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THE USE OF RELATIONAL DATABASES FOR IDENTIFICATION OF FISH LARVAE

by

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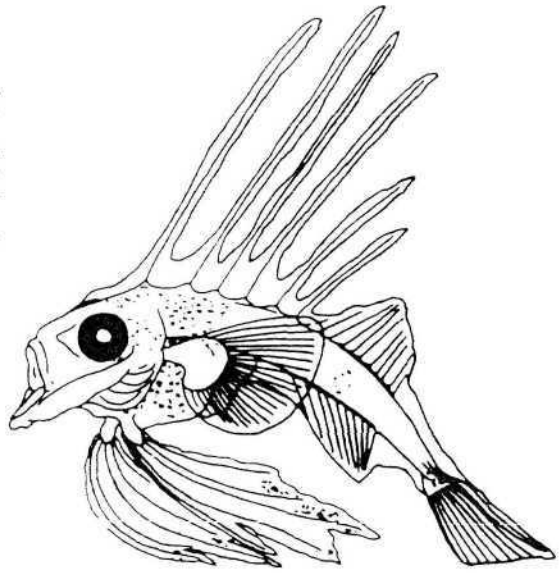

Contents

1 Abstract

Fish larvae are hard to identify because body proportions and pigmentation may change considerably in the course of the larval development. Modern relational databases provide features like choice fields (only one choice from a list of predefined entries is allowed for a field), query-by-forms (very user-friendly way of searching), and graphics. About 80 descriptive, meristic and metric characters of postlarvae have been identified as useful for identification. For 126 species of fish larvae from the Northeast Atlantic these characters have been filled with values from the literature. It is shown that a) a microcomputer-based database can be used to build a very efficient identification system, and b) that drawings and descriptions from the literature can be successfully used to build identification keys.

2 Introduction

This paper is the third in a series dealing with modern methods for identification of fish larvae. The first method was an expert system (Froese and Schöfer, 1987) which looked very impressive at the first glance, but except for its high comfort and the easiness of updating, it had no real advantage over traditional printed keys, i.e. the user still had to answer a series of more or less complicated questions. The second method (Froese, 1988) used morphometrics and a powerful statistical approach (a combination of cluster analysis and quadratic discriminant functions). Although this method still looks very promising, it needed at least 50 well preserved specimen of each species involved for building the key. Even in the Northeast Atlantic it was impossible to get enough larvae for more than about 30 species.

The present study was conducted to test two independent hypotheses:

Hypotheses A: Modern microcomputer-based databases can be used to build very efficient identification keys.

Hypothesis B: Drawings and descriptions from the literature can be used to extract measurements and characters as input for identification keys.

3 Material and Methods

3.1 The database used

The commercial software package DataEase 4.0 was used for the database. It is very user friendly (menu-driven) and has all the features of modern databases such as: form generator, entry validation, choice fields, default fields, calculated fields, lookup fields, up to 100 links per view, calling of other programs (e.g. for graphics), query-by-forms including the use of operators and equations, powerful programming language, etc. . Its main advantage is the easiness with which links are handled.

Choice fields
Choice fields are a modern user-friendly version o'f the traditional 'text field + thesaurus' concept and a replacement for the coding of text information. They are easy to search and enter, occupy one byte of storage space only for up ' to 60 characters of information, and prevent typing mistakes.

Choice fields are used whenever text-information could be structured. The user and the inputter are offered a choice from a predefined list of entries for a field. The options in the choice fields have to be unique and clearly separated, i.e. only one entry can be true. If a choice list does not cover all possibilities, the last choice is 'other'.

Text fields

In addition to the normal use *of* text fields for names, they are used to allow for detailed descriptions of facts that cannot be classified completely by choice fields.

min max mod

For many data, such as for instance 'number of vertebrae', there is a natural variability. In this case usually a maximum and a minimum value is given in the literature and the mean, modal, or typical value is estimated by the inputter.

early and late

Because of the change of characters in the course of the larval development, several fields are duplicated to allow entries for early and late post-larvae.

References

The LARVAE table has a *Main Ref* field which contains the number of the reference (in another table) where the data stem from. In addition, every important entry has its own reference field. If the source of such a referenced entry is the same as the main reference, then the *Ref* field may be left blank.

3.2 The structure of the Larvae table

3.2.1 Environmental parameters

The following environmental parameters are provided:

Months of presence of larvae, Reference
Depth of capture, max min mod, Reference
Temperature, max min mod, Reference
Salinity, max min mod, Reference
pH, max min mod, Reference
Oxygen, max min mod, Reference

3.2.2 Descriptive characters

The following descriptive characters are provided:

Picture
Striking features
Striking shape, lateral and dorsal

Shape of gut
Visibility and pigmentation of gas bladder, early and late
Spinal armature, early and late
Pigmentation of tail, early and late
Pigmentation of head and trunk, early and late
Pigmentation of urostyle region, early and late
Pigmentation of peritoneum
Appearance and pigmentation of pectorals
Appearance and pigmentation of pelvics
Additional descriptive characters (Text)

3.2.3 Meristic characters

The following meristic characters are provided:

Total number of myomeres / vertebrae, max min mod, Reference
Preanal no. of myomeres / vertebrae, max min mod, Reference

3.2.4 Morphometric characters

The following metric characters are provided:

Reference length (RL), max min mod, Reference
Type of Reference length (SL, TL, other)
Preanal length (% RL), max min mod
Prepectoral length (% RL), max min mod
Preorbital length (% RL), max min mod
Diameter of eye (% RL), max min mod
Depth above eye (% RL), max min mod
Depth above pectorals (% RL), max min mod
Depth of tail behind anus (% RL), max min mod

3.3 Source of information

All measurements and characters used in the database were extracted from drawings and descriptions provided by the following authors: ABOUSSOUAN 1964, AHLSTROM 1984, ARBAULT 1968, BERTOLINI 1931, DAHL et al. 1984, DEMIR and DEMIR 1961, DEMIR 1986, EGE 1930, EHRENBAUM 1904, 1905, 1936, FAGE 1908, FAHAY 1983, FIVES 1986, FRASER and MUUS 1965, HALBEISEN 1988, MARINARO 1971, NICHOLS 1971, PETERSEN 1906, RE' 1977, RUSSELL 1976, SCHMIDT 1905, THOMOPOULOS 1954, 1956.

3.4 Material

The test of the database identification system was conducted with larvae sampled in the Celtic Sea in April 1986. The larvae have been pre-identified independently by A. Röpke. From these samples we selected with bare eye larvae that appeared complete and well preserved. Once a larva was selected, it was used for the test no matter what problems arose.

3.5 Method of testing

Firstly, all morphometric measurements (see above) were conducted on the larva using a video system. The measurements were transformed in % standard length and entered in the search form of the database with a range of +/- 20 % for preanal length and +/- 30 % for the other measurements (e.g. for a preanal length of 50 % standard length, the entry in the database was : > 40 % arid < 60 %) . A first search was conducted to see how many species resemble the proportions of the unknown larva. If more than one species appeared in the resulting list, one additional descriptive character was ' entered and the search was repeated. This procedure was continued until only one species was left in the list.
Secondly, one morphometric measurement after the other was deleted to see, which measurements from the list of 7 were really needed for the final identification.

4 Results

The results of the test are listed in detail in the appendix in form of a record of the identification process. The results can be summarized as follows:

- All larvae could be identified.
- Half of the larvae could be identified with 3 characters only (minimum 1 character, maximum 6 characters).

- Four identifications were performed with morphometrics only, five with descriptive characters only, and eleven with morphometric and descriptive characters.

- Overall, 29 morphometric and 32 descriptive characters were used for identification.

- From 140 measurements that were made on the real larva, in 8 cases the range applied to the measurements (i.e. +/- 20 or 30 %) was to narrow to include the value from the literature contained in the database. The range was then enlarged to find the correct species. These cases are marked with an asterisk * in the listing.

5 Discussion

5.1 Hypothesis A:

In the light of these results modern databases seem to be an appropriate tool for building identification systems. The average of three easy tp obtain characters for an identification is a remarkable advantage over traditional identification keys.

Morphometrics and descriptive characters seem to be of comparable use for identification. Especially beginners often prefer to make measurements instead of searching for uncertain characters.

5.2 Hypothesis B:

The results demonstrate that measurements and • characters extracted from the literature can be successfully used to build identification keys. This offers possibilities for areas where no keys are available and pre-identified real larvae normally cannot be obtained, because there is a rich (but scattered) literature with drawings and descriptions of fish larvae from all over the world.
However, we feel that whenever a reasonable number of real larvae is available, they should be used to check and improve the measurements and characters obtained from the literature.

5.3 A proposed strategie for searching

From our preliminary experience, especially the problem of the range to apply to the measurements, the following strategy of searching seems to be appropriate to identify an unknown larva:

MEASURE LARVA

From the 7 presented measurements perform as many as can be obtained easily and accurately. Enter them with a range of +/- a quarter (25%) for preanal length and +/- a third (33.3%) for all others. Run the search. If there are more than 5 species in the resulting list, proceed with ADDITIONAL CHARACTERS. If there are 1 to 5 species in the list, proceed with CHECK PICTURES. If the list is empty, check the entries and the measurements for possible errors. If no error can be found, delete those measurements which are most uncertain and repeat the search. If the list is still empty, the larva does not match any entry for the species in the database.

ADDITIONAL CHARACTERS

Examine the larva for a striking distinct character, enter it in the search form and run a search. If there is no striking character, start with pigmentation of tail or urostyle region. If there are more than 5 species in the resulting list, proceed with the next definite character. If there are 1 to 5 species in the list, proceed with CHECK PICTURES. If the list is empty, delete the last entered character and try another one. If this does not help, check the measurements.

CHECK PICTURES

Compare the pictures of all species in the list with your larva. Proceed with CHECK ALL CHARACTERS for the species that resembles your larva most closely. If your larva resembles none of the species in the list, use the check options described in ADDITIONAL CHARACTERS and MEASURE LARVA.

CHECK ALL CHARACTERS

When you are already quite sure about the identity of your larva, you should get the full information about the species on the screen and carefully check through all the provided characters to ensure your identification.

6 References

ABOUSSOUAN, A. 1964. Contribution a l'etude des oeufs et larves pelagiques des poissons teleosteens dans le Golfe de Marseille. Rec. Trav. St. Mar. End., 32(48): 87-171

AHLSTROM, A. et al. 1984. Ontogeny and systematics of fishes. Special Publication Number 1, American Society of Ichthyologists and Herpetologists:760 pp.

ARBAULT, S. and N. BOUTIN, 1968. Ichthyoplancton. Oeufs and larves de poisson teleosteens dans le Golfe de Gascogne en 1964. Revue Traff. Off. scient. tech. Pech. maritim., 32(4):413-476

BERTOLINI, F; D'ANCONA, U.; MONTALENTI, G.; PABOA, E.; RANZI, S.; SANZO, L.; SPARTA, A.; TORTONESE, E.; VIALLI, M. 1931 - 1956. Uova, larve e stadi giovanili de Teleostei. Fauna e Flora del Golfo di Napoli, 38. Monografia:1064 pp.

DAHL, E.; DANIELSSEN, D.S.; MOKSNESS, E.; SOLEMDAL, P. 1984. The propagation of Cod *Gadus morhua* L. Flodevigen rapportser. 1, 1984, 895 pp.

DEMIR, M. and N. DEMIR 1961. Note on the sardine (*Clupea pilchardus Walb.*) and its reproduction in the sea of Marmara. Proc. gen. Fish. Coun. Medit., 6:221-223

DEMIR, N. 1986. Gadidae, Ciliata Couch, 1832. Fiches d'identification du plancton, 176:6 pp.

EGE, V. 1930. The North Atlantic and Mediterranean species of the genus *Paralepis* (Cuv.). A systematical and biological investigation (*Sudidae, Paralepis).* Rep. Dan. Oceanogr. Exped. 1908-1910, Medit. adjac. Seas, 2, Biology A.13:93 pp.

EHRENBAUM, E. 1904. Eier und Larven von Fischen der Deutschen Bucht, III. Fische mit festsitzendcn Eiern. Wiss. Meereunters. Abt. Kiel und Abt. Helgoland (n.s.), 6(2):127-200

EHRENBAUM, E. 1905. Eier und Larven von Fischen. Nordisches Plankton, 1:413 pp.

EHRENBAUM, E. 1936. Naturgeschichte und wirtschaftliche Bedeutung der Seefische Nordeuropas. Handb. Seefisch. Nordeurop., 2:337 pp.

FAGE, L. 1908. Shore-fishes. Rep. Dan. Oceanogr. Exped. 1908-1910, Medit. adjac. Seas, 2, Biology A.3, A.9

FAHAY, M. 1983. Guide to the stages of marine fishes occuring in the Western North Atlantic, Cape Hatteras to the Southern Scotian shelf. Journal of Northwest Atlantic. Fishery Science, 4:423 pp.

FIVES, J.H. 1986. Labridae of the Eastern North Atlantic (revised). Fich. Ident. Plancton, 172:6 pp.

FRASER, J.H. and BJ. MUUS 1965. Clupeoidae (by Alan Saville) 1964. Fiches d'identification des oeufs et larves de poissons. No. 1:5 pp.

FROESE, R. 1988. The use of quadratic discriminant functions in connection with video-based measurements for identification of fish larvae. ICES CM. 1988/L:11:8 pp.

FROESE, R. and W. SCHOFER 1987. Computer-aided identification of fish larvae. ICES C.M. 1987/L:23:10 pp.

HALBEISEN, H-W. 1988. Bestimmungsschlüssel fur Fische der Nordsee und angrenzender Gebiete. Berichtc aus dem Institut fur Meereskunde, Nr. 178:76 pp.

MARINARO, J.Y. 1971. Contribution a Petude des oeufs et larves pelagiques de poissons Mediterraneens. V. oeufs pelagiques de la Baie d' Alger. Bulletin de l'Institut Oceanographique d' Alger, volume III, Fascicule I, 118pp, pl. I-XXVII.

NICHOLS, J.H. 1971. Fiches d'identification des oeufs et larves de poissons. Pleuroneclidac. Conscil international pour l'exploration de la mer. Fiches Nos 4-6:18 pp.

PETERSEN, C.G.J. 1906. On the larval and post-larval stages of some Pleuronectidae (Pleuronectes, Zeugopterus). Meddr. Kommn Havunders., Ser.: Fisk., 3(1): 1-18

RE', P. 1977. The eggs and planktonic stages of Portuguese marine fishes. 1-Ichtyoplankton from the coast of Algarve (May, 1977). Arquivos do Museu Bocaque (2a serie), 7(3): 23-51

ROULE, L. and F. ANGEL 1930. Larves et alevins de poissons provenant des Croisieres du Prince Albert Ier de Monaco. Resultats des campagnes scientifiques, Prince Albert I, 79: 148 pp.

RUSSELL, F.S. 1976. The eggs and planktonic stages of British marine fishes. Academic press, London - New York - San Francisco:524 pp.

SCHMIDT, J. 1905. On the larval and post-larval development of fishes. Meddr. Kommn Havunders., Ser.: Fisk.,1(4), 2(3), 2(4).

THOMOPOULOS, A. 1954. Sur quelques oeufs planctoniques de teleosteens de la baie dc Villefranche. II. Peches du mois de septembre. Bull. Inst. oceanogr., Monaco, (1072): 1-16, 2pl.

THOMOPOULOS, A. 1956. Sur quelques oeufs planctoniques de teleosteens de la baie de Villefranche. Bulletin de l'Institut Oceanographique, Monaco, (1043):1-15

7 Appendix

Species	Characters used	Possible species
Clupea harengus	All measurements	* 2
Clupeidae	Ventral row of melanophores	1
	Depth above pectorals < 6.7 %	* 6
	Ventral row of melanophores	1

Sprattus sprattus	All measurements		2
Clupeidae	Ventral row of melanophores		1

	Preanal length > 65 and < 97 %		14
	Depth above eye > 4 and < 7.4 %		3
	Ventral row of melanophores		1
Argentina sphyrena	All measurements		1
Argentinidae	---		
	Preorbital length > 2.6 and < 4.9 %		23
	Depth above eye > 8 and < 14.9 %		13
	Depth above anus > 2.7 and < 5.1 %		1
Maurolicus muelleri	All measurements		3
Gonostomatidae	Melanophores on head (early)		1

	Melanophores on head (early)		1
Stomias boa ferox	All measurements	*	1
Stomiatidae	---		
	Preorbital length > 3 and < 5.6 %		37
	Depth above anus < 3.7 %	*	1
Benthosema glaciale	All measurements	*	15
Myctophidae	No rows of melanophores		1

	Preanal length > 40 and < 60 %		90
	Preorbital length > 3.7 and < 6.9 %	*	38
	Depth above pectorals > 11 and < 22.7 %	*	25
	No rows of melanophores		1
Merlangius merlangus	All measurements		18
Gadidae	Dorsal and ventral row of melanophores		9
	Urostyle region pigmented		3
	Tail partly covered with melanophores		1

	Preorbital length > 5.2 and < 9.8 %		78
	Dorsal and ventral row of melanophores		26
	Urostyle region pigmented		16
	Tail partly covered with melanophores		1
Micromesistius poutassou	All measurements		27
Gadidae	Dorsal and ventral row of melanophores		9
	Urostyle region unpigmented		5
	Tail with single melanophores		1

	Depth above pectorals > 15.7 and < 29.1 %		60
	Dorsal and ventral row of melanophores		26
	Urostyle region unpigmented		9
	Tail with single melanophores		1

Pollachius pollachius	All measurements		17
Gadidae	Dorsal, ventral, and lateral row of mel.		5
	Urostyle region unpigmented		3
	Tail with single melanophores		1

	Dorsal, ventral, and lateral row of mel.		17
	Urostyle region unpigmented		6
	Tail with single melanophores		1
Pollachius virens	All measurements		24
Gadidae	Dorsal, ventral, and lateral row of mel.		6
	Two dorso-ventral clusters		1

	Dorsal, ventral, and lateral row of mel.		17
	Two dorso-ventral clusters of mel.		1
Gadiculus argenteus thori	All measurements		15
Gadidae	No rows of melanophores		6
	Urostyle region unpigmented		3
	One dorso-ventral cluster of mel.		1

	No rows of melanophores		42
	Urostyle region unpigmented		18
	One dorso-ventral cluster of mel.		1
Scomber scombrus	All measurements	*	9
Scombridae	Dorsal and ventral row of melanophores		2
	Urostyle region pigmented		1

	Preanal length > 23.2 and < 49.8 %		46
	Prepectoral length > 15 and < 27.9 %	*	32
	Depth above pectorals > 13.7 and < 25.5 %		19
	Depth of tail behind anus > 7.7 and < 14.4	%	13
	Dorsal and ventral row of melanophores		2
	Urostyle region pigmented		1
Lebetus scorpioides	All measurements		7
Gobiidae	Dorsal, ventral, and lateral row of mel.		1

	Prepectoral length > 16.3 and < 30.3 %		82
	Dorsal, ventral, and lateral row of mel.		1
Cristallogobius linearis	All measurements	*	18
Gobiidae	Ventral row of melanophores		4
	Gas bladder pigmented		3
	Tail with single melanophores		1

	Depth above eye > 12.5 and < 23.2 %		59
	Ventral row of melanophores		12
	Gas bladder pigmented		3
	Tail with single melanophores		1

Helicolenus dactylopterus Scorpaenidae	All measurements		2
	Ventral row of melanophores		1

	Preorbital length > 7.3 and < 13.6 %		44
	Depth of tail behind anus > 7.8 and < 14.4 %		17
	Ventral row of melanophores		1
Glyptocephalus cynoglossus Pleuronectidae	All measurements		1

	Preanal length > 24.8 and < 37.1 %		5
	Depth above pectorals > 6.6 and < 12.2 %		3
	Depth of tail behind anus > 3.8 and < 7 %		1
Lepidorhombus boscii Bothidae	All measurements	*	4
	Gas bladder pigmented		2
	More than 2 dorso-ventral clusters of mel.		1

	Depth behind anus > 12.3 and < 23.9 %		50
	Gas bladder pigmented		7
	More than 2 dorso-ventral clusters of mel.		1
Microchirus variegatus Soleidae	All measurements		4
	Dorsal and ventral row of melanophores		3
	Tail completely covered with mel.		2
	Pectorals with marginal mel.		1

	Dorsal and ventral row of melanophores		26
	Tail completely covered with mel.		5
	Pectorals with marginal mel.		1
Solea solea Soleidae	All measurements	*	4
	Dorsal and ventral row of melanophores		3
	Tail partly coverd with melanophores		1

	Depth above eye > 27 and < 50.7 %	*	14
	Dorsal and ventral row of melanophores		4
	Tail partly coverd with melanophores		1
Lophius piscatorius Lophiidae	All measurements		1

	Preanal length > 26.9 and < 40.4 %		10
	Preorbital length > 4.4 and < 8.2 %		5
	Depth of tail behind anus > 5.6 and < 10.4 %		1

* The asterisk indicates that the applied range of +/- 20 or 30 % was not enough to find the correct species, i.e. the respective value contained in the database was larger or smaller. The adjusted range is given in the list.