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FISHBASE AS A TOOL FOR COMPARING THE LIFE HISTORY PATTERNS OF FLATFISH*

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ABSTRACT

The recent suggestion by a group of fisheries biologists to create species-specific 'flatfish fact sheets', to accelerate flatfish research is recalled. The suggested contents of these sheets are shown to overlap with the entries of FishBase, a global database on fish developed at the International Center for Living Aquatic Resources Management (ICLARM) in collaboration with the Food and Agriculture Organization of the United Nations (FAO), which is therefore proposed as the tool of choice for interested flatfish researchers. The modalities for possible cooperations are briefly presented.

1. INTRODUCTION

In November 1990, during the first Flatfish Symposium, the participants of the workshop on 'Life History Patterns' agreed that 'the large amount of data on the life history patterns of flatfish all over the world should be made easily accessible to everybody in order to stimulate future comparative studies and to offer a wider context for scientists studying individual species'.

The media suggested for this data compilation were 'fact-sheets', whose information should be retraceable to the original author, both in order to assign credit properly, and to allow updating (Anonymous, 1992). This group also prepared a list of 35 life history parameters and related information, to be included in the fact sheets in question (see below).

2. DEVELOPMENT OF FISHBASE

Since 1989, the International Center for Living Aquatic Resources Management (ICLARM), in collaboration with the Food and Agriculture Organization of the United Nations (FAO), and numerous institutions and colleagues throughout the world, and with support from the European Union (EU), is developing a powerful relational database called FishBase which summarizes global information on fish in standardized form (Froese, 1990; Pauly & Froese, 1991; Froese *et al.*, 1992; Froese, 1993).

Fig. 1 illustrates the structure and contents of FishBase as of late 1993. Some products that can be generated from FishBase are:
-preliminary checklists by countries (incl. threatened species, or species of particular interest, *e.g.,* for aquaculture, sport, or aquarium trade);
-bibliographies by species, author, or subject;
-structured printouts (species synopses) of all available information on a given species (incl. a distribution map, and a black and white or colour picture of the adult, larval and egg stages).

3. FLATFISH IN FISHBASE

Tables 1 and 2 give a summary of the information on flatfish so far (late 1993) included in FishBase. As can be seen, nearly half of all flatfish species have been entered, with some families, such as the Pleuronectidae, well covered while others, such as the Achiropsettidae, are covered only in terms of their nomenclature.

We expect that most flatfish species will have been entered in FishBase by the time the present contribution is published.

Table 2 shows that virtually all of the 'Life History Parameters' listed by Anonymous (1992) were included in the design of FishBase. This might be obvious in retrospect, but it is comforting to see that two groups of fisheries biologists working independently agree on an overlapping set of parameters for describing the life history of fish. The FishBase fields corresponding to the items in Table 1 of Anonymous (1992) and their difference to the fields suggested in that table are discussed below (see also Table 2):

Latin name, Family FishBase contains the scientific names with author and year following the latest revisions of experts. The taxonomic classification follows Eschmeyer (1990).

Common names FishBase contains about 40000 common names grouped by countries and lan-

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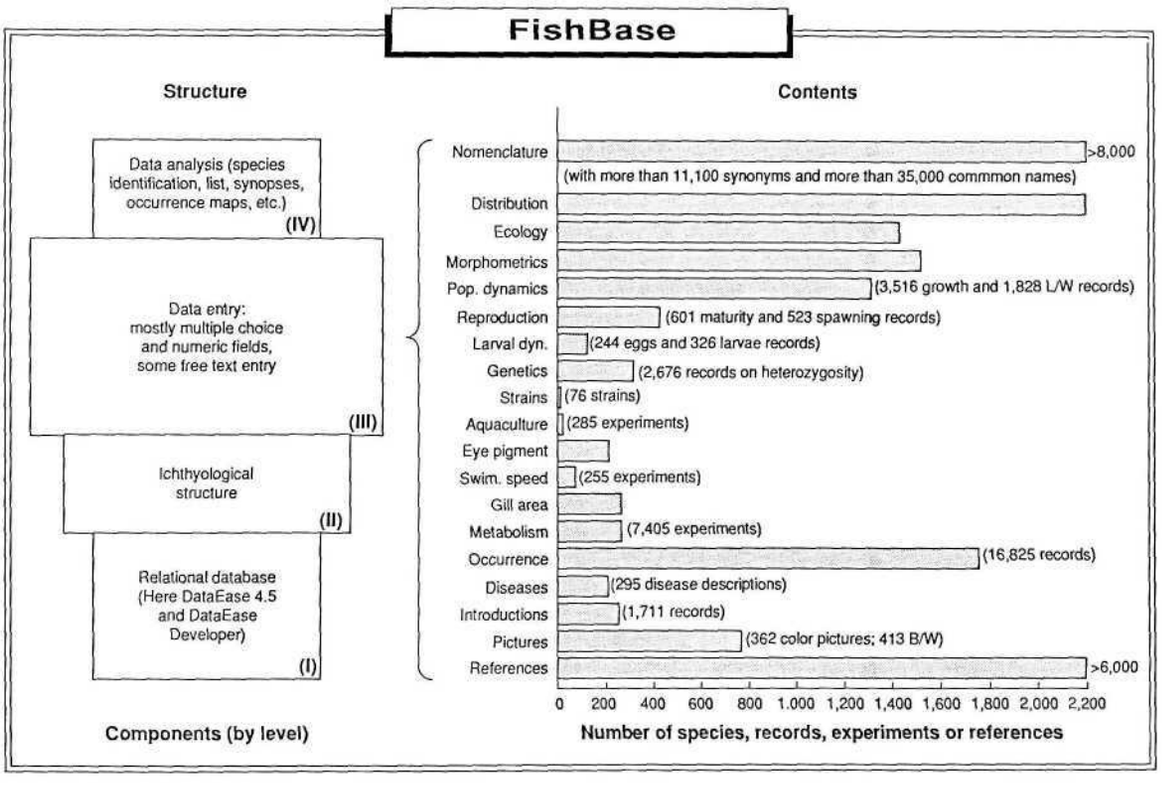

Fig. 1. Structure and contents of FishBase: Left: Level I is represented by a commercial database, which can produce executable files that can be distributed royalty-free; Level II is the ichthyological structure, created by ICLARM staff in cooperation with various specialists throughout the world; Level III consists of the entries themselves, of which only a small fraction—the free text entries—will require translation when preparing versions of FishBase for languages other than English. Level IV consists of various graphical and statistical routines for the presentation and comparative analysis of the quantitative and categorical data entered into FishBase. Right: Information incorporated in FishBase as of late 1993. Note that the bars refer to the number of species (except for references). Numbers in parentheses indicate the number of records entered. There can be several records for one species.

guages, including the standardized names of the Food and Agriculture Organization of the UN (FAO) and the of American Fisheries Society (AFS). We also included—if available—information on etymology in an effort to capture and preserve local knowledge (Pauly *et al.*, 1993). To date more than 1000 common names refer to flatfish.

Overall abundance This seemingly straightforward parameter is actually difficult to define and to classify since the frequency of human encounter with fishes depends on many factors such as locality, season, and gear. In FishBase we have adopted the categories used by ornithologists, *i.e.,* 'abundant', 'common', 'fairly common', 'occasional', and 'scarce'. We record this information for the species in general, for stocks/populations, on the country level, and from research vessel surveys. However, we were able to extract to date only relatively few records from the existing literature. This will improve once FishBase contains more research vessel data, the most reliable approach to fish abundance estimation.

Geographical distribution, latitudinal range For each species FishBase contains a list of FAO statistical areas, countries, and occurrences (museum, research vessel and other records), and a text description of its geographical distribution as well as dedicated fields for the latitudinal range. It is planned to add also a list of ecosystems which will allow retrieval of all flatfish occurring, *e.g.,* in the Kattegat or in the Sea of Okhotsk.

Adult habitat: depth, substrate FishBase contains dedicated fields for depth range and substrate types; however, few records for flatfish have been entered so far.

Stock units In FishBase, information can be attached to the species in general, to a wild stock/population, or to a cultured strain. The criteria for including stocks into FishBase are that 1. somebody has published an explicit definition/description of the stock and 2. additional data such as growth parameters are available for that stock. Thus, stocks are not identified automatically, even in cases where two

populations are known to be geographically separated and to have different environments. Rather, for each record, the country and locality are stated where a study was conducted e.g., on food consumption, diet composition, or growth. This allows assigning the information to a stock at a later stage, once the above-mentioned criteria are fulfilled.

Commercial importance The importance of a species for human use is dealt with in several fields. For fisheries we have two choice fields that follow FAO classifications for 'importance' ('highly commercial', 'commercial', 'subsistence fishery', 'of potential interest', or 'of no interest') and for 'catches' ('up to 1000', '1000-10000', '10000-50000', '50000-100000', '100000-500000', or 'more than 500000'), in tonnes per year. Additional fields deal with 'used for aquaculture' ('never/rarely', 'commercial', 'experimental', or 'likely future use') and 'used as bait' ('never/rarely', 'occasionally', or 'usually'), and also used as game fish, and aquarium fish. These fields are available for the species in general, and for each country.

Spawning grounds, period, temperature, fecundity, G.S.I. This information is covered in two tables in FishBase: The REPRODUC table contains general information such as mode of reproduction and fertilization, reproductive guild (after Balon, 1990), spawning frequency, and batch spawner (yes/no) on a one-record-per-species basis. The SPAWNING table contains site-specific data such as site and season, type of spawning ground, temperature, sex ratio, fecundity, relative fecundity, fecundity/length relationship, and daily spawning frequency on a many-records-per-species basis. The gonado-somatic index (G.S.I.) can be entered into a Remarks field; very few data have been encountered so far. This information will be transferred into a dedicated field once more data become available. It is planned to increase significantly the number of records in these tables by incorporating the data in classics such as Breder & Rosen (1966).

Age **and** length **at** 50% maturity This information is contained in the MATURITY table which allows many records per species. In addition to t_m and L_m, the table also can be used to record the age and length ranges at which the fish become mature, information that is frequently available.

Eggs, larvae, and juveniles Reflecting the wide availability of data, information on fish fry is stored in four separate tables: the EGGS table is meant to assist in the identification of eggs and contains information on place of development, size, shape, attributes, colour, number of oil globules, *etc.* The EGGDEV table contains site-specific information on temperature, salinity, egg diameter, and egg development time. The LARVAE table aims to assist in the identification of fish larvae and contains a wide range of descriptive, meristic, and metric fields, including length at birth and length at first feeding. The LARVDYN table was developed by Houde & Zastrow (1993) and contains fields for nursery area, temperature, larval stage duration, dry weight at hatch and at metamorphosis, growth coefficient, mortality rate, oxygen consumption and food ingestion. There are no fields for age at metamorphosis nor for the degree of concentration in the nursery area since there are hardly any data. The nursery area, the juvenile habitat and the feeding and spawning grounds of the adults are also described as stations of the life cycle in the free-text fields of the REPRODUC table.

Natural life span and natural mortality rate This information is entered as reported longevity for wild and captive specimens; it is, however, not distinguished by sex due to scarcity of data (when available, such information can be entered in the remarks field). Estimates of the rate of natural mortality are available for larvae (see above) and for juveniles and adults combined. No provision was made for 0-group specimens due to lack of data.

Bertalanffy growth parameters and condition factor FishBase contains the largest compilation of

TABLE 1

Summary of information on flatfish (by family) according to Eschmeyer (1990), contained in FishBase as of late 1993. [a]Some references have been used for several families, *i.e.,* this is less than the sum of references used by family.

family/ records	*Achiridae*	*Achiropsettidae*	*Bothidae*	*Citharidae*	*Cynoglossidae*	*Paralichthyidae*	*Pleuronectidae*	*Psettodidae*	*Scopthalmidae*	*Soleidae*	*total*
species estimated	28	4	116	5	103	86	100	3	10	86	544
FishBase species	9	5	37	3	42	43	51	3	7	26	226
Growth/M	0	0	1	0	6	4	101	4	6	45	173
L-W relationship	4	0	8	0	10	6	15	7	8	12	70
maturity	0	0	5	0	5	0	42	3	7	12	73
reproduction	0	0	3	0	2	0	6	1	2	3	17
ecology	0	0	6	1	3	1	5	2	2	8	28
food consumption	0	0	0	0	0	0	4	0	0	0	4
oxygen consumpt.	0	0	31	0	0	1	233	0	3	6	274
larval dynamics	1	0	1	0	0	1	2	0	0	1	6
genetics	1	0	0	0	1	4	6	0	0	0	12
references	12	6	70	10	41	47	135	38	25	34	294[a]

TABLE 2
List of life-history parameters suggested by Anonymous (1992) for coverage by a set of 'flatfish fact-sheets' (left column), and the corresponding entries in FishBase (right column; numbers refer to records in late 1993, usually with one per flatfish species). See text for details.

Parameter	*number of records*
Latin name	226
family	10
common names	1143
overall abundances (common, medium, rare)	6
geographical distribution	226
latitudinal range	0
adult habitat: depth	22
adult habitat: substrate	23
stock units	1
commercial importance (none, low, medium, high)	42
spawning grounds (estuarine, coastal, shelf, oceanic)	36
spawning period	36
spawning temperature	36
egg position (pelagic, demersal)	17
egg size	21
duration of egg stage	21
size at metamorphosis	5
age at metamorphosis	0
larval - juvenile 'migration'	17
nursery area (estuarine, coastal, shelf, oceanic)	17
degree of concentration in nursery area compared to adult distribution	0
juvenile habitat (depth, substrate)	17
diet of larvae	0
diet of juvenile	0
diet of adult	38
age/length at 50% maturity (male/female)	73
natural life span (male/female)	7
condition factor, weight-length relationship (male/female)	70
Bertalanffy growth parameters (male/female)	173
G.S.I. peak value in season of female	0
fecundity parameters	1
natural mortality estimates (M) of eggs*	0
M of larvae	6
M of 0-group	0
M of 1-group to maturation	23
M of adults	23
state specific variability in recruitment	0

* only direct estimates

growth parameters and length-weight relationships in the world. Presently, the POPGROWTH table includes 173 records for flatfish, with indication of locality, sex, data type and methods used for aging and curve fitting. The collection of length-weight relationships presently includes 70 records for flatfish with indication of locality, sex, number of fish, size range, and correlation coefficient. From these data the condition factor can be easily calculated for any length.

Diet Data on diet composition in terms of percent stomach content in volume, weight, or energy content are captured in the DIET table together with information on life stage (larvae, juveniles, adults), number of fish sampled, locality, and season. Food items are classified in a hierarchical system *(e.g.,* benthic animals, crustaceans, shrimps, *Crangon crangon*) in order to standardize the many different terms used in the literature and to facilitate comparisons and generalizations.

Recruitment variability This table, still to be created, will include (a subset of) the data in Myers *et al.* (1990, 1994).

4. DISCUSSION

As shown above FishBase accommodates most of the life history parameters suggested by Anonymous (1992), with the exception of the 'degree of concentration in nursery area compared to adult distribution', 'age at metamorphosis', 'G.S.I. peak value in season of female', and 'natural mortality estimates of eggs and 0-group'. We have very rarely encountered this type of information in the more than 6000 references (294 for flatfish) we have screened and used so far for FishBase. Thus, to the extent that we have not missed out too much of the relevant literature, these items represent some of the 'gaps in knowledge' foreseen by Anonymous (1992).

However, with the possible exception of growth parameters and length-weight relationships, the numbers in Table 2 reflect more the state of data collection than the state of knowledge: so far the Baltic flounder (*Platichthys flesus*) is the only flatfish for which we have made an explicit attempt to include all key information (Froese & Friess, 1992). The ultimate goal put forward by Anonymous (1992), to adequately 'cover all flatfish species in all geographic regions' needs similar efforts for many more species.

Interested colleagues should contact the authors to receive a set of FishBase data collection forms. The FishBase team will enter the data and references from the filled-in forms and return a 'FishBase species synopsis' for checking and for subsequent publication by the contributor as he/she sees fit. FishBase includes several mechanisms to acknowledge collaborators, ranging from specific references for each entry to a 'stamp' indicating collaborators' names at the end of each table of entries, synopsis or country list.

Information in FishBase can easily be printed in a variety of formats, including one that approximates the fact-sheets suggested by Anonymous (1992). A first diskette-based version of FishBase has been available since late 1992 to selected collaborators of the project, while the first public release of the CD-ROM version will occur in late 1994, and be updated annually.

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Note added in proof (August 1994): As anticipated and mentioned above, our coverage of flatfish has expanded markedly since the paper was originally written. Thus FishBase now includes 318 flatfish species with 201 sets of growth parameters and 116 length-weight relationships, *etc. (c.f.* data in Table 2). Perhaps more importantly, FishBase has meanwhile been ported from DataEase to ACCESS to make use of the graphic-orientated WINDOWS interface.