artistic value, an untold ecological one (see Economidis 2000, who examines some ichthyological, ecological, and fisheries aspects of the painting; and Fig. 1). The same is also true for other Minoan artists, who generally used bright colors and fine, detailed representations (Economidis 2000; Sherratt 2000; Eleftheriou 2004). Such a painting style makes possible for the specialist to identify, at the species level, many of the marine organisms (e.g., echinoderms, cephalopods, fishes, dolphins) depicted in the frescoes (Economidis 2000; Eleftheriou 2004).

In addition, there are many descriptions of various aspects of marine life and biodiversity, fishing methods, and the life of fishers in the scripts of many 'classic' writers, from the rhapsode Homer to the greatest polymath Aristotle (who, e.g., when mentioning that larger fishes prey upon smaller ones, implies that trophic level increases with size), and the poet Oppianos (who, e.g., refers to a variety of fishing gears). Such written sources are also of high scientific value (see e.g., CIESM 2003; Bekker-Nielsen 2005a). Indeed, the evaluation of such diverse information (i.e., written, pictorial, and archaelogical) clearly indicates that fish and fishing played a major role in the ancient life and economy (Bekker-Nielsen 2002, 2005a,b; Galil 2004).

Our anonymous Minoan artists, Homer, Aristotle, Oppianos, and all the many others, could not also have imagined that after thousands of years there will be an interactive framework to fully embody and use such 'seemingly irrelevant' and diverse sources. One such framework is FishBase (www.fishbase.org; Froese & Pauly 2000), the modern ecological tool of multiple uses (e.g., education, research, source, informing and sensitizing the public), which can be used to answer high-order scientific questions (CIESM 2003; Stergiou 2003; Froese this volume; Palomares & Pauly this volume). Thus, FishBase can be used for storing maximum lengths and length frequencies of species, reconstructed from frescoes (Fig. 1) and archaeological remains – in the latter case for storing also information on maximum weight and age, e.g., Leak (1990), Van Slyke (1998). For instance, Zohar *et al*. (2001) reconstructed the lengths of grey triggerfish (*Balistes carolinensis*; FishBase valid name: *Balistes capriscus*) from skeletal remains from a Pre-Pottery Neolithic C site (c. 8140–7550 BC). They report that its maximum standard length was about 41 cm (with a mode at 15-20 cm), which corresponds to a total length of 60 cm. The latter is the FishBase reported maximum total length for this species. Provided that inferences can be made about the fishing gears used

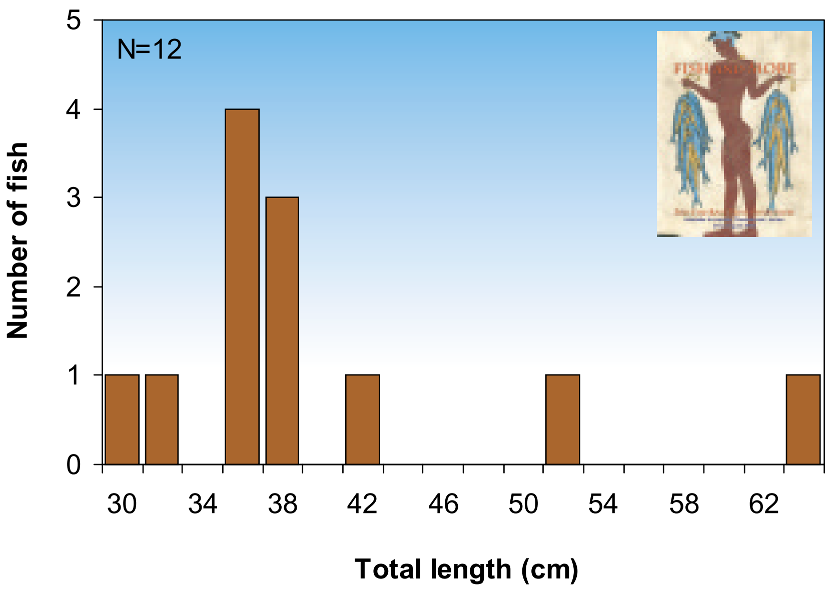

Figure 1 Length-frequency distribution of the 12 *Coryphaena hippurus* (common dolphinfish) hold by the little fisherman. Economidis (2000) assumes that "*If the height of the boy is about 120 cm, then the length of the ten smaller fish varies from about 27 to 37 cm, while, of the two biggest, that in the righthand string is about 50 cm long, and that in the lefthand string about 60 cm.*" Here the total lengths of each individual fish were reconstructed from the original, based on Economidis' assumption

back then, and thus of their size-selection properties, such information is critical for establishing 'baselines' (Pauly 1995) and reconstructing the history of marine animal populations (Holm 2003).

In order for FishBase to accommodate such diverse information it must constantly evolve and expand, be updated and funded. The diverse contributions presented in the 3rd FishBase Symposium with theme '*Fish and More*' touch these issues. Thus, the contributions show: (i) the strength of FishBase as an ecological tool (Froese; Palomares & Pauly: this volume) that in order to meet the emerging challenges can change in structure (Bailly *et al*. this volume) and content from 'just fish to more than fish' (Karpouzi *et al*. this volume); (ii) how big a task is to locate and eventually embody the plethora of the existing information, often hidden in drawers, grey literature or local databases, as well as the new one which is produced annually at an exponential rate (Yang; Kallianiotis *et al*.; Politou; Tsikliras *et al*.; Bobori *et al*.; Karachle & Stergiou: all in this volume); and (iii) the policy processes influencing the discussions about the 7th Research Framework Programme of the European Union (Nauen this volume), which can also be considered as a potential venue for funding and, thus, for the realization of items (i) and (ii) above.

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References

Bekker-Nielsen T (2002) Fish in the ancient economy (Available at http://www.pontos.dk/e_pub/TBNFish.pdf)

Bekker-Nielsen T (ed) (2005a) Ancient fishing and fish processing in the Black Sea region. Aarhus University Press, Black Sea Studies 2

Bekker-Nielsen T (2005b) Source materials for fishing in antiquity and the early middle ages (Available at http://www.pontos.dk/e_pub/TBN_sourc_materials.htm)

CIESM (2003) Mediterranean biological time series. *CIESM Workshop Monogr Ser* **22:** 1-142 (CIESM publications, Monaco, available online at www.ciesm.org/publications/split03.pdf)

Economidis PS (2000) The 'little fisherman' and the fish he holds. *In:* Sherratt S (ed) The wall paintings of Thera. Proceedings of the 1st International Symposium, Nomikos PM Conference Center, 30 August – 4 September 1997, Athens, Volume II: 555-562

Eleftheriou A (2004) Marine biodiversity in the Aegean Bronze Age. *History of*

Marine Animal Populations, Mediterranean Workshop (Barcelona, Spain) **Sept 2004**: 10

Froese R, Pauly D (eds) (2000) Fishbase 2000: Concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines

Galil BS (2004) Of fish bones and mosaics – the fisheries of the ancient Mediterranean. *History of Marine Animal Populations, Mediterranean Workshop (Barcelona, Spain)* **Sept 2004:** 4-5

Holm P (2003) History of marine animal populations: a global research program of the census of marine life. *Oceanol Acta* **25:** 207–211

Leak A (1990) Cleaning archaeological fish scales. *Circaea* **6(2):** 119-120

Pauly D (1995) Anecdotes and the shifting baseline syndrome of fisheries. *Trends Ecol Evol* **10:** 430

Sherratt S (ed) (2000) The wall paintings of Thera. Proceedings of the 1st International Symposium, Nomikos PM Conference Center, 30 August – 4 September 1997, Athens, Volume II

Stergiou KI (2003) The balance and conservation of the North Atlantic ecosystems? Book review of Pauly D & J MacLean's "In a Perfect Ocean – the State of Fisheries and ecosystems in the North Atlantic Ocean" (Island Press). *Rev Fish Biol Fish* **13:** 455-457

Van Slyke N (1998) A review of the analysis of fish remains in Chumash sites. *Pac Coast Archael Soc Quart* **34(1):** 25-58

Zohar I, Dayan T, Galili E, Spanier E (2001) Fish processing during the early Holocene: A taphonomic case study from coastal Israel. *J Archaeol Sci* **28:** 1041–1053

Use of FishBase for exploring life-history strategies of fishes

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This presentation shows how FishBase can be used to explore life-history strategies of recent fishes with a data set that is two orders of magnitude larger than any used in previous studies. Trophic level, size, and productivity were taken as key traits and proxies for many other closely related traits.

Size was strongly correlated with most life-history traits of fishes and also with morphological characters, with behaviour, and with preferred environmental conditions. Size was also a good predictor of placement on the r-K continuum. Productivity was derived from growth, age at maturity, maximum age, and fecundity data. It was positively correlated with metabolism and level of activity and was also an indicator for placement of species on the r-K continuum. It was strongly correlated with most life-history traits of fishes and also with morphological characters, with behaviour and with preferred environmental conditions. It was negatively correlated with status of threat.

The position of species in the food web was shown to restrict life-history options. The addition of trophic level as orthogonal axis on the r-K continuum revealed unoccupied regions in life-history space such as the combination of small size and high productivity with either herbivory or top-predatory, and the combination of very large size and very low productivity with herbivory. Discrete classes of size, trophic level (Fig. 1), and productivity (Fig. 2) were used to define 80 life history strategies. Only 50 of these strategies were used by recent species, with an exponential decline in species numbers from the most to the least used strategies. This decline was interpreted as an exponential increase in constraints associated with less-used strategies.

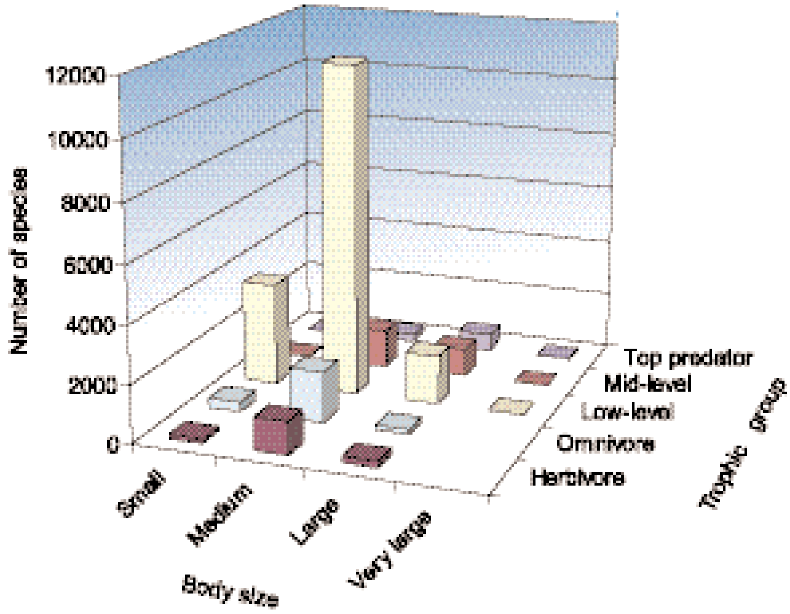

Figure 1 Number of species by size and trophic group classes for 20,480 species

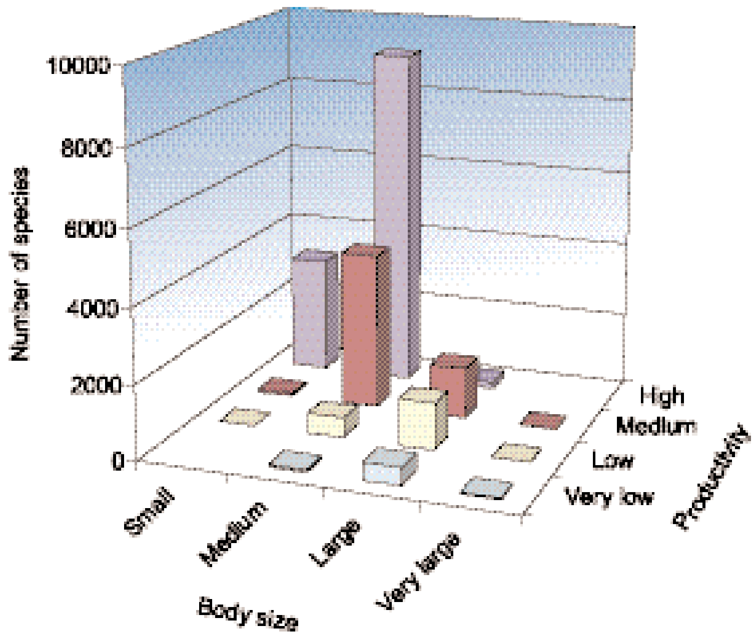

Figure 2 Number of species by size and productivity classes for 20,480 species

Analysis of trade-off or constraint curves in life-history space revealed unoccupied areas as well as local maxima, i.e., areas occupied by more species than the surrounding space. Such local optimum was occupied by very large top predators with very low productivity. Low-level predators of small to medium size and medium to high productivity were the three strategies used by altogether 60% of the species. Strategies used in extreme environments such as the deep and polar seas or high-altitude lakes were not 'specialist strategies' but rather among the 10 most-used strategies, suggesting that constraints imposed by extreme environments excluded strategies that had a high degree of inherent constraints.

The number of strategies used by phylogenetic, environmental, morphological or behavioral groupings of fishes was highly predictable from the number of species in the respective groups. A preliminary chronology of life-history strategies showed that over 2/3 of recent strategies were invented only 200-150 million years ago during several radiations of the Actinopterygii, including small size, very large size (invented in parallel by Elasmobranchii), high productivity, and true herbivory.

Phylogeny restricted the life-history options available to species with respect to size, place in the food web, and productivity. There was evidence for a non-overlap of preferred life-history strategies between the two largest recent Classes, with Elasmobranchii tending towards large size and low to very low productivity, and Actinopterygii tending towards medium size with medium to high productivity.

Nine evolutionary theories were tested as to their ability to correctly predict adaptation of life-history traits in response to environmental conditions such as salinity, climate, zoogeographic realm, ocean basin, and habitat type. Predictions were 88-100% correct when cases where different theories predicted different adaptations were excluded. In conflicting cases predictions by temperature theory usually prevailed over those by r-K and succession theories. Life-history strategies were examined with respect to their correlations with body shape, brain size, reproductive guild, migratory behaviour, and status of threat. Productivity increased with body shape from eel-like to short and/or deep, with brain size from very small to normal and large, and with migratory behaviour from catadromous to amphidromous and non-migratory. Size decreased with migratory behaviour from catadromous to non-migratory, and with parental care from nonguarders to bearers (in Actinopterygii). Trophic level decreased with increase in brain size. Several life-history strategies were only used by migratory species. Non-threatened fishes had significantly higher productivity than threatened fishes.

Life history-strategies that combined large size and low productivity contained proportionally more threatened species than other strategies. Independent estimates of abundance and distributional range of species were used as indicators of success of life-history strategies. Species showed preferences for strategies that were associated with high abundance or small to medium ranges. When abundance and range were combined into a single measure of success (Impact), most strategies were associated with impacts that were not significantly different from the overall mean. Only medium-sized low-level predators and omnivores with high productivity had significantly higher impact; these two strategies were used by 39% of the species.

The *Sea Around Us* project as a FishBase partner

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Introduction. Since its inception in 1999, the *Sea Around Us* project of the Fisheries Centre, University of British Columbia, and as a founding member of the FishBase Consortium, has been involved with the various FishBase activities. The project, funded by the Pew Charitable Trusts in Philadelphia, is devoted to the study and documentation of the impact of fisheries on marine ecosystems, and to the identification and implementation of policies that will reduce this impact.

Fishes are the major component of the catch of most fisheries. Thus, the project relies heavily on information available in FishBase in order to characterize commercially important groups of species, i.e., using: (1) taxonomic; (2) geographical (e.g., distribution); and (3) biological (e.g., maximum lengths, growth, trophic levels, food and diet) information on fishes, as well as the (4) treaties and conventions applying to fisheries targeting these species.

The *Sea Around Us* project, in the course of its 'heavy' use of FishBase, in turn contributes data, notably on common names used in the national fisheries statistics, e.g., of Brazil and India; and routines that, e.g., calculates the vulnerability of marine fishes to be exploited by the various fisheries operating in a country. This contribution discusses in detail the user/contributor role of the *Sea Around Us* project as a FishBase partner and outlines future activities that will further enhance the existing links between these two databases.

The *Sea Around Us* project as a FishBase user - Implicit uses. The *Sea Around Us* project database uses FishBase as a standard for scientific and common names to correct misidentifications in reported catch statistics in a given country. This permits the disaggregation of catch statistics in the *Sea Around Us* project database, notably for items such as 'miscellaneous fishes', into family, genus and, when possible, species. In addition, information on the distribution of fishes by country, depth distributions and latitude ranges (i.e., north-south limits) provided in FishBase is used by the *Sea Around Us* project database to verify reported occurrences of species in the catch of a particular country or area, e.g., as illustrated by Watson & Pauly (2001) to document the over-reporting of China's catches.

Spatial allocation of catches in *The Sea Around Us* project database is enhanced by routines extrapolating catches using biological information provided by FishBase. Cheung *et al.* (ms) developed a routine that aims to enhance predictions of taxon distributions by associating habitat preferences (or the 'versatility' of a species to inhabit different habitat types) with the species' maximum length. Heuristic rules are applied to define the maximum effective distance that a species would 'stray' from its preferred habitat while relative abundance of a species in a given habitat is defined using heuristic descriptions. This component of the *Sea Around Us* project database thus allows, given that the heuristic rules and assumptions apply, a general tool to predict, at large spatial scales, the distribution of commercial marine species by habitat.

A more extensive use of FishBase biological parameters by the *Sea Around Us* project database resulted in a fuzzy expert system routine, which calculates the intrinsic vulnerability of marine fishes to extraction, developed by Cheung *et al.* (2004). This routine uses, as input variables, maximum length, age at first maturity, longevity, the von Bertalanffy growth parameter K, natural mortality rate, fecundity, geographic range and strength of spatial behavior. All except the last parameter are obtained from FishBase. This routine was applied to seamount-associated fishes by Morato *et al.* (2004, in press) who found that, in general, seamount-aggregated species are highly vulnerable to fishing, and thus puts in question the plans of some countries to expand their fisheries to distant water seamounts.

The *Sea Around Us* project as a FishBase user - Explicit uses. The online interface of the *Sea Around Us* project (www.seaaroundus.org) extensively uses deep-links to the various lists provided by FishBase. The most visible of these links are those provided under the *Biodiversity* button (see Fig. 1A), i.e., categorical lists of fishes by country. Another link is used under the *Governance* button for *Treaties and Conventions* which lists agreements ratified and/or pending ratification by the country in question. In addition, under the *Eco-systems* button, i.e., the fish parameters link which displays the list of FishBase life-history parameters useful for *Ecopath with Ecosim* models; and the trophic pyramid link which displays FishBase's *Lindeman pyramid* (see Lindeman 1942) for that country's Exclusive Economic Zone (EEZ) (Εικόνα 1A,B).

Figure 1A Information on the EEZ of a country, in this example, Greece (for which the EEZ represents the territorial waters to 6 nm and international waters). Note the list of choices under the biodiversity button. All fish-related choices display FishBase lists created on demand

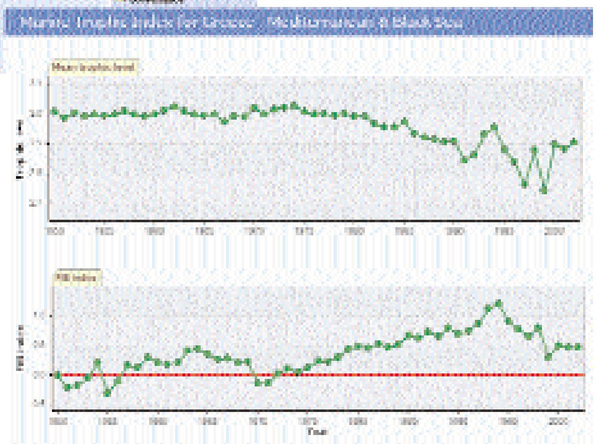

Figure 1B The Marine Trophic Index (MTI) page accessed through the Ecosystem button of the countries' EEZ routine available at the Sea Around Us project website (www.seaaroundus.org). The MTI is computed, here for the Greek EEZ (see comment in Fig. 1A), with the exclusion of all fishes with trophic levels less than 3.25 to exclude small pelagics

Finally, the *Sea Around Us* project catch database plots the Marine Trophic Index and the Fishing-In-Balance Index (FIB) by country (see Fig. 1B). The Marine Trophic Index (MTI) was identified by the Conference of the Parties to the Convention on Biological Diversity (CBD), in February 2004, as one of the eight indicators for 'immediate testing' of their ability to monitor progress toward reaching the target to "achieve by 2010 a significant reduction in the current rate of biodiversity loss" (CBD 2004). The original routine to calculate trophic levels was used in FishBase to create *Lindeman pyramids* (see above). This was used by Pauly *et al.* (1998) and more recently by Pauly & Palomares (2005) to calculate the trophic levels of the fisheries catch statistics supplied by FAO and modified by the *Sea Around Us* project database to illustrate the 'fishing down marine food webs' phenomenon. It was also incorporated in the CD version of FishBase 2000 (Froese & Pauly 2000).

All of these links to FishBase direct *Sea Around Us* products users to the

FishBase website, thus increasing the number of hits received by FishBase by an average of 130,000 per month. Note that, for example, in December 2004, the *Sea Around Us* website received a total of 200,000 hits; this is a significant increase in user trends since its launching in November 2003.

The *Sea Around Us* project as a FishBase contributor. As heavy FishBase users, the *Sea Around Us* project team members, and many of the students of the Fisheries Centre, are bound to encounter information gaps in FishBase. These encounters turn out to be useful in filling in these gaps in FishBase as *Sea Around Us* project team members and Fisheries Centre students gather the information from other sources and provide them to FishBase.

A first kind of information gap is encountered at the nomenclatural level, notably on common names. This prompted the second author to suggest to his students to work on lists of common names by language used in a specific locality or country. One of the most extensive of these contributions are the lists of Portuguese, Guarani, and Tupi local names of fishes (both marine and freshwater) occurring in Brazil assembled by Ms Katia Freire and resulting in several contributions on analyses of common names (Freire & Pauly 2003; Freire & Pauly in press). Another extensive contribution of this sort by Ms Brajgeet Bhathal is the assembled lists for India covering Andamanese, Assamese, Bengali, English, Gujarati, Hindi, Kannada, Mahl, Malayalam, Marathi, Oriya, Punjabi, Tamil, Telugu and transcribed common names from Roman characters into eight different scripts, e.g., Hindi, Punjabi, Tamil, Telugu, Malayalam, Kannada, Marathi, and Nepali (Bhathal 2003; Bhathal & Pauly 2004). Ms Freire and Ms Bhathal continue the collection of fish common names used in their countries and both are maintaining their own databases in order to analyze these common names following the methodology set by Palomares *et al.* (1999). Other contributions include English and Amerindian common names for fishes occurring in British Columbia, Canada; common names of fishes in Indonesian, Japanese, Maltese, some languages used in Malawi, and Russian. Overall, Fisheries Centre students and staff members have contributed more than 15,000 common names to FishBase.

A second kind of information is encountered at the 'biological' and 'distribution' levels, which is more difficult to quantify in terms of absolute numbers of contributions made. However, frequent exchanges occur between *Sea Around Us* project staff members and the FishBase team in the Philippines identifying additions, corrections and verifications of biological parameters, i.e., notably trophic levels and maximum sizes, and questions on geographical and vertical distributions of species. Results of studies conducted by the *Sea Around Us* project are sent to FishBase to add to or to correct existing records.

In addition, copies of sources used by these studies are sent to the FishBase team for extraction and encoding of other pertinent information. This ensures that gaps are continually being filled for the next round of data extraction and subsequent analyses.

The *Sea Around Us* project assures that the data being contributed by its members are incorporated in FishBase by maintaining a small contribution to fund one FishBase encoder in the Philippines (Ms Arlene Sampang) and one FishBase coordinator within the project at the Fisheries Centre in Vancouver (Dr M.L. Deng Palomares).

Future collaborations. In addition to the ongoing uses and contributions between these two databases, we have identified some desirable links which will enhance the use of these databases on both ends. These are enumerated below:

(1) As the *Sea Around Us* project database improves its coverage of historic expeditions and scientific surveys (see www.seaaroundus.org for links), a routine that lists all expeditions and surveys conducted in a country can be added under its *Biodiversity* section. FishBase, on the other hand, has its own *Expeditions* table that lists fish specimens sampled by an expedition, through records of fish occurrence. It will thus be possible in the future to provide links from the historical accounts of an expedition in the *Sea Around Us* project database to the list of specimens by station sampled by that expedition in FishBase. In return, FishBase will be able to provide links to the historic and qualitative component of these expeditions in the *Sea Around Us* project database. These 'synergetic links' will thus make an expedition story whole.

(2) Recent discussions with FishBase team members illustrated the need for a re-evaluation of the choices used in categorizing the global commercial importance of a species. These discussions led to the conclusion that the *Sea Around Us* project price database maybe able to help in this re-categorization as it will provide the necessary information on the global value of a species. Once this re-categorization has been implemented, links to the *Sea Around Us* Project price database can be provided by FishBase to enhance the background information needed in justifying the re-categorization.

(3) The *Sea Around Us* project database user's manual is currently in preparation. Once finished and launched online, links to FishBase where FishBase data and/or routines are used will be provided.

(4) Funding for a database of marine organisms was obtained from the Oak Foundation, Geneva and we will have to consult with the FishBase Consortium concerning the allocation of these funds.

Conclusions. Overall, the relationship between the *Sea Around Us* project and FishBase has matured, and can be expected to continue flourishing.

References

Bhathal B (2003) Gateway to Indian fishes. *FishBytes* **9(5):** 4-5

Bhathal B, Pauly D (2004) Paris and its Jardin des Plantes, or the 2004 Anuual Meeting of the FishBase Consortium. *FishBytes* **10(5):** 6

CBD (2004) Annex I, Decision VII/30, p 351. *In*: The 2020 Biodiversity Target: a Framework for Implementation. Decisions from the Seventh Meeting of the Conference of the Parties of the Convention on Biological Diversity, Kuala Lumpur, 9-10 and 27 February 2004. Secretariat of the CBD, Montreal

Cheung WWL, Kitchingman A, Watson R (ms) Consideration of habitat association in the distribution of commercial species

Cheung WWL, Pitcher TJ, Pauly D (2004) A fuzzy logic system to estimate intrinsic vulnerabilities of marine fishes to fishing. *Biol Conserv* **124:** 97-111

Freire KMF, Pauly D (2003) What's in there? Common names of Brazilian marine fishes, p 439-444. *In*: Haggan N, Brignall C, Wood L (eds) Putting fishers' knowledge to work. *Fisheries Centre Research Report* **11(1)**, University of British Columbia, Vancouver

Freire KMF, Pauly D (in press) Richness of common names of Brazilian marine fishes and its effect on catch statistics. *J Ethnobiol*

Froese R, Pauly D (eds) (2000) FishBase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines

Lindeman RL (1942) The trophic-dynamic aspect of ecology. *Ecology* **23:** 399-418

Morato T, Cheung WWL, Pitcher TJ (2004) Vulnerability of seamount fish to fishing: fuzzy analysis of life history attributes, p 51-60. *In*: Morato T, Pauly D (eds) Seamounts: biodiversity and fisheries. *Fisheries Centre Research Reports* **12(5)**, University of British Columbia, Vancouver

Morato T, Cheung WWL, Pitcher TJ (in press) Vulnerability of seamount fish to fishing: fuzzy analysis of life history attributes. *J Fish Biol*

Palomares ML, Garilao CV, Pauly D (1999) On the biological information content of common names: a quantitative case study of Philippine fishes, p 861-866. *In*: Séret B, Sire J-Y (eds) Proc 5th Indo-Pac Fish Conf Nouméa, 1977, Societé Française d' Ichthyologie, Paris

Pauly D, Palomares MLD (2005) Fishing down marine food webs: it is far more pervasive than we thought. *Bull Mar Sci* **76:** 197-212

Pauly D, Christensen V, Dalsgaard J, Froese R, Torres JrF (1998) Fishing down marine food webs. *Science* **279:** 860-863

Watson R, Pauly D (2001) Systematic distortions in world fisheries catch trends. *Nature* **414:** 534-536

Towards a concept-based taxonomy management in FishBase

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A taxonomy can be stored in an information system as name-, taxon-, or concept-based.

Name-based: The scientific name is equivalent to the taxon it labels. Practically, there is only one name for one taxon, the synonyms are not treated.

Taxon-based: A taxon may have several names one of them being the current accepted name (implicitly it is valid). Practically, there are two linked tables, one for the taxa, and one for the synonyms. The synonyms are generally recorded *sensu lato*, i.e., including misspelling, new combinations, even misidentifications.

Concept-based: A taxon has a signification only if its name is linked to a publication where the definition (= circumscription) of the taxon is given or is easily deducible. Practically, the links between names and taxa are made between and through couples [Name, Reference], which are the Potential Taxa described by Berendsohn (1995), or Chresons as named by Le Renard (pers. comm.). The word "concept" has a taxonomic meaning here: every taxon is a concept in the sense that it is always a hypothesis that can be falsified later when more specimens are discovered, more characters are studied, and/or new phylogenetic and classification methods are used to analyze data.

FishBase pertains to the taxon-based category, which is pertinent to manage the combination changes or reversion of synonymy (the previously thought senior becoming a junior synonym), or both. Such changes like *Raja radiata* to *Amblyraja radiata*, *Labrus bimaculatus* to *L. mixtus*, or *Salmo gairdneri* to *Oncorhynchus mykiss* were easy to manage in FishBase. In general, if the taxon circumscription is not changed or only slightly modified (new specimens, new characters, etc), a change in name is straightforward.

On the contrary, when taxon circumscription changes imply a taxon splitting or lumping, the update in FishBase is a tedious process. At present, this is the main task about taxonomy in FishBase after all species were entered (FishBase is thought to be complete with about 29,000 fish species; still, about 300 species per year are described and require 2.5 full-time working months per year). But, the rate of taxonomic changes is too high compared to the time that can be allocated to these updates, if FishBase is to be updated timely.

We propose to move towards a concept-based approach using the potential taxon concept that will help to manage splitting and lumping. The first challenge to ensure efficiency is that the current description of a taxon recorded in the table MORPHDAT should be computed from the data on the related potential taxa. It is easy for multiple choice fields like the meristic characters (to compute a new range, the minimum and maximum of the potential taxa data are to be compared); it is very difficult for the remarks and comments fields like the description of biology/ecology, the synthetic statement on distribution, etc. The second challenge is that it implies that at a certain time, a specialist has to decide which potential taxa pertain to a given taxon. The third challenge is that it implies a deep change in the links between the following tables: SPECIES, SYNONYMS, REFRENS, BIBLIO (which is already close to a potential taxon table).

The result is an increase in complexity of the structure and the management procedures (but also in quality), whereas FishBase has always tried to keep things simple. To keep simplicity with respect to the information dissemination to the public, we also propose to maintain the tables in their current state (although with slight field modifications); but the content of these tables would be as far as possible the result of computations from the newly developed tables gathered in a taxonomy "module". This module would represent the immersed part of the information system (Bailly 2004), dedicated only to taxonomists and advanced amateurs. Possible structures like that shown in figure 1 will be presented.

In addition, several other improvements should be included in a new taxonomy module project, all more or less linked to the changes proposed above: (i) new fields in the table synonyms; (ii) management of the intermediate categories (super-, sub-, infra-, -classes, -orders, -families, -genera when relevant); (iii) management of genera; (iv) redefinition of the management of the table Families; (v) reassessment of the "Revision" and "Check-list" features for the references; and (vi) well defined procedures for the relationships

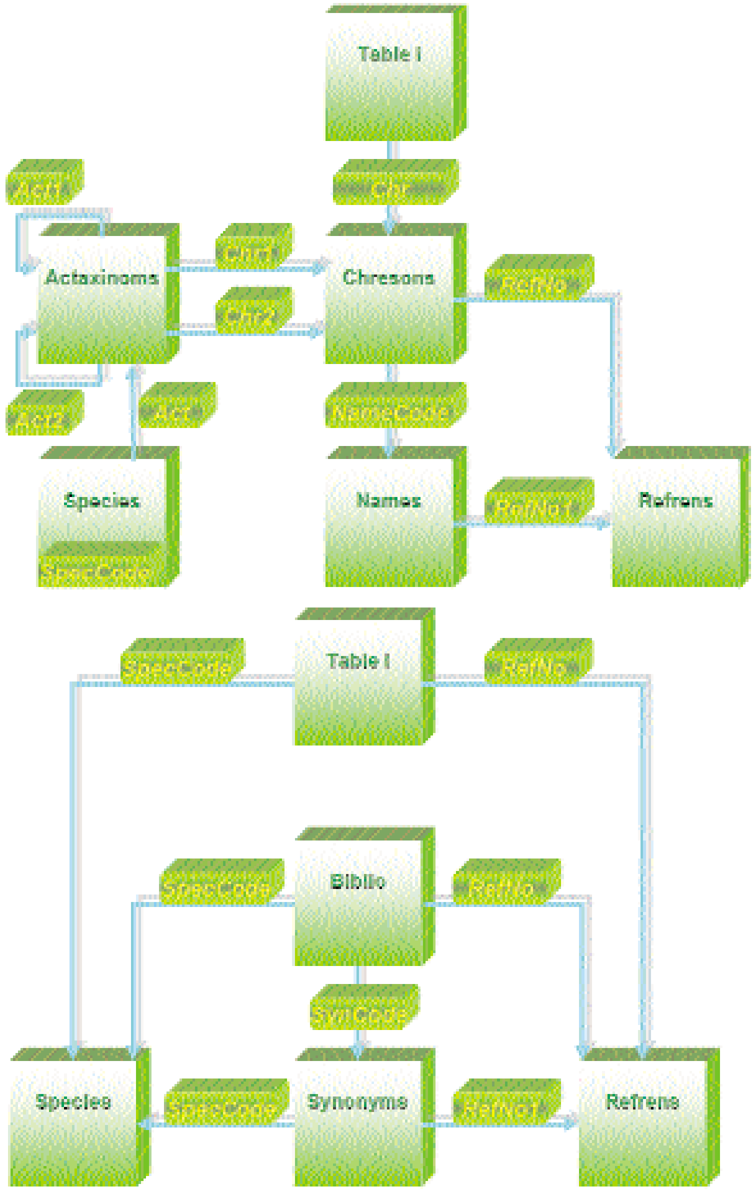

Figure 1 Possible new structure (upper) using the potential taxon concept (here under the name Chresons), compared to the current structure (lower). The synonymies are recorded in the table Actaxinoms, whereas the table Names is a simple repository of words used as names (without author)

between FishBase, Catalog of Fishes, Fishes of the World, and the Integrated Taxonomy Information System. All these improvements should facilitate the maintenance of the taxonomy in FishBase that many taxonomists would like to be more up-to-date than we can afford at present.

References

Bailly N (2004) Bases de données et systèmes à base de connaissances en Systématique: application aux Gadiformes (Actinopterygii: Teleostei). Thèse Doct, Mus Natl Hist Nat, Paris, France

Berendsohn WG (1995) The concept of potential taxa in databases. *Taxon* **44:** 207-212

Fish and more: A global seabird-base is underway

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Data on marine biodiversity are scattered in databases or exist on paper or other published forms, but are not available for interactive searching. However, for sustainable use and management of marine ecosystems, it is essential to make information readily accessible to decision-makers and scientists (Bisby 2000; Edwards *et al*. 2000). Efforts to make information available in a digital form include, among others, the creation of FishBase (www.fishbase.org; Froese & Pauly 2000), which is a comprehensive biological database on all known marine and freshwater fishes. Similarly, Cephbase (www.cephbase.org) provides thorough biological information on all living cephalopod species. Lastly, investigators at the *Sea Around Us* Project (SAUP; www.seaaroundus.org) have constructed a global database of fisheries catches to investigate what impacts fishing has on the marine environment. Towards a more comprehensive understanding of marine ecosystems, the SAUP has also started gathering information on groups such as marine reptiles, echinoderms, marine mammals, and seabirds.

Under the scientific framework of the SAUP, a Microsoft Access database with global coverage was created to include information on the taxonomy, global distribution, biology, ecology, and population dynamics of 351 seabird species. Information was extracted from sources published in peer-reviewed journals as well as in the grey literature. Some existing online seabird databases (e.g., BirdLife International, www.birdlife.net) were also used for data mining (Karpouzi 2005).

All 351 species belong to four orders and 14 families. Their taxonomic classification followed that by Peters (1934, 1979) and was included in the

Taxonomy table. The *Morphology* table included species-specific information on morphological attributes of species (i.e., body mass, culmen, tarsus, and wing length), as well as information on their breeding biology (e.g., clutch size, duration of the species' breeding period). Lastly, data on the species' foraging behaviour was compiled in the *Foraging* table.

The latter included data on foraging attributes, such as: (i) distance flown from colony in search of prey; (ii) diving depths; (iii) traveling speeds; (iv) foraging trip duration; (v) habitat preferences (i.e., nearshore, coastal, pelagic, and foraging over continental shelves); and (vi) affinities with ice.

Each seabird species, within its distributional range, comprises of breeding populations (i.e., number of individuals breeding at a locality, thus forming a breeding colony). From 1950 to 2003, a mean annual population size (usually expressed in the literature in breeding pairs) per colony was recorded in the *Population* table. To account for non- and pre-breeders present in colonies, breeding pairs were transformed into numbers of individuals using equations developed by ICES (2000). Lastly, a *Diet* table was constructed to include diet composition data (% gravimetric abundance) that was available for various breeding populations of 174 seabird species.

Data stored in the *Foraging* table were used for mapping the at-sea distribution of seabird species using a GIS-based modelling approach (Fig. 1). The model parameters considered were: (i) the species' north and south latitudinal range; (ii) their breeding localities; (iii) foraging range; (iv) habitat preferences; and (v) distribution maps of forage prey available in the SAUP database. For the majority of seabirds, probability of occurrence was assumed to decrease linearly with distance from land, to zero at the maximum reported foraging range. For only four out of 351 species, probability of occurrence was described by a trapezoidal probability distribution (i.e., occurrence was assumed to be uniformly highest within a threshold distance from the breeding colony, and then decrease linearly to zero at the maximum reported foraging range). The models predicted that the waters around New Zealand, the eastern coast of Australia, and the sub-Antarctic Islands were characterized by highest species richness (Fig. 1).

The majority of seabird species is distributed in the Southern hemisphere (Fig. 1). The same pattern is particularly evident for albatross and petrel species (Chown *et al*. 1998; Karpouzi 2005). Albatross and petrel populations are declining at an alarming rate because longline fishing poses a great threat (Birdlife International 2004). Indeed, 73 out of 351 species are critically endangered, endangered, or near threatened in the 2003 IUCN Red List of Threatened Species (www.redlist.org), most occurring in the southern hemisphere. Thus, areas of highest probability of holding important concentrations of seabirds may require immediate attention for conservation actions.

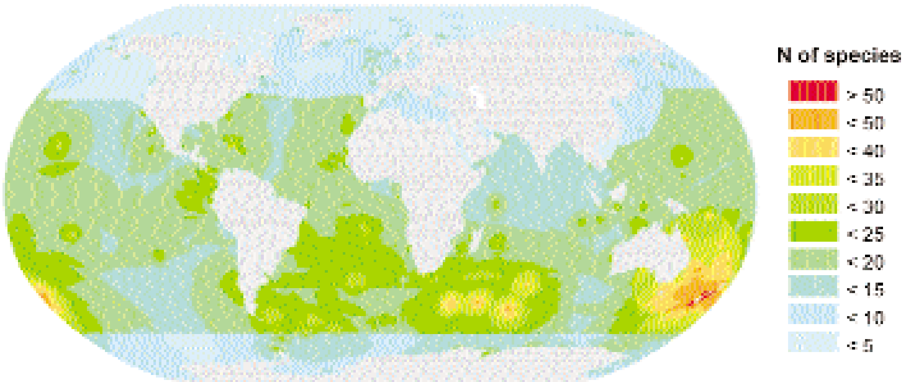

Figure 1 Map of predicted at-sea distribution of seabird species during an average year in the 1990s, expressed in number (N) of seabird species per 30-min (longitude and latitude) spatial cell

Future steps for the improvement of the database include continuous updating of all tables with information that becomes available. Furthermore, the *Population* table will expand to include minimum and maximum population sizes. Breeding populations of seabirds occurring in countries/areas with long coastline (e.g., India, People's Republic of China, Gulf of Alaska) require more adequate representation. Lastly, information on foraging attributes of seabirds is lacking to a great extent; thus the *Foraging* table needs to be further populated and expanded.

References

Birdlife International (2004) State of the world's birds 2004: indicators for our changing world. BirdLife International, Cambridge, UK

Bisby FA (2000) The quiet revolution: biodiversity informatics and the Internet. *Science* **289:** 2309-2312

Chown SL, Gaston KJ, Williams PH (1998) Global patterns in species richness of pelagic seabirds: the Procellariiformes. *Ecography* **21:** 342-350

Edwards JL, Lane MA, Nielsen ES (2000) Interoperability of biodiversity databases: biodiversity information on every desktop. *Science* **289:** 2312-2314

Froese R, Pauly D (eds) (2000) FishBase 2000: concepts, design, and data sources. ICLARM, Los Baños, Laguna, Philippines

ICES (2000) Report of the Working Group on Seabird Ecology. ICES CM 2000/C: 04, 72 p (Available online at http://www.ices.dk/reports/occ/2000/)

Karpouzi VS (2005) Modelling and mapping trophic overlap between fisheries and the world's seabirds. MSc Thesis. Department of Zoology and the Fisheries Centre, University of British Columbia, Vancouver BC, Canada

Peters JL (1934) Checklist of birds of the world. Vol 2. Harvard University Press, Cambridge, MA, USA

Peters JL (1979) Checklist of birds of the world. Vol 1. 2nd edition. Harvard University Press, Cambridge, MA, USA

Policy processes in support of European commitments for international sustainability in relation to aquatic resources - from CBD to the 7th Research Framework Programme

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The sustainability dimensions are usually defined as ecological/environmental, economic, and social. Sustainable development is then the result of deliberative policies that get formulated and implemented by concomitantly integrating these dimensions.

For a long time, managers in charge of fisheries and other natural resources have displayed certainty about their ability to manage the environment and its resources, though there were early dissident voices. Policy, much research and planning were directed at producing more output and controlling production processes through technical measures.

However, with the on-set of environmental movements in response to the degradation of biodiversity, ecosystems and entire land and seascapes, as articulated in the Brundtland report in an internationally recognized way, single-minded production perspectives came under considerable fire in the eighties. In the late eighties and nineties, economics got rising currency through World Bank and IFM structural adjustment policies, while concomitant demand from social movements for greater participation in policy processes that build on and partially take over from more conventional labour movements and trade unions have become more articulate also in the last part of the nineties and the New Millennium.

These movements were important to push governments and UN organizations towards the global environmental conventions that are among the international treaties with highest rates of ratification/adhesion, particularly the Convention on Biological Diversity (CBD), for which Europe was a key supporter. Biodiversity remains a strong political concept in Europe with the Council of Ministers deciding in 2001 to halt biodiversity loss by 2010, though compartmentalization among sustainability dimensions and complicated institutional arrangements have slowed progress.

Over the last decade, movements inspired by adaptive governance that is inclusive with consultation of social actors has been included in the up-date of the Sustainable Development Strategy. Major challenges remain in such sectors as fisheries and aquaculture, however, where major players have not bought into the process.

Attempts to become more inclusive and participatory in setting priorities for policy and research that produces knowledge, capabilities, and innovation to help implement policies have increased significantly, however, remain largely voluntary processes or are lived out as conflicts. Without wide-ranging institutional adaptations and new developments, it will be difficult to engage constructively on a broad enough front, even though stakeholder consultations are now mandatory for all policy and expenditure-relevant initiatives at European level since the Sustainable Development Strategy was adopted in 2004.

In this context, an Action Plan for Biodiversity Research in Europe was developed during two years as a result of a Research Thematic Network funding a European Platform for wide-ranging consultation and dialogue. Inspired by DG Environment, several open internet consultations have been organized since 2002 in preparation of a European Marine Strategy aiming at the protection of the sea. More recently international S&T cooperation conducted an online consultation to better understand expectations of social actors in Europe and abroad about the future of such cooperation as part of an impact assessment and strategic positioning exercise.

These and many other European institution's attempts to reconnect to citizens and adopt participatory modes for developing strategies and implementation to our international policy commitments influence current discussions about the 7th Research Framework Programme. It is fair to say that these participatory modes are still in their infancy, but also that the institutional requirements offer potential if actively used by large numbers of civil society movements, organizations, and individual citizens. This also puts new demands on communicating science to citizens in ways that empower them more effectively to articulate and defend their interests and bring them to bear in a variety of ways, including through dialogue processes underlying policy making and implementation.

Chinese information system of aquatic germplasm resources

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China is the largest fish-producing nation in the world. China has more than 3,500 fish species, of which, about 2,400 are marine species, distributed in the South and East China, Yellow, and Bohai Seas. More than 900 are freshwater species, distributed in the Yangtze, Pearl, Yellow, and Heilong Jiang River Basins, and in Qinhai, Tibet, and Taiwan waters. In addition, China has about 70 alien fish species introduced in the last decades. All these species are very important resources for the Chinese fishing industry and provide numerous varieties for aquaculture.

However, China's aquatic biodiversity is seriously threatened because of the global climate change, subsequent damage to some ecosystems, soil erosion, water pollution, and overfishing. Take the Yangtze River as an example. Over the past decades, driven by commercial interests, the government has built many dams and facilities on the river for the generation of electricity and other purposes. These constructions directly or indirectly disturb ecosystems by blocking the feeding and spawning migration of some fish species. Thus, quite a few stocks are now unable to access their original feeding or spawning grounds. As a result, some fish stocks have severely declined. It is reported that in the 1980s, fishing production in the river was less than half of that of the 1950s, and fry-catching production was only one fourth of that in the 1960s. Some high-valued species, such as *Lipotes vexillifer,* and *Macrura reevesii*, have become seriously endangered. Marine fish stocks also suffer from serious decline mainly from overfishing and water pollution. For instance *Chrysophrys major*, *Paralichthys olivaceus*, and *Ilisha elongata* (as well as the crustaceans *Penaeus* *orientalis* and *Eriocheir sinensis*) were very commercially important in China. Nowadays, their wild biomass is estimated at only 29% of that ten years ago. How to conserve and adequately utilize fish resources is becoming a critical issue for China to ensure sustainable development of the fishing industry. The Chinese government is aware of such problems and recently started to support some projects to solve them. For example, over the past years, the government invested to build and protect some natural fish ecosystems in the Yangtze River and supported research on fish germplasm. The Chinese database of Aquatic Germplasm Resources is one of the projects supported by the Ministry of Science and Technology. The aim of this project is to collect and process information on fish germplasm and make it available to the public.

The information system of Aquatic Germplasm Resources is based on Microsoft Access and primarily consists of information on nine aspects (Fig. 1).

Basic information of species available in China waters contains information on 3,872 fish species, 2,563 of which are marine and 1,476 freshwater species (some species may be over counted as they are brackish water living

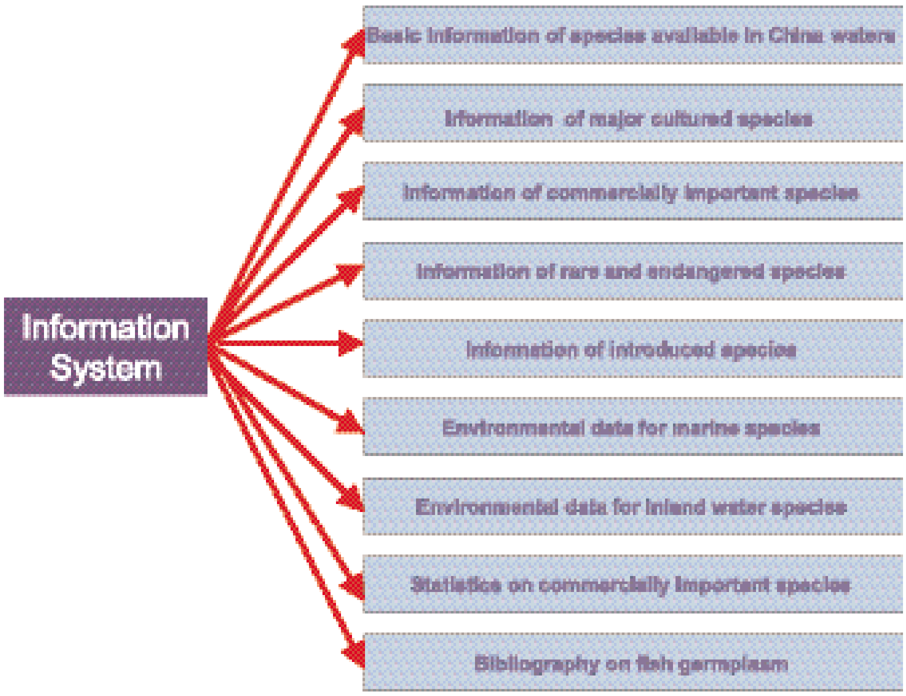

Figure 1 The information system of Aquatic Germplasm Resources

species). Collected information includes species picture, classification, morphology, habitat, propagation, and geographical distribution.

Information of major cultured species contains information on 177 fish species including their culture technologies (seed production, farming, disease control, feeding, and harvesting).

Information of commercially important species includes information on 69 species, including genetic, molecular, and stock characteristics.

Information of rare and endangered species collects information on 22 species, including species characteristics and culture technologies.

Information of introduced species refers to 72 species that China has introduced from foreign countries since 1970s, including seed production, farming, disease control, feeding, and harvesting.

Environmental data for marine species concerns fish stocks and related data on marine waters where fish stocks are found.

Environmental data for inland water species concerns fish stocks and related data on inland waters where fish stocks are found.

Statistics on commercially important species provide data and charts on catches or aquaculture of those species.

Bibliography on fish germplasm includes research papers and other literature on the particular fish stocks.

References

Qisheng T, Xianshi J (1999) Developing and utilizing of fishery bio-resources. The Strategic Studies on Scientific and Technologic Development of China fisheries for the 21 century. China Agriculture Science & Technology Press

Laining Y (1999) Fishery germplasm resources. The Strategic Studies on Scientific and Technologic Development of China fisheries for the 21 Century. China Agriculture Science & Technology Press

Yongsheng C. Jianjun B, Yuan H (1999) The information system of agriculture crops in China. Computer and Agriculture

International bottom trawl survey in the Mediterranean: The MEDITS project

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The MEDITS program (International bottom trawl survey in the Mediterranean) was organized with the instigation of the European Commission (Directorate of Fisheries, 1993), for supporting the Common Fishery Policy in the Mediterranean. This led to the development of a standardized observation network on demersal resources of the area. The objective was to contribute to the fisheries monitoring system in the Mediterranean by organizing regular large-scale bottom trawl surveys and producing assessments of the demersal resources to serve as references for their sustainable management. The program began in 1994 with four partner countries (Spain, France, Italy, and Greece) with surveys being conducted along their coasts. Almost all the Adriatic Sea was covered with the additional participation of Slovenia, Croatia, and Albania since 1996. The south of the Alboran Sea was included in the survey in 1999, with the Moroccan contribution, and the waters around Malta were included in 2000 (Fig. 1). The participation of Cyprus in 2005 will further expand the surveyed area to the eastern Mediterranean.

The surveys in Greek waters are carried out by three teams: (i) Institute of Marine Biological Resources, IMBR/HCMR-Athens, in the Ionian Sea and the Argosaronikos area; (ii) IMBR/HCMR-Crete in the Southern Aegean Sea; and (iii) Fisheries Research Institute, FRI-Kavala in the Northern Aegean Sea. IMBR/HCMR-Athens is the National Coordinator. The international coordination is ensured by the Coordination Committee, which is composed of the national coordinators of each country, and by the Steering Committee, which is composed of the regional coordinators.

At the beginning of the project, common standardized sampling protocols were adopted by all partners. The protocols included the design of the survey, the sampling gear (feature and handling), the information to be collected, and data management (i.e., data format, standardized analyses). The "Manual of protocols" agreed by the Steering Committee was distributed to the participants before the first survey. This manual, which was published later

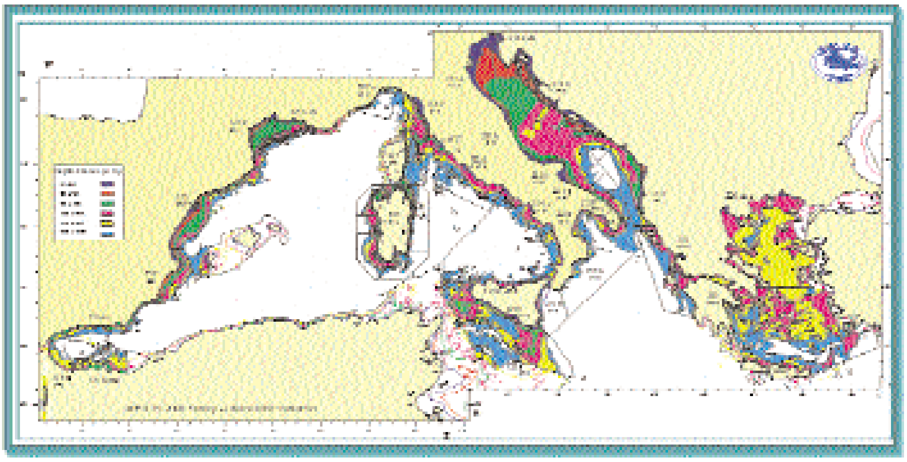

Figure 1 Subareas of the MEDITS 2000 survey

to ensure its distribution (Anonymous 1998), has been created based on different experiences and particularly on those of the IBTS Group (ICES 1992). The protocols were amended when necessary in the following years.

The bottom trawl surveys cover all trawlable areas of the shelves and upper slopes, from 10 to 800 m depth. The sampling area is stratified by depth (strata: 10-50 m, 50-100 m, 100-200 m, 200-500 m, 500-800 m) with random distribution of hauls within each stratum. The same haul positions were kept each year. Haul duration is fixed to 30 min at depths less than 200 m and 60 min at depths greater than 200 m. The sampling gear is a bottom trawl designed for this purpose (IFREMER-Sète) with a cod-end stretched mesh size of 20 mm. All surveys take place in summer. An effort was made to use the same vessel every year in each area. A list of 36 common target species was defined taking into account their commercial importance, their accessibility to a bottom trawl, and their potential interest as biological indicators in the different areas. Collected information on each of these species (26 fishes, 6 cephalopods, and 4 crustaceans) includes total number of specimens, total weight, length frequency distribution, and sex (including stage of sexual maturity according to the MEDITS protocols). The total number and weight are also recorded for a complementary list of 22 species (19 fishes, 1 cephalopod, and 2 crustaceans).

Raw data are stored in computer files by each team using standard exchange formats of five standard file types: TA (haul data), TB (catches by haul), TC (biological parameters), TD (temperature data) and TR (stratification scheme). An automatic checking of the data is done by each partner using specific software developed for this purpose (Souplet 1996a,b). The data were regrouped for a second validation at an international level (IFREMER- Sète) until 2001 or at a national level, after the incorporation of MEDITS in the National Projects for Data Collection 2002-2006 (EC regulation 1543/2000). The standard analyses produced every year include biomass and abundance indices (in kg/km^2 and number of $specimens/km^2$) and length frequency distributions by target species and stratum. The analyses are made using specific software (Souplet 1996a,b), which was included later in the MEDITS Data Management System (EC/NCMR Contract No 96-016).

Furthermore, specific results obtained from the project on the properties of the fishing gear and the biology and ecology of the species caught in each area were presented during an international symposium held in Pisa in 1998 (Bertrand & Relini 2000). An additional analysis of the MEDITS data obtained until 1999 was made in the framework of the project SAMED (Stock assessment in the Mediterranean-EC/SIBM Contract No 99/047). A special issue of the journal *Scientia Marina* was also devoted to a series of articles concerning spatial and temporal trends of the MEDITS target species and other contributions based on this program (Abelló *et al*. 2002). In the framework of the MEDITS 2000-2001 project three sub-tasks were defined in order to study the following subjects using the data obtained until then: species assemblages, nursery areas, and statistical analysis of temporal trends. Finally, in 2004, a MEDITS working group was organized in order to: (1) select sets of indicators to assess population and fish communities in the Mediterranean; (2) apply them to the whole MEDITS series in order to evaluate their potential as assessment tools; and (3) produce preliminary assessments. A meeting of the group was held in Nantes (France) in March 2005 for a first data analysis and discussion. Specific software was developed to perform all calculations and produce the relevant figures (Rochet *et al*. 2004). A scientific report with the results will be produced in 2005.

References

Abelló P, Bertrand J, Gil de Sola L, Papaconstantinou C, Relini G, Souplet A (eds) (2002) Marine demersal resources of the Mediterranean: the MEDITS International trawl survey (1994-1999). *Sci Mar* **66 (Suppl 2)**

Anonymous (1998) Campagne internationale de chalutage démersal en Méditerranée (MEDITS): manuel des protocoles. *Biol Mar Medit* **5:** 515-572

Bertrand JA, Relini G (eds) (2000) Demersal resources in the Mediterranean. Actes de Colloques, 26. IFREMER, Plouzané

ICES (1992) Manual for the International Bottom Trawl Surveys. Revision IV. ICES/CIEM: 47 p

Rochet MJ, Trenkel VM, Bertrand JA, Poulard J-C (2004) R routines for survey based fisheries population and community indicators (R-SUFI). IFREMER, Nantes. Limited distribution

Souplet A (1996a) Calculation of abundance indices and length frequencies in the MEDITS survey. *In:* Bertrand J (ed) Campagne internationale de chalutage démersal en Méditerranée (MEDITS). Campagne 1995 Vol. III. Rapport final de contrat CEE-IFREMER-IEO-NCMR (MED/93/020,018,006,004)

Souplet A (1996b) Checkmed: a software to check the MEDITS data files. *In:* Bertrand J (ed) Campagne internationale de chalutage démersal en Méditerranée (MEDITS). Campagne 1995 Vol. I, pp 21-26. Rapport final de contrat CEE-IFREMER-IEO-NCMR (MED/93/020,018,006,004)

Fisheries Research Institute: Ten-year data from experimental fishing and landings recording

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Introduction. During the last ten years the Fisheries Research Institute (FRI) has co-ordinated a series of projects (Table 1) funded primarily by the European Union and secondarily by national sources. These research projects concern experimental fishing or monitoring of catches onboard of professional fishing vessels and recording of landings before the public auction. Collected data (most of which are relevant to FishBase) and subsequent analyses (Table 2) concern species occurrence, length- and age-frequency distributions, length-weight relationships, sex ratio, and maturity stages. Such data have been published in 11 technical reports, available upon request through FRI, as well as in other scientific publications (e.g., Kallianiotis 1995; Kallianiotis *et al*. 2001, 2004, in press; Machias *et al*. 2001; Lambrakis *et al*. 2003; Adamidou *et al*. 2004; Beltrano *et al*. 2004). The analysis of the data gathered during these projects has greatly improved our knowledge on marine fishes inhabiting the areas studied by FRI. Based on the results of the above-mentioned projects and using GIS and haul coordinates various distributional maps have been produced (Fig. 1). The three main projects in which FRI has been involved are briefly described below.

MEDITS. This project is in cooperation with other national and European bodies and organizations based on a standard methodology and following the same protocols (see Politou this volume). During 1996-2005, 612 hauls were carried out by FRI at depths ranging from 30 to 650 m, in the N Aegean Sea (north of 38°N). This project has greatly contributed to the accumulation of abundance and density data concerning one of the most productive Greek fishing grounds, for which practically no information was available before.

Table 1 The main projects co-ordinated by the Fisheries Research Institute (FRI; Kavala, Greece) during the last ten years (N is number of hauls; *Number of interviews)

Project acronym	Description	Year	Depth (m)	N
MEDITS	International bottom trawl survey in the Mediterranean	1996-2005	30-650	612
DISCARDS	Analysis of trawl discard operation in the Central and E Mediterranean	1998-2005	10-550	400
PURSE SEINE	The purse seine landing composition in Central and E Mediterranean	2000-2001	50- 50	32
NETRASEL	*Nephrops* trawl discards reduction using activating selection grids	1999-2001	150- 50	20
FAR	Fanari artificial reef	1997-2004	15-25	120
KAR	Kalymnos artificial reef	1998-2000	20-40	16
IAR	Ierissos Artificial Reef	2005-	20-50	8
FAD	Fish aggregating device (FAD) fisheries in the E Mediterranean: An alternative technique to enhance pelagic fish catches and diversify fishing effort?	2000-2001	20-50	10
SACS	Stock assessment of some coastal species caught by artisanal fishery	1997-2000	10-50	3887*
TRAMMEL NET	Fishing power and selectivity of net and vessel type	2000-2001	10-30	46
ANREC	Association of physical andbiological processes acting on recruitment and post recruitment of anchovy	2002-2005	50-150	64

Table 2 Number of species recorded per project and number of species for which length-frequencies and sex ratio and maturity data are available

Project	Species caught	Length frequencies	Sex ratio and maturity
MEDITS	141	23	21
DISCARDS	167	23	
PURSE SEINE	18	2	2
NETRASEL	47	1	
FAR	57	7	
KAR	33	7	
IAR	98	7	
FAD	8	8	
SACS	110	3	3
TRAMMEL NET	45	3	
ANREC	2	1	1

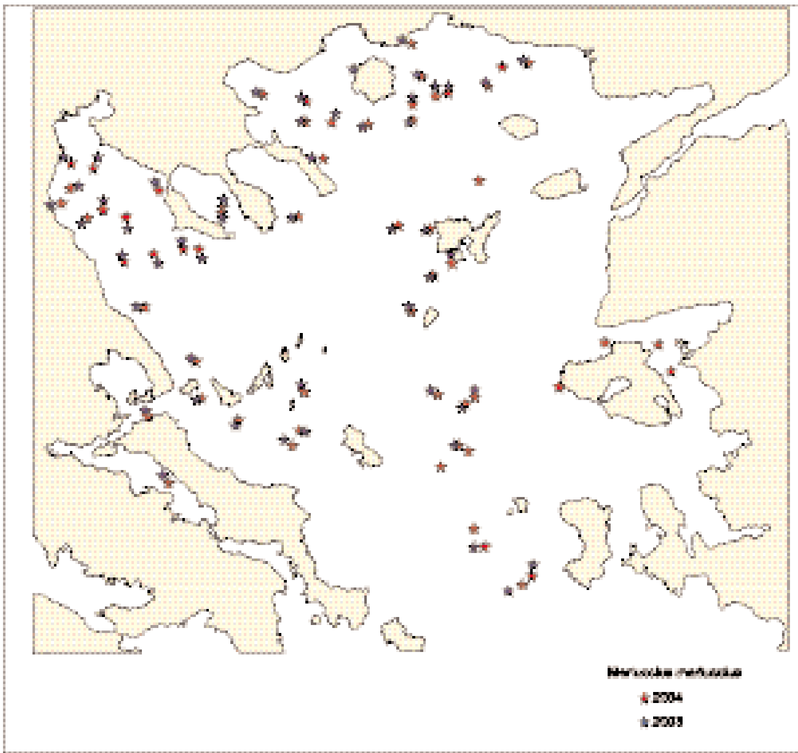

Figure 1 Distribution of *Merluccius merluccius* in N Aegean Sea

DISCARDS. The aim of this project is to estimate discard rates in the trawl fishery of the Central and E Mediterranean Sea. The study area for FRI is the N Aegean Sea. The project lasted from 1995 to 2000. The main data recorded was: (i) species composition per depth stratum (0-150, 150-300, >300 m), and species' mean hourly yield and abundance per sampling season (autumn, winter, summer); (ii) mean total yield (±SD) and relative proportion of the marketable and discarded fraction per stratum and season; (iii) mean abundance (±SD) and mean yield per hour (±SD) of the target species per stratum and season; (iv) catch composition by weight of all marketable and discarded species, per stratum and season; (v) length-frequency distribution of the target species, the three most abundant low demand and three totally discarded species, per stratum and season. Since 2003, this project continues in the framework of the National project.

FAR. This project concerns the construction and monitoring of an artificial reef in the Fanari area (Rodopi, Thracian Sea). Sampling depth ranged between 15-25 m. Overall, 120 hauls were conducted with a special trawl net during 1997-2004 and 57 fish species have been recorded. This project provided a plethora of data on coastal fishes, previously difficult to monitor with trawling, which is not allowed throughout the year in the shallow zone of the Thracian Sea. The resulted time series are among the longest ones available from the Greek coastal zone.

Other projects. FRI also participates in projects concerning the fish fauna and the fisheries landings of lagoons and lakes. In particular, landings have been collected from all coastal lagoons of Northern Greece. In addition, data on fish assemblages or the biology of estuarine resident or migrant fish species (53 species in total) have been collected from nine lagoons (Monolimni, Drana, Agios Andreas, Vistonis, Lagos, Porto-Lagos, Vassova, Eratino, Agiasma) and two estuaries (Strymon and Rihios).

References

Adamidou A, Kallianiotis A, Holst R (2004) Size selectivity of trammel nets used in the common sole, *Solea solea*, fishery in the Thracian Sea (NE Mediterranean). *Rapp Comm Intl Mer Medit* **37:** 303

Beltrano A, Kallianiotis A, Canizzaro L, Scalisi M, Vitale S, Bono G, Vidoris P, Milazzo A (2004) Morphological variability among populations of *Diplodus vulgaris* (Pisces, Sparidae) in the Mediterranean Sea. *Rapp Comm Intl Mer Medit* **37:** 311

Kallianiotis A (1995) The anchovy fishery in the Aegean Sea: a flourishing industry or a lost affair? *Sci Mar* **60(Suppl. 2):** 287-288

Kallianiotis A, Vidoris P, Kokkinakis A (2001) Common octopus (*Octopus vulgaris*, Cuvier 1797) coastal fishery, during the peak of fish reproduction. *Rapp Comm Intl Mer Medit* **36:** 279

Kallianiotis A, Vidoris P, Sylaios G (2004) Fish species assemblages and geographical sub-areas in the North Aegean Sea, Greece. *Fish Res* **68:** 171-187

Kallianiotis A, Torre M, Argyri A (in press) Age, growth, mortality, reproduction, and feeding habits of the stripped seabream, *Lithognathus mormyrus* L. (Pisces, Sparidae) in the coastal waters of the Thracian Sea, Greece. *Sci Mar*

Lambrakis M, Kallianiotis A, Moutopoulos DK, Stergiou KI (2003) Weight-length relationships of fishes discarded by trawlers in the North Aegean Sea. *Acta Icthyol Pisc* **33:** 145-151

Machias A, Vassilopoulou V, Vatsos D, Bekas P, Kallianiotis A, Papaconstantinou C, Tsimenides N (2001) Bottom trawl discards in the Northeastern Mediterranean Sea. *Fish Res* **53:** 181-195

Reproduction of Mediterranean fishes

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The reproductive strategies of fishes have long been a central issue in fisheries biology, ecology, and management (e.g., Beverton 1963, 1992; Balon 1975; Froese & Binohlan 2000, 2003; Froese & Pauly 2000). An exploited fish population reacts to increasing fishing effort, i.e., as mortality increases, compensatory mechanisms take place, e.g., in growth and recruitment such as changes in fecundity and survival as well as in size and age of first maturity (Ricker 1975; Jennings *et al*. 2001; Olsen *et al*. 2004).

Despite the fact that the Mediterranean Sea has been fished for many millennia, information on the biology/ecology of fishes in the Mediterranean is limited when compared to most Large Marine Ecosystems. Part of this lack of information could be related to the fact that information is mainly published in local journals, and in languages other than English, and/or remains unpublished, often kept in drawers (CIESM 2003). In order to update FishBase (Froese & Pauly 2000; www.fishbase.org) with information on Mediterranean fishes, we collected data from the literature on the fecundity (F), spawning season, the size (L_m, cm) and age (t_m, yr) at first maturity and maximum reported length (L_{max}, cm) for 504 Mediterranean fish stocks (Fig. 1), belonging to 130 species. This expands on an earlier, preliminary report by Tsikliras *et al*. (2005).

In general, available information on the reproduction of Mediterranean fishes diminishes from north to south and from west to east (Fig. 1). It is interesting to note that from a total of 202 sources used, only 68 (33.7%) were indexed in the Science Citation Index (SCI). In contrast, 50 (24.8%) were found from other international or local journals not listed in SCI, whereas the remaining 84 (41.5%) sources were derived from conference proceedings, reports, and theses (i.e., grey literature). This clearly shows the importance of locating and using such secondary sources.

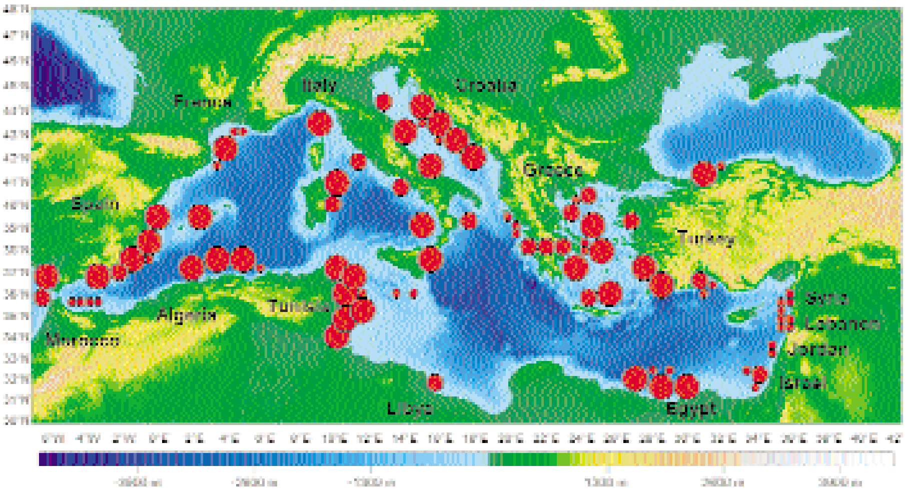

Figure 1 Map of the Mediterranean Sea showing approximate locations where data on at least one aspect of fish reproduction is available (total: 504 stocks). The red-bubble size is proportional to the number of stocks (small=1, medium=5, large=10 stocks). The bottom bar indicates depth and altitude (in m). Map from Università degli Studi di Pavia (Centro Interdisciplinare di Bioacustica a Ricerche Ambientali) (downloadable at http://www.unipv.it/web cib/edu-Mediterraneo-uk.html)

We found data on: (i) fecundity for 94 stocks, belonging to 61 species (derived from 69 sources); (ii) spawning season for 301 stocks, belonging to 117 species (derived from 144 sources); and (iii) L_m for 301 stocks, belonging to 93 species (derived from 127 sources). All sources used will be soon incorporated into FishBase.

Out of the 301 stocks for which data on the spawning season was available, 203 stocks were long-day breeders, i.e., spawning between April and August, 87 were short-day breeders, i.e., spawning between September and March, while the remaining 11 were all-year-round breeders. In addition, 156 out of the 301 stocks were characterised by an extended (>4 months) spawning season.

Across species, L_m exhibited a positive linear relationship with L_{max} for both males (L_m=0.466L_{max}+3.777, r^2=0.72, n=115, P<0.001) and females (L_m=0.550L_{max}+1.180, r^2=0.79, n=135, P<0.001), with the two slopes being significantly different (analysis of covariance, F=5.34, P=0.02). The two regression lines intersected at L_{max} of about 30 cm, after which males had smaller L_m than females of species of the same L_{max}. Across species, maximum F exhibited an exponential relationship with L_{max}, its slope increasing after the length of about 30-35 cm (Tsikliras *et al*. 2005). Thus, for species with L_{max} > 30 cm, male L_m was smaller than that of females of the same L_{max}. This indicates that females of species with L_{max} > 30 cm delay maturation, i.e., benefiting from the strong exponential increase in fecundity when L_{max} > 30-35 cm.

The L_m/L_{max} ratio ranged between 0.23 (*Lithognathus mormyrus*, L_{max}=83.3 cm) and 0.94 (*Oxynotus centrina*, L_{max}=64 cm) with a mean of 0.59 (SD=0.14, n=290). The L_m/L_{max} of the Mediterranean fishes was lower for large-sized species (> 50 cm), around 50%, and higher for fast growing, small-sized fishes (<50 cm), more than 60%, conforming with the general observations of Beverton (1963), Longhurst & Pauly (1987), and Pauly (1994).

References

Balon EK (1975) Reproductive guilds in fishes: a proposal and definition. *J Fish Res Bd Can* **32:** 821-864

Beverton RJH (1963) Maturation, growth and mortality of clupeid and engraulid stocks in relation to fishing. *Rapp Proc-Verb Réun Cons Int Explor Mer* **154:** 44-67

Beverton RJH (1992) Patterns of reproductive strategy parameters in some marine teleost fishes. *J Fish Biol* **41(Suppl B):** 137-160

CIESM (2003) Mediterranean biological time series. *CIESM Workshop Monogr Ser* **22:** 1-142 (CIESM Publications, Monaco, available online at www.ciesm.org/publications/split03.pdf)

Froese R, Binohlan C (2000) Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. *J Fish Biol* **56:** 758-773

Froese R, Binohlan C (2003) Simple methods to obtain preliminary growth estimates for fishes. *J Appl Ichthyol* **19:** 376-379

Froese R, Pauly D (eds) (2000) Fishbase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines

Jennings S, Kaiser MJ, Reynolds JD (2001) Marine fisheries ecology. Blackwell Science, London

Longhurst AR, Pauly D (1987) Ecology of tropical oceans. Academic Press, San Diego

Olsen EM, Heino M, Lilly GR, Morgan MJ, Brattey J, Ernande B, Dieckmann U (2004) Maturation trends indicative of rapid evolution preceded the collapse of northern cod. *Nature* **428:** 932-935

Pauly D (1994) On the sex of fish and the gender of scientists. Chapman and Hall, London

Ricker WE (1975) Computation and interpretation of biological statistics of fish populations. *Bull Fish Res Bd Can* **191:** 1-382

Tsikliras AC, Antonopoulou E, Stergiou KI (2005) Patterns and propensities in the reproduction of Mediterranean fishes. *Proc Conf Hellenic Soc Biol Sci* **27:** 397

Growth of freshwater fishes from the Balkans and Turkey

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The countries of the Balkan Peninsula and Turkey host a diverse freshwater ichthyofauna with numerous endemic species and subspecies (Economidis & Banarescu 1991; Balik 1995; Economidis 1995; Maric 1995; Mrakovcic *et al.* 1995; Povz 1995; Rakaj & Flloko 1995). Yet, age and growth of freshwater fishes from these countries are poorly covered in FishBase (www.fishbase.org; Froese & Pauly 2000). This could be partially attributed to the fact that the results of studies on this topic are mainly published in local, and otherwise not easily accessible, journals.

In order to fill this gap, we surveyed the available literature for data on age and growth of fishes from the rivers, lakes, reservoirs, and lagoons of the Balkan Peninsula (Albania, Bulgaria, countries of the former Yugoslavia, Romania, and Greece), and Turkey. In particular, we collected data on: (i) maximum length (L_{max}, cm) and age (t_{max}, yr); (ii) length-at-age; and (iii) the von Bertalanffy (1938) growth parameters, asymptotic length L_∞ (in cm), the rate at which L_∞ is approached, K (in 1/yr), and the theoretical age at zero length, t_0, (in yr). We also tabulated auxiliary information such as study year, frequency of sampling, sampling gear, sample size, method used for the estimation of growth parameters, and skeletal structure used for age determination. When the original authors did not provide estimates of growth parameters, we estimated them iteratively from the available length-at-age data using the Simplex minimization algorithm.

So far, we found 85 relevant papers [from journals in Science Citation Index, SCI: 36 (42.4%); from international or local journals not listed in SCI:

27 (31.8%); from conference proceedings, reports, theses, etc: 22 (25.8%)]. The vast majority of these papers are not included in FishBase and will be soon incorporated.

Overall, we assembled age and growth data for 140 fish stocks, belonging to 46 species, from Greece (63 stocks, 28 species), Turkey (55 stocks, 20 species), Bulgaria (10 stocks, 4 species), Croatia (8 stocks, 4 species), Serbia (3 stocks, 3 species), and FYROM (1 stock).

L_{max}, length-at-age, and t_{max} were available for all stocks. L_∞ and K were provided by the original authors for 108 stocks (belonging to 41 species; derived from 53 sources). For one stock, the original L_∞ was unrealistically high (*Carassius auratus*: L_{max}= 27.3 cm, L_∞= 122.7 cm) and thus not included in further analyses. We were also able to estimate growth parameters for 23 stocks (belonging to 11 species). For 24 stocks the t_0 value was higher than ¦1.5¦, indicating that these estimates may be questionable.

The two most studied species were tench, *Tinca tinca*, and roach, *Rutilus rutilus*, both members of Cyprinidae, which was the most intensively studied family.

Finally, we estimated the relationships between K and t_{max} (Fig. 1), and K and L_∞, the latter both across all species and families.

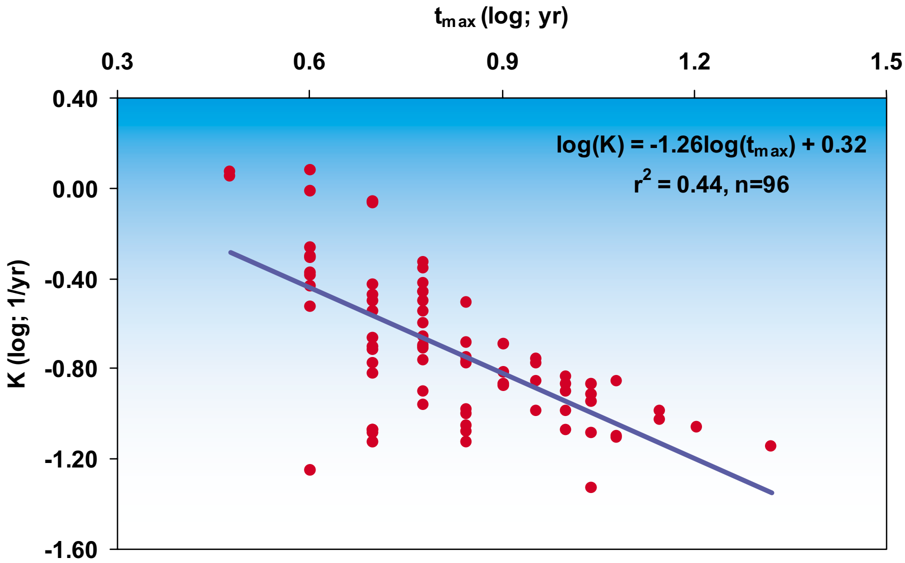

Figure 1 Relationship between K (log; 1/yr) and t_{max} (log; yr) for 96 freshwater fish stocks from the Balkans and Turkey

References

Balik S (1995) Freshwater fish in Anatolia, Turkey. *Biol Conserv* **72:** 213-223

Bertalanffy L von (1938) A quantitative theory of organic growth. *Hum Biol* **10:** 181-213

Economidis PS (1995) Endangered freshwater fishes of Greece. Status of freshwater fishes in the Adriatic catchment of Slovenia. *Biol Conserv* **72:** 201-211

Economidis PS, Banarescu PM (1991) The distribution and origins of freshwater fishes from Balkan Peninsula, especially in Greece. *Int Revue Ges Hydrobiol* **76**: 257-283

Froese R, Pauly D (eds) (2000) Fishbase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines

Maric D (1995) Endemic fish species of Montenegro. *Biol Conserv* **72:** 187-194

Mrakovcic M, Misetic S, Povz M (1995) Status of freshwater fish in Croatian Adriatic river systems. Status of freshwater fishes in the Adriatic catchment of Slovenia. *Biol Conserv* **72**: 179-185

Povz M (1995) Status of freshwater fishes in the Adriatic catchment of Slovenia. *Biol Conserv* **72:** 171-177

Rakaj N, Flloko A (1995) Conservation status of freshwater fish of Albania. *Biol Conserv* **72:** 195-199

Morphometric relationships in fishes

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Expressing various morphometric characteristics (e.g., body girth, mouth dimensions, gut length, tail height and area) in relation to body size is useful in understanding various aspects of fish ecology, biology, and fisheries (e.g., Peters 1983; Froese & Binohlan 2000, 2003; Froese & Pauly 2005). Such relationships are important, among other reasons, in (a) describing gear selectivity patterns and therefore improving fishing gear technology; and (b) assessing the approximate trophic position of a species and thus defining its role in the ecosystem (e.g., Kramer & Bryant 1995a, 1995b; Karpouzi & Stergiou 2003; Stergiou & Karpouzi 2003). In this report we present preliminary results on the relationship between total length and various morphometric characteristics that are related to feeding (i.e., mouth dimensions, gut length, and tail characteristics) for various fish species. The data was collected within the framework of a project on the feeding habits and trophic levels of about 50 fish species in the N-NW Aegean Sea.

Samples were collected on a seasonal basis, from spring 2001 to summer 2005, using commercial fishing vessels (i.e., trawlers, purse-seines, and gill-netters). We measured total (TL), fork (FL), and standard (SL) lengths (cm), weight (W, g), horizontal (HMO) and vertical (VMO) mouth opening for each individual per species, and gut length (GL), when possible. Mouth area (MA) was calculated from HMO and VMO, modeled as an ellipse (Erzini *et al*. 1997). Furthermore, tail area (TA), perimeter (TP), and height (TH) were estimated using UTHSCA ImageTool (Wilcox *et al*. 1997) for a large number of individuals per species. TL was regressed against: (i) W, FL, SL; (ii) VMO, HMO, and MA; (iii) GL; and (iv) TH, TP and TA.

We will link these characteristics to other ecological parameters, such as fractional trophic level (estimated from the species' quantitative diet composition) and habitat type. As an example, we present the TA-TL relationship for 18 fish species grouped by habitat type, i.e., pelagic (5 species), benthopelagic (5 species), reef associated (4 species), and demersal (5 species) (habitat type extracted from FishBase; www.fishbase.org). The TA-TL relationships formed four distinct habitat-related groups (Fig. 1). The slope *b* of all four groups differed significantly (Fig. 1; analysis of covariance for log-log plots, $P<0.05$ for all combinations). TA for TL=15cm increased linearly with log-transformed trophic level ($r^2=0.32$, n=18, $P<0.05$). Similar analyses will be performed for the remaining morphometric characteristics measured.

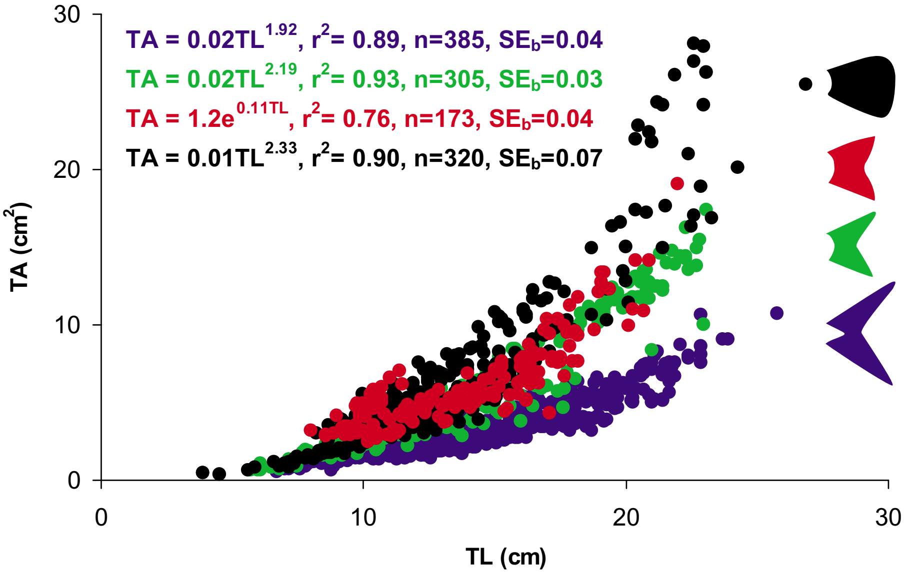

Figure 1 Relationships of tail area (TA) and total body length (TL) for 18 fish species from the N-NW Aegean Sea, grouped according to their habitat (the latter following FishBase): Froese & Pauly 2005). **Blue**: pelagic (5 species); **Green**: benthopelagic (5 species); **Red**: reef-associated (4 species); and **Black**: demersal (5 species)

Such relationships are useful for the estimation of other morphometric characteristics and rates in fishes (e.g., aspect ratio, from TA and TH, and thus Q/B: Pauly 1989). In addition, linking these characteristics, together with length, to trophic levels could be useful for obtaining more precise estimates of trophic levels for fish when diet data are lacking. Thus, incorporation of such relationships into new FishBase tables will be useful.

References

Erzini K, Gonçalves JMS, Bentes L, Lino PG (1997) Fish mouth dimensions and size selectivity in a Portuguese longline fishery. *J Appl Ichthyol* **13:** 41-44

Froese R, Binohlan C (2000) Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. *J Fish Biol* **56:** 758-773

Froese R, Binohlan C (2003) Simple methods to obtain preliminary growth estimates for fishes. *J Appl Ichthyol* **19:** 376-379

Froese R, Pauly D (eds) (2005) FishBase. World Wide Web electronic publication. URL: www.fishbase.org http//:www.fishbase.org

Karpouzi VS, Stergiou KI (2003) The relationships between mouth size and shape and body length for 18 species of marine fishes and their trophic implications. *J Fish Biol* **62:** 1353-1365

Kramer DL, Bryant MJ (1995a) Intestine length in the fishes of a tropical stream: 1. Ontogenetic allometry. *Env Biol Fish* **42:** 115-127

Kramer DL, Bryant MJ (1995b) Intestine length in the fishes of a tropical stream: 2. Relationships to diet – the long and short of a convoluted issue. *Env Biol Fish* **42:** 129-141

Pauly D (1989) A simple index of metabolic level in fishes. *FishBytes* **7(1):** 22

Peters RH (1983) The ecological implications of body size. Cambridge Studies in Ecology, Cambridge University Press, New York

Stergiou KI, Karpouzi VS (2003) Length-girth relationships for several marine fishes. *Fish Res* **60:** 161-168

Wilcox CD, Dove SB, McDavid WD, Greer DB (1997) UTHSCSA Image Tool User Manual. University of Texas Health Science Center, San Antonio, Texas