

## Cephalopods: What makes them an ideal group for an Internet database<sup>a</sup>

by

Uwe Piatkowski<sup>b</sup> & James B. Wood<sup>c</sup>

### Abstract

Living cephalopods include cuttlefishes, squids, octopuses and the chambered nautilus. There are 703 species described today, but the status of their systematics worldwide is decades behind that of other major marine taxa. They are quite distinct from fish not only in their morphology but also in their life history. Cephalopods have short life spans, fast growth rates (exponential when young), and they tend towards semelparity. Cephalopod research is of interest and importance firstly because of the intrinsic value in understanding the complex biology and peculiar life cycles of these animals. While world-wide traditional fish stocks are decreasing the total world landings of all cephalopods have nearly doubled over the last decade (to 3.3 million tonnes in 1997). Cephalopods have gained an excellent market price and have become subject of global trade including developing countries. With an average value of US\$ 2,100 per metric tonne, they gained a total market value of more than US\$ 5.3 billion in 1989, which ranked them third after shrimp and tuna. Despite the increasing fishing pressure on cephalopods, basic knowledge of their biology and of management strategies of fished stocks lags behind that of most fish species. Hence, a widely accessible Internet database would certainly become a valuable tool to collect and provide comprehensive information to better understand and document major aspects of cephalopod biology and fishery.

a) Presented by the first author at the INCO -DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000;

b) Institut für Meereskunde, Universität Kiel, Düsternbrooker Weg 20, D -24105 Kiel, Germany. E-mail: [upiatkowski@ifm.uni-kiel.de](mailto:upiatkowski@ifm.uni-kiel.de)

c) National Resource Center for Cephalopods, University of Texas Medical Branch, Galveston, TX 77555 - 1163, USA. E-mail: [ceph@is.dal.ca](mailto:ceph@is.dal.ca)

### **Relatively few species, but unsolved systematics**

Living cephalopods include cuttlefishes, squids, octopuses, the chambered nautilus, and a unique species found only in the deep sea called the vampire squid (*Vampyroteuthis infernalis*). They are by far the most advanced group within the phylum of mollusks, which also includes snails, slugs, clams, scallops, oysters and mussels. All cephalopods are entirely marine and distributed throughout the seas of the world. There are more than 700 species described today (Sweeney & Roper, 1998), and that number increases every year as scientists discover new species, particularly in tropical and polar seas. However, the status of cephalopod systematics worldwide is decades behind that of other major marine taxa. The group is very attractive to taxonomists, but difficulties in obtaining adequate funding and material have resulted in a low level of understanding (Roeleveld, 1998). There are very few fossils of them since modern cephalopods do not have hard external shells like other mollusks. Consequently, the lack of a fossil record of coleoid cephalopods makes systematics much harder. In comparison with other marine groups, such as crustaceans, fishes or sea mammals, sound ecological studies on cephalopod ecology are sparse. This is not in concordance with the important position that cephalopods have in major marine ecosystems (Clarke, 1996). Two obvious shortcomings are responsible for this: (1) cephalopods are difficult to catch and mostly taken as by-catch in surveys targeting other taxa; (2) they have complicated life cycles and distribution patterns which are only roughly understood for a few species.

### **Physiology studies dominate ecological research**

Cephalopod research is of interest and importance firstly because of the intrinsic value in understanding the complex biology and peculiar life cycles of these animals. Cephalopods are famous for outstanding physiological performance, which makes them the most highly evolved marine invertebrates. This is documented in their elaborate sense organs, large brains, active lifestyle and complex behaviour (Hanlon & Messenger, 1996). Modern research encompasses detailed studies on genetics, symbiotic bacteria and biomedical research that makes them very attractive for a variety of research fields and new biochemical technologies. The wealth of information on cephalopod physiology is in great contrast to our poor knowledge of their ecology. Nevertheless, physiological studies are important prerequisites to understanding their ecology in the field.

### **Cephalopod age and growth – still a mystery?**

There is general agreement in cephalopod research about their exceptionally high metabolism, but still much speculation about their growth pattern and age. It is well accepted that the giant octopuses can live up to five years, and nautilus can attain ten years. But most squid and many octopuses are short-lived annual species, thus being the marine equivalent of weeds without a "robust age structure" (O'Dor, 1998). Ageing of cephalopods has always been a severe obstacle in modeling growth patterns. Reading of periodic increments within the squid statolith microstructure has developed into a routine technique to obtain individual age estimates which form the basis for most growth models that are essential in studying cephalopod population dynamics (Pauly, 1985). Validation and culture studies, although another main problem for most short-lived species, have shown that statolith increments (similar to increments in larval fish otoliths) are produced daily in a number of squid species. Statolith age analysis has revealed that temperate squids can complete their life cycle in less than two years while tropical species live for less than eight months; both following linear or exponential growth models (see review of Jackson, 1994). In contrast, growth

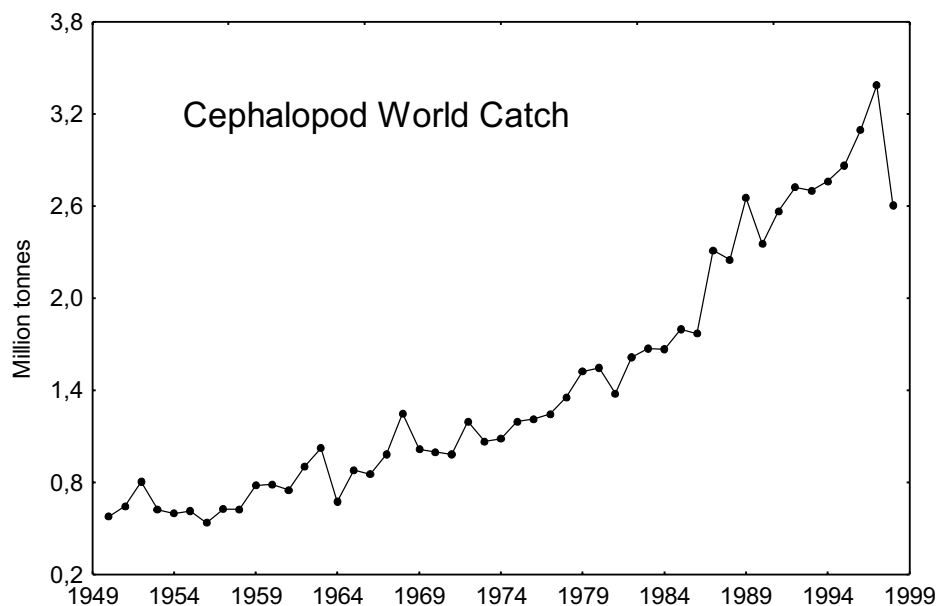
curves generated from analysis of length frequency data suggested an asymptotic growth curve and ages in excess of three years for some tropical squid. Such analyses, therefore, appear to be inappropriate (Jackson & Choat, 1992), and point out the complete failure of state-of-the-art fish modeling software to produce realistic life spans of cephalopods. Cephalopod growth remains a biological mystery and is still a matter of some debate (e.g., Jackson & Choat, 1994; Pauly, 1998). It is curious though, that we know nothing about age and growth of the giant squid, the largest invertebrate in the world, which can attain total lengths exceeding 20 metres. Furthermore, no reliable method to age octopuses has yet been developed.

### Trophic relationships

The overall role of cephalopods in the marine environment, their significance as food resources for higher trophic levels such as mammals and birds and their impact as predatory consumers of fish and other invertebrates, is only beginning to be studied (Clarke, 1996). It is a great challenge to intensify field and laboratory studies on trophic interrelationships where cephalopods are involved, because they will elucidate cephalopod ecology and form the basis for further ecosystem modeling.

### Cephalopod fisheries and markets

Worldwide traditional fish stocks are decreasing due to over fishing and/or environmental changes. In response to this cephalopods have gained an immense importance in substituting the traditional marine harvest and will gain a much larger importance in the future to supply mankind with marine living resources (Caddy, 1994; Caddy & Rodhouse, 1998).



**Fig. 1.** Cephalopod world catch (from FAO, 2000).

As well as comprising commercially important fishery resources, selected species also show some potential for aquaculture (Nabhitabhata, 1995). Many cephalopods are very efficient in converting food to biomass, particularly protein (O'Dor & Wells, 1987) Hence, the rapid growth rate and high

food conversion rates of cephalopods are both advantageous traits for aquaculture. Cephalopod landings have steadily increased worldwide since the 1950s, peaking in 1997 at more than 3.3 million tonnes (FAO 2000; Fig. 1). Although increased cephalopod landings may partly reflect increased market demand, particularly in the Far East nations, over fishing finfish stocks has positively affected cephalopod populations. Data from fifteen key FAO areas reveal that, with the exception of the north-east Atlantic, cephalopod landings have increased significantly over last 25 years while groundfish have risen more slowly, remained stable, or declined (Caddy & Rodhouse, 1998).

**Table 1. Estimated total value of marine catches in 1989 (after FAO, 1993).**

<b>Species group</b>	<b>Marine catch [million tonnes]</b>	<b>Average unit value [US\$ per tonne]</b>	<b>Total value [billion US\$]</b>
Shrimp	1.841	4000	7.370
Tuna	3.985	1700	6.775
<b><i>Cephalopods</i></b>	<b>2.545</b>	<b>2100</b>	<b>5.344</b>
Flatfish	1.193	2900	3.459
Salmon and salmonids	0.936	3500	3.278
Lobster	0.202	11270	2.275
Alaska pollack	6.259	331	2.072
Atlantic cod	1.783	1068	1.904
Herring, sardine	8.630	200	1.726
Blue whiting	0.663	66	0.044

Cephalopods have an excellent market price and are the subject of global trade. This can easily be seen in a recent FAO study which compares total catch or production, respectively, average unit value and total value of major aquatic species groups (FAO, 1993; Table 1). With an average unit value of 2100 US\$ per metric tonne, cephalopods gained a total market value of more than 5.3 billion US\$ in 1989, which ranked them third after shrimp and tuna demonstrating their important economic value.

Their increased economic importance may reflect a change in their ecological importance, e.g. species replacement has been suggested as an underlying factor in changing fishery patterns in the Saharan Bank fishery (Balguerías, 2000). There is a need for development of models and forecast fishery trends in cephalopods. Ideally such models should be able to integrate environmental, biological, fishery and economic information. The accumulation of such information clearly warrants a database on cephalopods. It would form a necessary prerequisite not only for providing and intensifying biological and ecological information on as many cephalopod species as possible, but also for modeling and forecasting fluctuations of cephalopod stocks.

Management strategies for cephalopod fisheries present similar challenges to those encountered in fisheries for finfish. However, despite the increasing fishing pressure on cephalopods, basic

knowledge of their biology lags behind that of most fish species. Therefore, it is critical that fisheries workers not base cephalopod policies on what works for fish. A comprehensive database would certainly be a valuable tool to develop management strategies that adapt to cephalopod fisheries.

## References

- Balguerías, E., M.E. Quintero, & C.L. Hernández-González, 2000. The origin of the Saharan Bank cephalopod fishery. *ICES J.Mar.Sci.*, 57:15-23.
- Caddy, J.F., 1994. Cephalopod and demersal finfish stocks: some statistical trends and biological interactions. Squid 94 Venice. The 3rd International Cephalopod Trade Conference. Agra Europe.
- Caddy, J.F. & P.G. Rodhouse, 1998. Cephalopod and groundfish landings: evidence for ecological change in global fisheries? *Rev. Fish Biol. Fisheries*, 8:431-444.
- Clarke, M.R. (ed), 1996. The role of cephalopods in the world's oceans. *Phil.Trans.R.Soc.Lond. B*, 351:979-1112.
- FAO, 1993. Marine fisheries and the Law of the Sea: a decade of change. *FAO Fish.Circ.*, 853.
- FAO, 2000. Total production 1950 -1998. FAO homepage <http://www.fao.org/> (former FAO Yearbook of fisheries statistics "Catches and landings").
- Hanlon, R.T. & J.T. Messenger, 1996. Cephalopod behaviour. Cambridge University Press, 232 p.
- Jackson, G.D., 1994. Application and future potential of statolith increment analysis in squids and sepioids. *Can.J.Fish.Aquat.Sci.*, 51:2612-2625.
- Jackson, G.D. & J.H. Choat, 1992. Growth in tropical cephalopods: An analysis based on statolith microstructure. *Can.J.Fish.Aquat.Sci.*, 49:218-228.
- Nabhitabhata, J., 1995. Mass culture of cephalopods in Thailand. *World Aquaculture*, 26:25-29.
- O'Dor, R.K. & M.J. Wells, 1987. Energy and nutrient flow. pp. 109 -133 *IN* Boyle, P.R. (ed.). Cephalopod life cycles. Vol. II. Comparative reviews. Academic Press, London.
- O'Dor, R.K., 1998. Can understanding squid life-history strategies and recruitment improve management? *S.Afr.J.Mar.Sci.*, 20:193-206.
- Pauly, D., 1985. Population dynamics of short-lived species, with emphasis on squids. *NAFO Sci.Coun.Stud.*, 9:143-154.
- Pauly, D., 1998. Why squid, though not fish, may be better understood by pretending they are. *S.Afr.J.Mar.Sci.*, 20:47-58.
- Roeleveld, M.A.C., 1998. The status and importance of cephalopod systematics in southern Africa. *S.Afr.J.Mar.Sci.*, 20:1-16.
- Sweeney, M.J. & C.F.E. Roper, 1998. Classification, type localities, and type repositories of recent Cephalopoda. *Smithson.Contr.Zool.*, 586:561-599.

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Edited by

**Enrico Feoli**

University of Trieste, Italy

and

**Cornelia E. Nauen**

Directorate General for Research, European Commission, Brussels, Belgium

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## Abstract

The present report contains the proceedings of the INCO-DEV International Workshop on Information Systems for Policy and Technical Support in Fisheries and Aquaculture, convened in Los Baños, Philippines, 5-7 June 2000. It was convened to address issues associated with the difficult transition from abundance to scarcity in aquatic resources. Reliable information will spread the right perception of the productive capacity and result in more realistic assessment of decreasing benefits and rising costs. Conservation of aquatic biodiversity, ecosystem approaches to fisheries and aquaculture production and food quality and safety along the entire chain from production to the consumer are key concepts that will govern approaches to aquatic living resources in the future. International trade is a major driving force in bringing many of these problems to a head, while also offering opportunities for socio-economic development.

To this effect, scientists and other knowledgeable persons active in relation to these key aspects contribute a panorama of existing information resources, experience with their development, but also difficulties encountered. The papers point out avenues how global public goods necessary for the transition towards sustainability can be either created or more effectively shared. International cooperation based on mutual respect and interest, mobilising the best of science across continents to ensure trustworthy information and knowledge, is confirmed as a most useful approach to support societal demands for sustainable fisheries and aquaculture.

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