SCI. MAR., 64 (Supl. 1): 23-29 SCIENTIA MARINA 2000

TRENDS IN HYDROZOAN BIOLOGY - IV. *C.E. MILLS, F. BOERO, A. MIGOTTO and J.M. GILI (eds.)*

Trends in hydroidomedusan research from 1911 to 1997*

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SUMMARY: The papers on hydroidomedusae published from 1911 to 1997 total 10,934. They have been assigned to the following categories: faunistics and systematics; sub-organismal biology; ecology; evolution; life cycles; paleontology. The general trend, comprising all papers, can be divided into four time intervals: the first (1911-1939) with an average of sixty papers/year and with a slight decrease due to First World War; the second one (1940-1947), with an average of 38 papers/year, marked by a dramatic decrease coinciding with Second World War; the period 1948-1991 shows a steady increase until the mid-Seventies, when a small decrease occurred, followed by an increasing trend reaching its apex in the late Eighties-early Ninenties with a record of 296 papers in 1991 and with an average of 175 papers/year; the period 1992-1997, with an average of 178 papers/year, is marked by a sharp decrease, reaching the values of the mid Sixties. The most important category in terms of number of papers is sub-organismal biology, followed by faunistics and systematics. Systematic studies dictated the trend in the first decades of the century, whereas sub-organismal ones are prevalent from the Sixties onwards. Faunistic and systematic-taxonomic papers have a steady trend of production, with just a slight decrease over these last years. The formerly leading countries in systematics (UK, USA, France) are now almost inactive in this discipline, whereas countries with little or no tradition in this field (such as Spain) are taking the leadership.

Key words: Cnidaria, Hydrozoa, history, bibliography.

INTRODUCTION

Literature data are important in all fields of science but, due to the law of priority, they are essential for taxonomic work. The law of priority, in fact, obliges taxonomists to be aware of every description throughout the literature and no paper can be ignored, no matter the language employed and the journal chosen for publication. The decline of taxonomy (Boero, 1994) is due to manifold causes, from low impact of tribunes for publication and related career opportunities, to enormous requirements in terms of bibliographic expertise.

Biodiversity assessment requires answering the basic question "How many species are there on Earth?" (May, 1988) and if, on the one hand, it is true that many species are still to be discovered, it is also true, on the other hand, that many "species" are just names which have been given autonomous rank often because of unavailability of previous descriptions of the same material. The task of modern taxonomy, thus, is not just to describe and name the still unknown species, but also to revise the known taxa (especially at generic level) getting rid of all the syn-

*Received March 15, 1999. Accepted August 24, 2000.

onyms that burden the inventory of biodiversity. A serious taxonomic revision requires huge bibliographic resources and taxonomists routinely build up specialised libraries and make their inventory. As for hydroids and hydromedusae (from now on termed here hydroidomedusae, as suggested by Bouillon *et al.,* 1992), Bedot (1901; 1905; 1910; 1912; 1916; 1918; 1925) listed all the papers published in the period 1581-1910 and all the taxa mentioned therein, with nomenclatural updates. The same did Mayer (1910), providing description, synonymy and complete literature for every medusan species known at the time. The year 1910, thus, is a landmark in hydroidomedusan literature, dividing an almost completely surveyed production from a *terra incognita*. This lack in knowledge has been partly filled by Kramp (1961) with the Synopsis of the Medusae of the World, covering the period 1911-1959. In this case, as with the case of Mayer, however, just the medusae were dealt with, whereas hydroids were neglected.

Vervoort (1995) published a list of papers on hydroidomedusae from 1911 to 1995. No attempt was made to provide information on species, and the sole list required 432 pages!

Modern personal computers allow easy information retrival, and in a more efficient format than a simple list on paper. The scope of this work is to refer on a computerised data base of hydroidomedusan literature from 1911 to 1997, deriving from Vervoort (1995) and from subsequent updates. The data base was built up for easy access to systematic literature, but is also a tool to reconstruct the history of hydroidomedusan research as witnessed by the trends in the production of papers in different fields.

MATERIALS AND METHODS

The list of papers in Vervoort (1995) was transcribed into a single file using the software FileMaker Pro 4.0, a relational database (Mac/Windows) allowing the archiviation of information with the possibility of multithematic indexing and research.

Papers from 1985 to 1997 have been searched for through S.I.B.A. (Servizi Informatici Bibliotecari di Ateneo, of the University of Lecce) consulting the **'**Biological Abstracts**'** and the **'**Current Contents**'**. The last ten years of Vervoort's (1995) list were thus checked against commercially available data bases. The choice of key words was crucial since apparently "logical" choices such as "Hydrozoa" did not extract all papers on Hydrozoa present in the data bank. We finally chose "Cnidaria" as the sole keyword, then extracting relevant records from a longer list (including also Anthozoa, Scyphozoa, and Cubozoa).

A file with about 11,000 records was created. Each record comprises the following fields: Author(s), Title, Journal, Year, Volume, Issue, Pages, Keys.

Keys cover general subjects such as Ecology, Evolution, Faunistics and Systematics, Life Cycles, Paleontology, Sub-organismal biology, and other minor disciplines. Papers were ascribed to categories according to the information deriving from their title; a given paper can be ascribed to more than one category, but only the main one has been considered for the present analysis. Further information was obtained by consulting directly each paper, even though the library available to us includes just 6,000 papers. The Keys include also abbreviations of the genera mentioned, but this entry is present only for the papers available to us.

The papers have been ascribed to nations according to the nationality of the first author.

For the papers extracted from electronic data banks we added also the abstract. A "Notes" field is available to contain any other information on the paper (e.g., author's address) and might even contain the whole scanned paper. A last field informs whether or not the paper is present in our library.

The size of the file is 22 MB but, in spite of its size, searches lead to immediate results even with small computers and never caused problems.

Specific information on scientific production throughout the data base has been extracted by customised Macros (series of computer operations performed authomatically as a single command) which enabled to order references against time and to divide yearly records by main Subject. Yearly trends were smoothed with the technique of mobile averages over five-year periods.

RESULTS

General trends in hydroidomedusan research

The scientific production on hydroidomedusae in the period 1911-1997 sums up to 10,934 papers. The whole trend, expressed in number of papers per year, can be divided into four periods, marked by changes in the patterns of scientific production (Fig. 1):

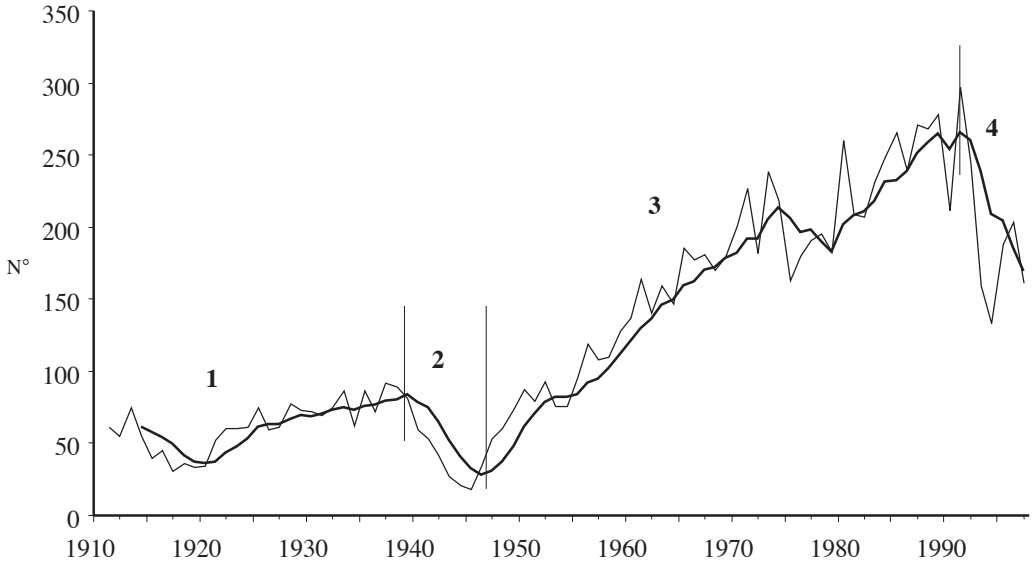

FIG. 1. – General trend in hydroidomedusan research (thin line) with mobile average over 5 year periods (thick line). Vertical lines separate four main periods within the trend.

- 1911-1939, with an average of 60 papers/year and a sharp decrease due to First World War;

- 1940-1947, with an average of 38 papers/year, almost coinciding with Second World War;

- 1948-1991, with an average of 175 papers/year: 125 papers/year in the sub-period 1948-1969, and 226 papers/year in 1970-1991, with a record of 296 papers in 1991;

- 1992-1997, with an average of 178 papers, marked by the inversion of the steady increase of the preceeding period.

In the period 1580-1910 (not covered in the present survey) 2942 papers have been published, with an average of about 9 papers per year.

Trends in the main scientific areas

A better understanding of what determined the general trend is possible by considering specific topics (Fig. 2).

Sub-organismal biology covers topics ranging from general physiology to histology, cell biology, molecular biology, and genetics. It is the most productive area of study, with 4,429 papers, representing 41% of the total. This topic contributed little to the production of the first decades of the period, whereas it dominated the production from the Sixties onwards (Fig. 3). The papers on *Hydra* (Fig.4a) alone comprise 23% of the total production. These works treat mainly sub-organismal biology and represent 56% of the papers on this topic, being the main topic responsible for this trend (Fig. 4b).

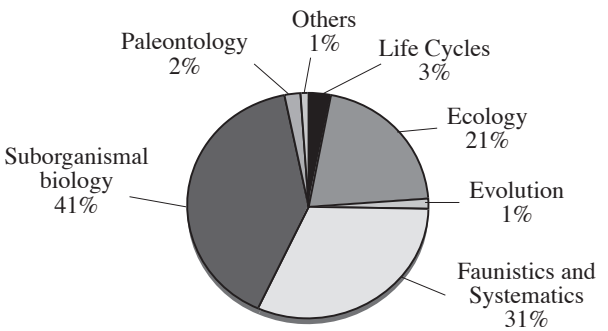

FIG. 2. – Percentages of papers treating the main topics in hydroidomedusan literature from 1911 to 1997.

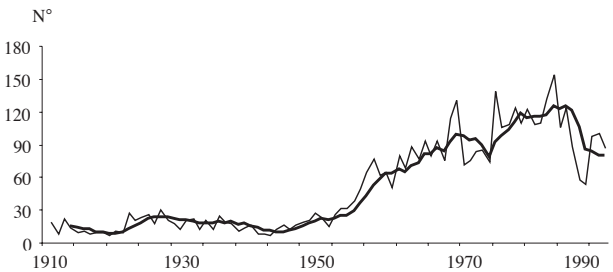

FIG. 3. – Trend of production on sub-organismal topics (thin line) with mobile average over 5 year periods (thick line).

Faunistics and systematics is the second most important subject, with 3,404 papers (31% of the total) and a stable trend of production, with just two sharp decreases coinciding with World Wars and a decrease over the last few years (Fig. 5). Faunistics and systematics was the first-ranked topic from the

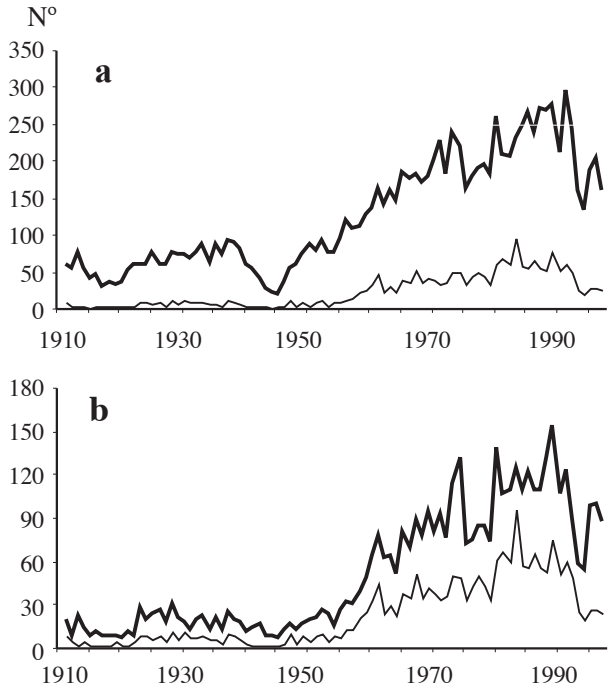

FIG. 4. – The contribution of papers devoted to research on *Hydra* (thin line) compared with: a) the whole trend (thick line); b) the trend of sub-organismal biology (thick line).

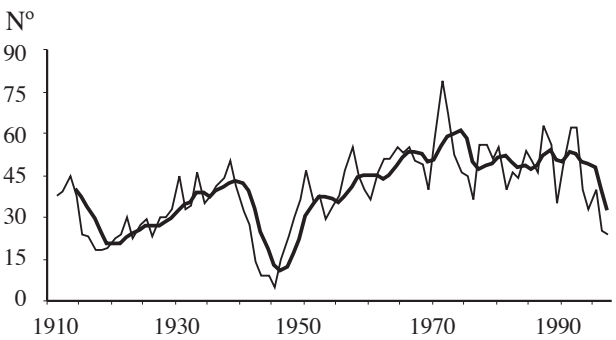

FIG. 5. – Trend of production on faunistics and systematics (thin line) with mobile average over 5 year periods (thick line).

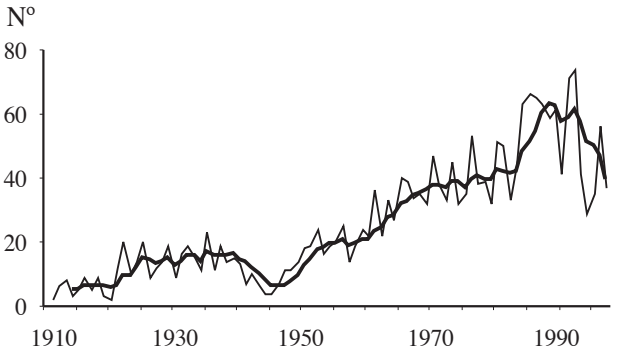

FIG. 6. – Trend of production on ecology (thin line) with mobile average over 5 year periods (thick line).

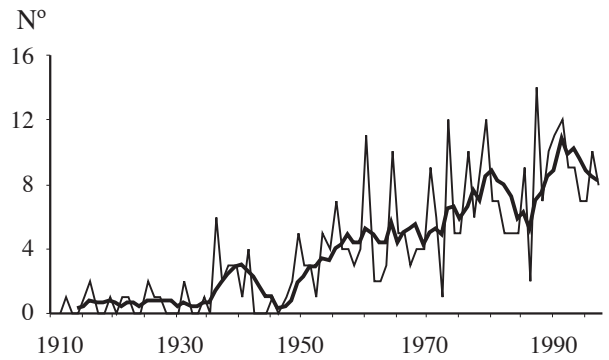

FIG. 7. – Trend of production on life cycles (thin line) with mobile average over 5 year periods (thick line).

beginning of the period to 1956, being responsible for the general trend, whereas it became the lowest-ranking topic in the last decades.

Ecology (2,270 papers, 21% of the total) was rather neglected in the first decades, but went through a steady increase after Second World War (Fig. 6). Ecology cannot be considered a trendy topic in hydrozoan literature as a whole (see Gili and Hughes, 1995, for a recent review).

Life cycle studies (348 papers, 3% of the total), after a boom in the mid-Thirties, and the usual decrease during Second World War, display a fluctuating increase after the mid-Forties (Fig. 7).

Paleontology (223 papers, 2% of the total) and Evolution (162 papers, 1% of the total) have almost no detectable trends, representing a negligible portion of the total production.

A small number of papers (98, 1% of the total) deal with various topics and cannot be ascribed to particular research areas.

Contribution of the main countries in hydrozoan systematics and faunistics

One of the main reasons for the decline of taxonomy is that taxonomic journals have low Impact Factor and that career opportunities in research are often based on the scores of Impact Factor of the applicants for a certain position. This system of evaluation of research is partial, since journals are also classified according to the time their articles continue to be cited. Taxonomic papers will be cited as long as there will be taxonomic work: descriptions of new species are “immortal”. A low immeditate impact is counterbalanced by a prolonged life of taxonomic production. We made a particular analysis of the trend of production in systematics and faunistics, so to have a test of the tendencies regarding this field of research not only on a global scale but also country by country.

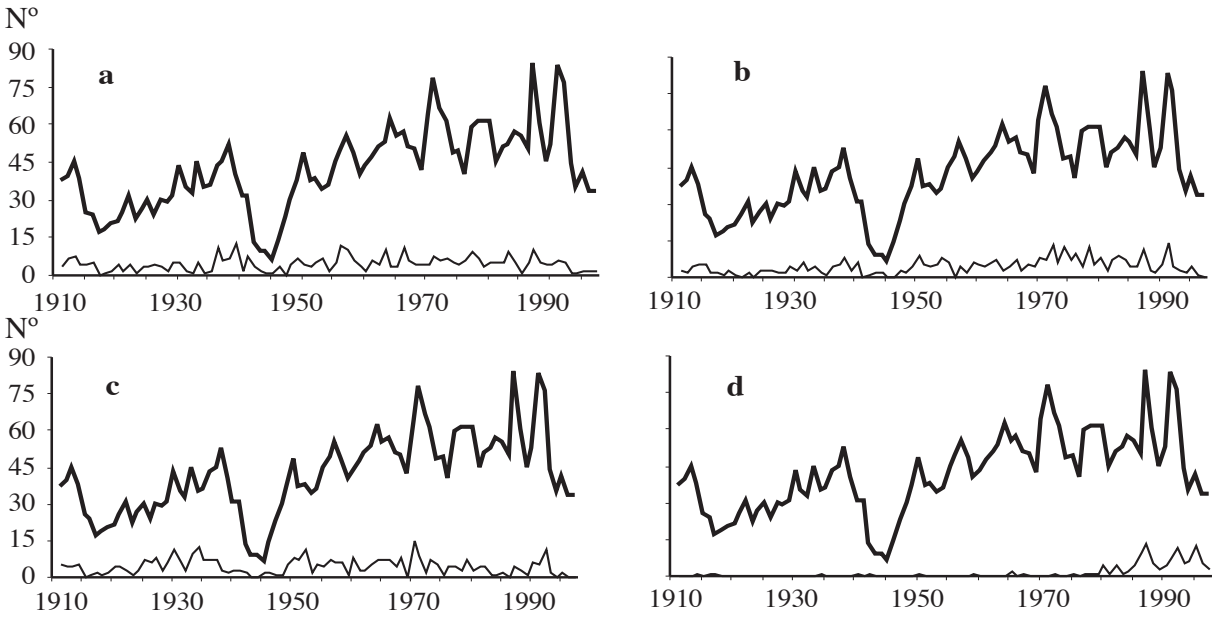

FIG. 8. – Trend of production on faunistics and systematics in the three Countries that more contributed to this field (thin line) against the total faunistics and systematics trend (thick line): a) United Kingdom; b) USA; c) France. The same for an "emerging" Country: d) Spain.

With the exception of the very last years, most taxonomic papers have a single author. Only recently a fine network of collaboration led to multi-authored papers, with authors from different countries. This new trend of international collaboration is the result of the institution of the Hydrozoan Society, established in 1985 and, since then, a major cataliser of international work. We tried to extract the contribution to systematics of single countries by considering the nationality of the first author. The main contributors to faunistics and systematics are United Kingdom, United States of America, and France (Fig. 8a, b, c), each going through a fall in scientific production in the last decades. Other countries are now flourishing in this field and the main example is Spain (Fig. 8d), with an almost non-existent production in most of the considered period and with a recent production, in the last 20 years, that parallels that of the leading countries in their best periods. The situation of Spain is the result of the influence of such eminent personalities as Ramon Margalef, one of the founders of modern ecology. Margalef advised his pupils to study taxonomy before carry out ecological research (J. M. Gili, pers. comm.).

Fig. 9 reports the yearly average production, with standard deviation, of the countries that contributed more than other ones to faunistic-systematic research on hydroidomedusae.

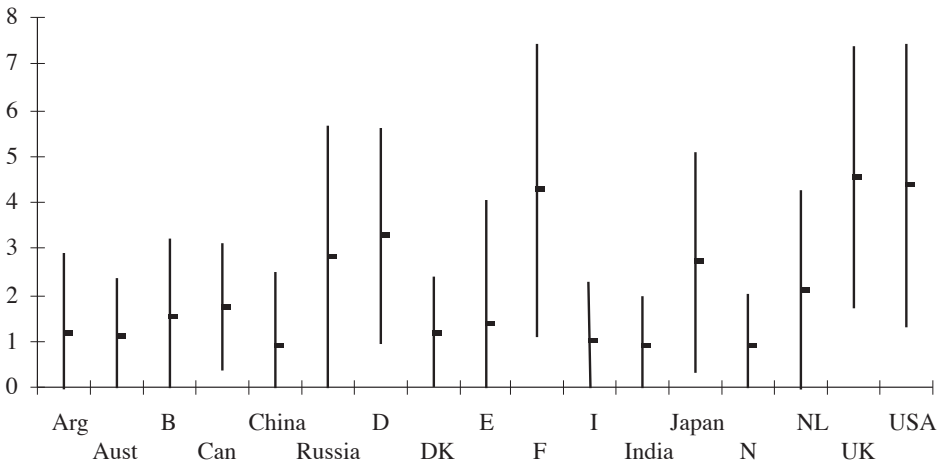

FIG. 9. – Average yearly production of papers, with standard deviation, of the main Countries in hydroidomedusan faunistics and systematics (Arg: Argentina; Aust: Australia; B: Belgium; Can: Canada; D: Germany; DK: Denmark; E: Spain; F: France; I: Italy; N: Norway; NL: The Netherlands).

DISCUSSION

Besides the negative influence of the World Wars, the interest in hydroidomedusae saw a continuous increase until the Nineties, when a tendency towards a decrease occurred. It is not certain whether this is due to an actual decrease in production or to an artefact due to our inability to find all records. The decrease was sharper in Vervoort's survey since many papers published in the Nineties (especially 1993-94) are not reported, but the trend towards a decrease is evident even after the addition of many papers to the last considered years. One reason advanced by Volker Schmid (personal communication) is that recent focusing of sub-organismal biology on model animals other than hydrozoans has distracted many researchers from working on the group.

The main discipline from 1911 to 1959 was systematics and faunistics, whereas sub-organismal biology dominated the production from 1960 to date. Systematics and faunistics was the least category in the last two years of the survey. This change in scientific trends reflects a general attitude in biology, with a shift of interest from organisms to cells and molecules.

The decline of taxonomy is due to manifold reasons:

1. The introduction of the Impact Factor to evaluate the scientific content of publications. Taxonomists publish mainly in journals that are not covered by the Institute for Scientific Information, such as those issued by Museums and scientific Societies. Monographs are ignored by the Impact Factor system. The publication score of taxonomists is usually low and not competitive. The "life" of publications (almost "eternal" due to the priority law) is never considered to evaluate the level of publications.
2. Difficulties in locating and/or getting type material for revisions.
3. Difficulties in tracing and consulting a huge body of specialised literature.

A scientific paper in taxonomy requires a high investment in terms of time and expertise, whereas the reward in terms of impact and career possibilities is low. The tendency towards the decrease of interest in systematics and faunistics is more evident in the leading scientific countries, since they have abandoned this type of research almost completely. This is paradoxical if the recent concern on biodiversity is considered. The leading countries in the knowledge of biodiversity are now relinquishing their expertise in this field in favour of newcomers like Spain and Italy, with the eclipse of an important scientific tradition. Worldwide political choices orient young researchers towards sub- or supra-organismal topics (Boero, 1994).

Ecology is the third-ranking category throughout the whole period, but is less important than the former two areas and, in fact, does not deeply influence the general trend in any period. Life cycle studies are not important from a quantitative point of view, but also acquire a relevant role in systematics. The building of a single classification for hydroids and hydromedusae started to be perceived as a strategy in the mid-Thirties and continues to date. The number of papers dedicated to this topic is small (with a maximum of 14 in 1987) but the trend towards increase contrasts the general trend in faunistics and systematics. Life cycles should be much more relevant in ecological papers, but these are mostly one-stage oriented (in fact only a small percentage of ecological papers consider life cycles) in spite of ecology being labelled as the science of connections and interactions. Most hydroidomedusae have complex life cycles, and the existence of polyps is dictated by the success of the medusae and vice versa, this being relevant to ecological approaches (see Boero *et al.,* 1996 for a discussion of the importance of life cycles in marine ecology).

Palaeontology gives a scant contribution of hydroidomedusan science: only few groups fossilise easily and only Milleporids, Stylasterids (e.g., Cairns, 1983) and a host of supposed *Velella* and *Porpita* (e. g., Stanley, 1982) are usually considered.

The study of evolution is rather neglected in the hydroidomedusae; most evolutionary papers, furthermore, refer to the internal evolution of supraspecific taxa, whereas the importance of the Hydrozoa, and of the Cnidaria as a whole, in the evolution of the Metazoa is mostly neglected. This is surprising since the Cnidaria are diploblastic, as were the ancestors of the triploblasts that dominate the animal kingdom today. The importance of the last existing diploblasts in the understanding of metazoan evolution should be greater than it actually is (Boero *et al*., 1998). The reason for this illogical tendency is possibly that scientists that argue about metazoan evolution do not care for Cnidaria and that cnidarian specialists are not attracted by evolutionary speculations. Recent molecular techniques are now calling attention to Cnidaria and it is possible that this trend will be inverted (Bridge *et al.,* 1995; Schierwater *et al.,* 1991; Schierwater and Kerstin, 1998).

Bibliographic information is paramount mainly in systematic and faunistic work, whereas the bearing of old literature on fastly developing fields such as molecular biology is almost negligible. Our database, thus, will be of great help mainly to systematists and we hope to make it available in electronic format as soon as possible.

ACKNOWLEDGEMENTS

Work supported by M.U.R.S.T. (COFIN and 60% funds), the Amministrazione Provinciale di Lecce, C.N.R., and N.S.F. (P.E.E.T.) funds.

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