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Taxonomic and distributional databases of fishes in Taiwan

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Synopsis

The fishes of Taiwan comprise total 2450 species in 250 families, about 1/10 of the world's fishes. Curatorial and distributional data of Taiwanese fish have been integrated into a database that can be accessed interactively on the Internet at http://fishdb.sinica.edu.tw. The database includes the following items: basic information and specimen photo of each species, distributional database, bibliographic database, curatorial database, inquiring system for Chinese fish names of the world fishes, and new version of erratum of 'Fishes of Taiwan'. The above regional database of Taiwanese fishes provides hyperlinks to fish data for each species in the global fish data, FishBase, of ICLARM (http://www.fishbase.org). Through the collaboration with FishBase and other global networks for taxonomic purposes, like Species 2000, BioNet, or GBIF (Global Biodiversity Information Facilities), users in the world can also obtain updated data provided by Taiwan. We hope our experience with database establishment can be used as a model to help other countries to develop their own regional fish databases or even to build up databases of other groups of organisms. There should be one good approach for all people in the world for sharing complete and updated biodiversity information via the Internet.

Introduction

Fish databases in the world

Large fish databases distributed via CD-ROM or the Internet are useful for exchanging information and promoting the development of science and education. They are also an essential task to strengthen the utilization and conservation of our aquatic biological resources. However, the scope of a fish database may be potentially very broad, and its information may range from the basic to the applied, including public education and academic research in taxonomy, ecology, physiology, biochemistry, applied aquaculture, fish pathology, and fisheries sciences.

Current taxonomic databases cover five areas including nomenclature (scientific names, synonyms, and common names), zoogeography (distribution), bibliography (references), inventory (specimens), and characters (morphology or ecology) (Allkin & Bisby 1984). Some of the above databases have been well established globally. For instance, the 'Catalog of the Genera of Recent Fishes' (Eschmeyer 1990) and 'Catalog of Fishes' (Eschmeyer 1998) for the nomenclature database have been incorporated into one global fish database called 'FishBase' (Froese & Pauly 1998). This database is distributed and updated annually on CD-ROM since 1996 and can be accessed on the WWW (http://www.fishbase.org) since 1999. The two Eschmeyer databases not only contain the most complete nomenclature data, but also taxonomic history including the localities of type specimens and original literature. It is an excellent source for taxonomist, especially in those countries that lack access to original literature, such as Taiwan. The 'FishBase' of ICLARM is just like an encyclopedia that almost covers everything especially a list of local publications and local fish names that were provided from collaborators in different countries. There is another global fish taxonomic database built by J. Nelson who is the Chair of AFS/ASIH Committee. This committee is now revising the AFS Publication on

'Names of Fishes'. Only a few regional or national fish databases seem to exist currently, such as for Australian fishes (http://amol.org.au/collection/hostedwebs/fish/index.html) or New Zealand freshwater fishes (http://www.niwa.cri.nz/NIWA_research/fwfishatlas/fishFinder.htm).

Although many biological taxonomic databases exist, most were constructed by taxonomists for their own research convenience. Consequently, their purposes, data format, and both hardware and software systems are quite varied. This problem will hinder the integration and distribution of these databases even if they were already available on the web. Although to integrate taxonomic databases among different groups of organisms is difficult, some global databases have integrated certain regional or country databases of one particular group of organisms quite successfully. They include *FishBase* developed by ICLRAM, and *Prokaryobase, World Virus Database, Legumes*, IOPI, etc. by various institutions. The nomenclatural data in these databases now can be acquired via *Species 2000* (indexing the world's known species) (http://www.sp2000.org).

Purposes of building a fish database in Taiwan

Our three main purposes are to:

(a) Provide the most up to date results of fish taxonomic studies in order to strengthen the information exchange and research cooperation in research communities.
(b) Provide ecological data of the aquatic environment for assessment, conservation, exploitation, and management of marine biological resources.
(c) Promote the unification of fish names especially for scientific Chinese fish names and Chinese and English common names.

The total number of valid fish taxa in Taiwan has now reached 2450 species in 250 families. This figure is about 1/10 of the total number of recent world fish species. In addition to many new records and continually increasing spatio-temporal distribution data, many fish names also will be changed after many revision papers are published. It was estimated that 1/10 of species names need to be replaced every 10 years on the average (Froese & Pauly 1998). Such changes result from misidentifications, typographical errors, different taxonomic perspectives, and new systems of classification. Consequently, many synonyms or undetermined species status have resulted. Correct species identification and accurate distributional data are essential for users' proper experimental design, field sampling, and publishing. Thus, it should be the responsibility of local fish taxonomists to establish their own fish database for public use.

Materials and methods

History and data sources

We began building a fish database of Taiwan in 1988 by integrating faunistic data files for many monitoring localities from different research projects. Two years later, we received a 5-year grant from the National Science Council (NSC) (1989–1994) and another 6-year grant from Council of Agriculture (COA) (1991–1996) which partially assisted this work. The differences between these two projects were as follows. The data of NSC project were mainly obtained by underwater observation and specimen collections so that many coral reef or non-economic species were included, whereas the data of COA project were mostly obtained from fishermen's questionnaires, and only inshore economic species were taken into consideration. Other fish data were collected from various monitoring and assessment projects, such as nuclear power plants, Kenting National Park and artificial reefs as well as underwater surveys of marine ecotourism etc. Other miscellaneous data were obtained from literature review or provided by anglers, divers, and even fishermen.

Our survey sites cover almost all coastal waters around Taiwan and some islets, the South China Sea, Quemoy and Matsu, as well as the watersheds of the Tamshuei, Nanao, and Holong rivers. The temporal and spatial distributional data have increased very rapidly. For example, the total number of known species from Taiwan has increased from 2028 (Shen et al. 1993) to 2450 within the past 7 years, excluding unidentified or doubtful species.

Results

Current status of the fish database in Taiwan

Through the past 12 years, we devoted ourselves to improving and developing our fish database. It now can be accessed on the WWW at http://fishdb.sinica.edu.tw.

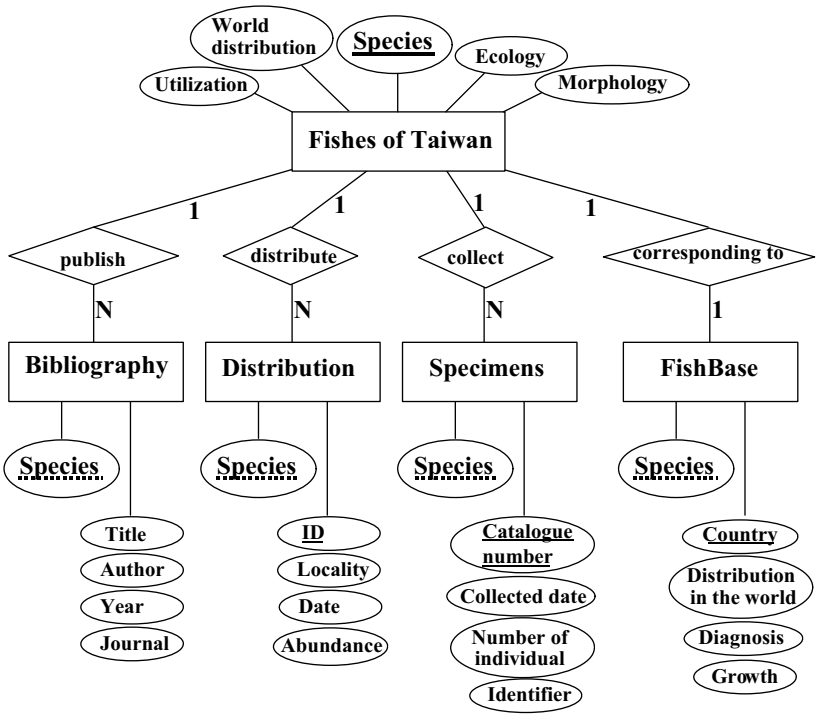

Figure 1. Entity-Relationship model of the fish databases of Taiwan.

Figure 1 shows the Entity-Relationship model (Korth & Abraham 1991) of above database. All data files use fish scientific names as the link.

The fish database includes the following items:

1. Updated checklist of fishes from Taiwan and the reason for change. As of March 2000, there are 250 families and 2450 species of fishes included in that checklist. Unpublished new records of species are included in cases where their occurrence has been established by specimens or by *in situ* photos. The reasons for each addition, deletion, or modification of a name in the list are provided.

2. Basic information and specimen photo of each species. Inquiries can be made by fish names (scientific name, Chinese name, and Chinese vernacular name), body contours, or fish pictures etc. The basic information contains morphology, ecology, habitat, world distribution, and fisheries and utilization (Figure 2).

3. Distributional database. Users can check the actual distribution areas of each species on the map (in a grid system, 10′ each) or obtain a total list of species for each grid based on the selected conditions of fishing gear, month, and abundance. The monthly abundance variation of selected species can also be obtained. To date, lists of the economically important inshore fishes within 12 nautical miles (Figure 3), all coastal fishes within three miles, and the freshwater and estuarine fishes are complete. A checklist of fish at Nan-Sha (Spratly Island) and Tung-Sha (Prata's Island) in the South China Sea are provided. The relation between the distribution of each particular species and the water surface temperature (remote sensing map of NOAA satellite) can be inferred by using the GIS system of ArcView/MapInfo which has been incorporated into the database.

4. Curatorial database. The fish specimen collections include the Institute of Zoology, Academia Sinica (ASIZP) and the National Marine Science Museum (NMSMP). So far, a total number of 2109 species, 5234 lots and 10,590 individuals of specimens are included for ASIZP and 175 families, 1000 species and 1444 specimens for NMSMP.

5. Bibliographic database. Two hundred and thirty-seven taxonomic, ecological, or distributional publications on fishes of Taiwan are provided, including local or non-SCI journal articles, some of them written in Chinese.

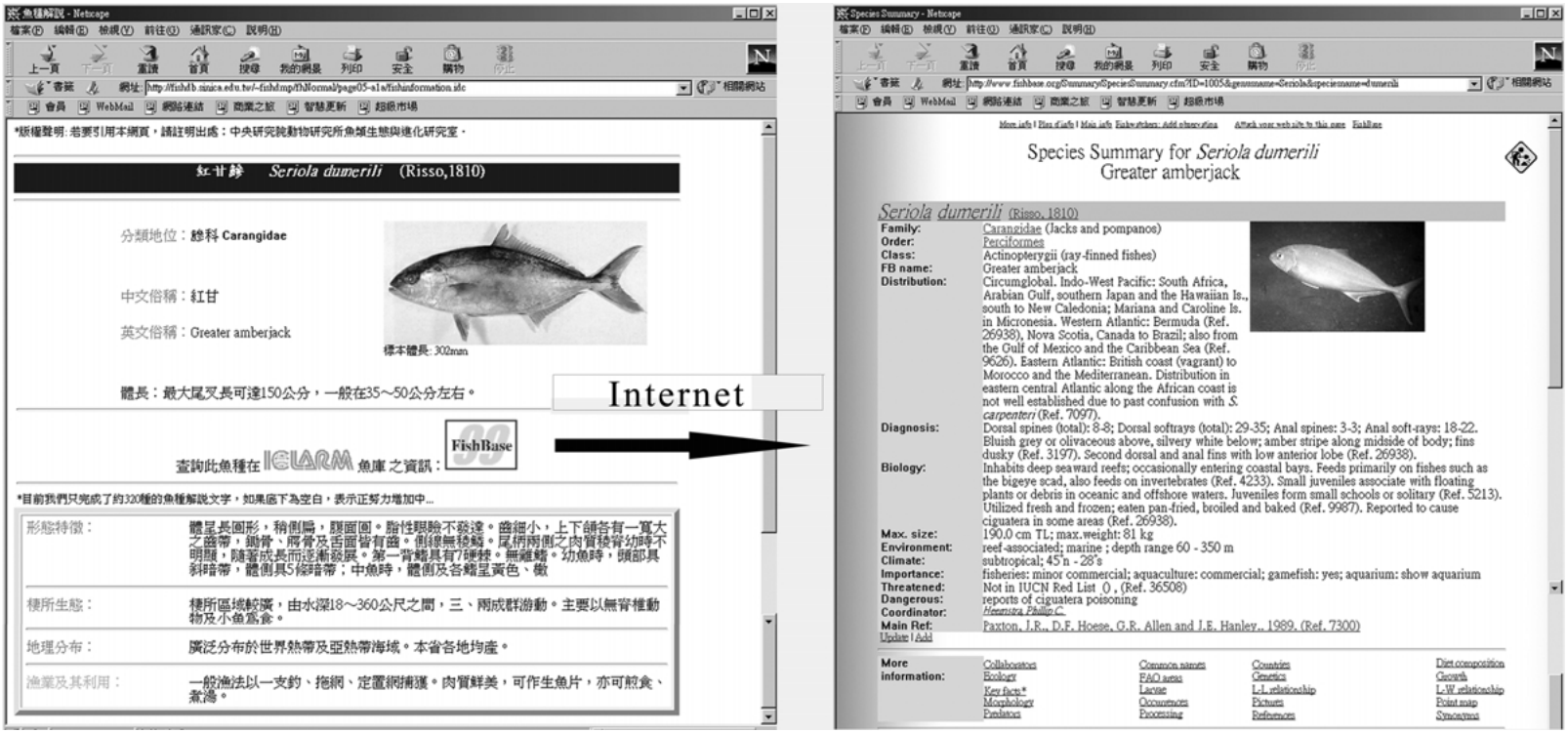

Figure 2. Basic information on *Seriola dumerili* in the fish database of Taiwan. Through dynamic HTML, users can obtain fish data directly from FishBase.

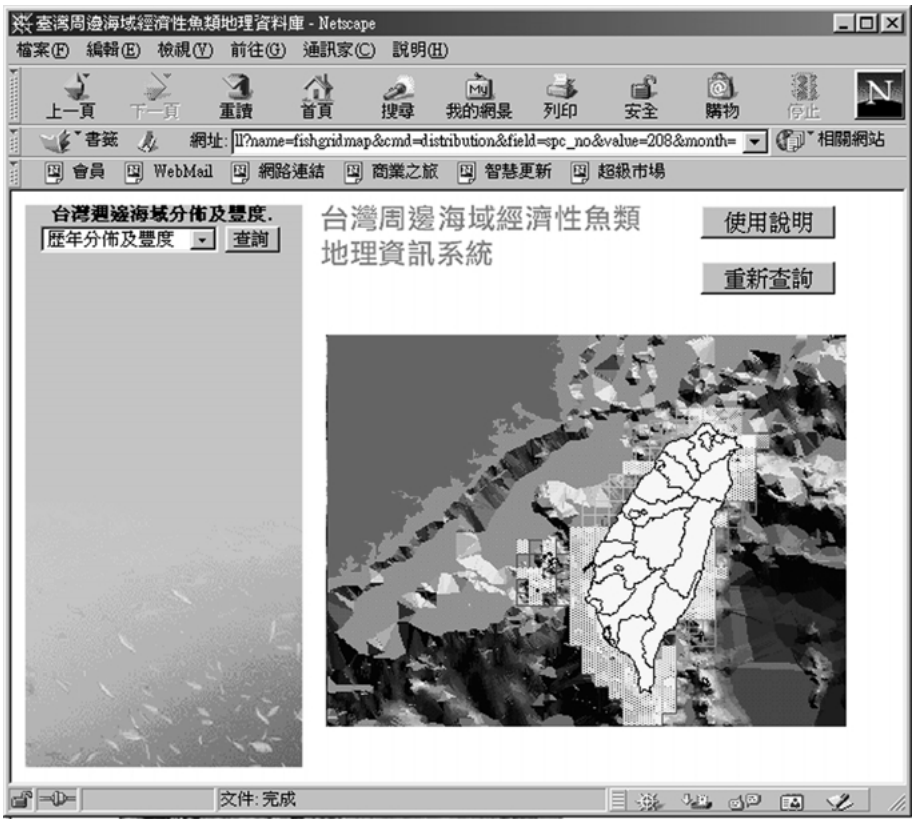

Figure 3. The distribution map of *Seriola dumerili* in the inshore waters around Taiwan obtained from the GIS system.

6. Inquiring system for Chinese fish names of the world fishes (Wu et al. 1999). includes 26,600 species.

7. Miscellaneous. A new version of the errata of *Fishes of Taiwan* (Shen et al. 1993). All 1800 specimen photos in this book were scanned to provide the major image source in the database.

Discussion

The relationship between Taiwan fish database and global fish databases

The purpose of the present article is to summarize our experiences with establishing our fish database over the past 10 years, and to describe some future projects. Although our regional database has been developed in collaboration with the global *FishBase* and periodically updated with Taiwanese fish data since 1993, it was not until 1999, that both databases could provide fish data for each species and from each other directly on the web through dynamic HTML. It is not necessary to search the data by entering the website of the counterpart. This approach achieves our goal of working locally but sharing our information internationally (Figure 4).

Future perspectives

Presently, not all data fields have been completed, and additional data entry remain in the following components:

1. Currently we have only photos for approximately 1900 species altogether, of which only 800 are underwater photos.
2. Descriptive text is available in Chinese for only 500 species.
3. Scanning of all color photos of deposited specimens must also be completed when the fishes are fresh, so that the important color patterns can be used.
4. We need to complete the English version of this database.
5. We need to solve the problems of missing fonts of Chinese characters, continuously developing the

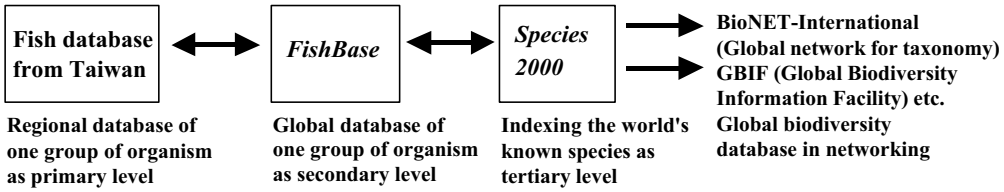

Figure 4. Relationships and cooperation between regional and global databases.

new techniques associated with metadata, intellectual property protection, water mark, query by image content (QBIC), GIS, and multi-media systems etc.

We intend cooperate with *FishBase* of ICLARM to do machine-translation of *FishBase* into Chinese version and to search for collaborators from different Asian-Pacific countries so that fish names in different languages can be incorporated into *FishBase* (e.g., Chinese, Japanese, Korean, Thai, Russian, and so on). Then, all Asian language speaking people can easily access detailed information on each species from the Internet by keying in or browsing their local fish names without having to know the scientific names of the fishes. We hope that our experience in database construction is useful to other countries in developing, for themselves, fish databases or even building the databases for other organisms. Sharing complete and updated biodiversity information is fundamental to economic utilization and biodiversity conservation.

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