EJAR

Growth, mortality and exploitation of European hake *Merluccius merluccius* in the Moroccan North Atlantic Sea

Sadia Belcaid[1] and Md. Sagir Ahmed[2]*

[1]*National Institute of Fisheries Research, Regional Center, Tangier, BP: 5268-Dradeb, Tangier, Morocco.* sadiabelcaid@hotmail.com
[2]*University of Dhaka, Department of Zoology, Laboratory of Aquatic Resource Management, Dhaka 1000, Bangladesh. E-mail:* sagir@univdhaka.edu sagir_udhaka@hotmail.com

*Corresponding author's present address:
Aquatic Resource Management Lab
Department of Zoology
University of Dhaka, Dhaka 1000, Bangladesh
Fax: 880-2-8615583; Tel. 880-2-9661900 Ext. 7597
E-mail: sagir@univdhaka.edu

Received 31st October 2010, Accepted13th July 2011

Abstract

The European hake (*Merluccius merluccius*) is one of the most heavily exploited fish species in Northeast Atlantic demersal fisheries and is taken as part of mixed-species fisheries in the Moroccan waters. The growth and mortality of *M. merluccius* in Northeast Atlantic (Moroccan coast) were investigated based on length frequency data using the FiSAT software. Total length of the sampled 4440 fish ranged from 9.5 to 70.2 cm. The von Bertalanffy growth function estimates were L_∞ = 72.45 cm, K = 0.28 /year, t_0 = -0.72 years. The total, natural and fishing mortality were computed as Z = 1.80, M = 0.50 and F = 1.31 /year, respectively. The exploitation rate E = 0.73, indicating that the southern stock of hake fishery is over-exploited in the Moroccan North Atlantic sea.

Keywords: *Merluccius merluccius*, Southern Stock, exploitation, Northeast Atlantic, Moroccan sea.

1. Introduction

The European hake *Merluccius merluccius* (Linnaeus, 1758) is widely distributed throughout the Northeast Atlantic, from the coast of Mauritania at about 21º N to 62º N off the western coast of Norway, and reaches greatest density between the British Isles and the Southern Iberian Peninsula (Casey and Pereiro, 1995) as well as in the lower Mediterranean. It is one of the most valuable and heavily exploited demersal species in Western European fisheries. The status of *M. merluccius* populations in the NE Atlantic is assessed annually by the International Council for the Exploration of the Sea (ICES) on the basis of two separate stocks, the Northern stock and the Southern stock, to the north and south of Cape Breton Canyon (Bay of Biscay), respectively (ICES, 1979). Recent assessments of the status of the Southern stock (Spanish and Portuguese waters) reveal a dramatic decline of the spawning stock biomass that has been attributed to overfishing (ICES, 2006).

Hakes are also distributed throughout the Moroccan Atlantic coast. It is one of the most heavily exploited commercial fish species in Moroccan demersal fisheries, and is taken as part of shrimp-hake fisheries in the North Atlantic of Morocco, mainly exploited by trawl and gillnets. This species have a large bathymetric distribution, it is found from only several meters in the coastline to 1000 m depth, from the Strait of Gibraltar to 21ºN. Moreover, have a bathymetric segregation of sizes; the largest individuals are caught in waters deeper than 200 m, however the coastal shelf is habited by a mostly juveniles (Turner and El Ouairi, 1986; Caverivière *et al.*, 1986), whereas medium-sized fish appear at the lower depths (Turner and El Ouairi, 1986; Meiners, 2007). This species prefer muddy bottoms, but are well distributed on other types of bottom as well (muddy-sandy and sandy bottoms).

The annual catch recorded by the Moroccan coastal fleet has experienced a steady increase between 1998 and 2003. Production in 2003 reached 11 600 tons, double the landings recorded in 2002. Since 2004, the catches show a significant drop. The study of abundance indices of hake from research campaigns (INRH, 1982-2007) shows a general downward trend since 1982 until 2006. The abundance of hake in 2006 was about 36% as compared to 2005. Moreover, the percentage of juveniles is continuously increasing; it rose from 53% in April 2006 to 83% in June 2007 in north area. The size of fish in the catches decreased progressively from 2000 (27.74 cm) to 21.60 cm in 2007. Moroccan management measures applied a regulation to limit mesh size to 50 mm and prohibited fishing within 3 miles of the coastline which is poorly practiced.

The hake is a species of temperate waters; relatively have a long life (12-13 years) and moderate growth. In reality, growth is one of the most sensitive biological problem in the study of hake, because of its importance to the assessment and management of fisheries that develop in any of their distribution areas.

Although there is an extensive literature on the study of the growth of the hake in most areas where it is distributed, and that have been carried out various exchanges and ad hoc working groups to improve the accuracy of the estimating age of stocks in the area ICES (Piñeiro, 2000; Piñeiro *et al.*, 2000; ICES, 2003; Piñeiro and Sainza, 2002 and Piñeiro and Sainza, 2004), There is currently no method for determining the age internationally accepted and validated better than that based on the hard structures of *M. merluccius*. The structure of the rings of the otoliths is difficult to interpret, because factors such as defining the nucleus of the otolith, the formation of annual rings and intermediate and extending the period of its formation, contribute to the discrepancies that exist between different readers. As a result, the descriptions of the growth of the hake vary depending on the area of capture and interpretations of the rings of the otoliths (Casey and Pereiro, 1995).

In Moroccan coast, the studies were carried out on growth of *M. merluccius* by reading scales (Belloc, 1935), the longitudinal section of otoliths (Maurin, 1954; AtlantNIRO, 1978; Rami, 1979) and cross section of the otoliths (Goñi, 1983; El Ouairi, 1990). Goñi (1983) established the first key length-age *M. merluccius* according to the technique of Nichy (1977). In that study he analyzed the seasonal training from the edge of the otoliths through back-to medium size by age and growth parameters for each sex and the sexes combined. He mentioned that the first ring of winter, which should be distinguished as a false ring was a major problem for determining the real age of *M. mirluccius* and El Ouairi (1990) also demonstrated the same thing.

However, recent evidence about the growth of *M. merluccius* has proved to be underestimated. Garcia-Rodriguez and Esteban (2002) proposed a scenario of rapid growth in the western Mediterranean, through the contrast between estimates by reading otoliths and length progression. Subsequently, de Pontual *et al.* (2004) presented preliminary results of a pilot study of capture, marking and recapture *M. merluccius* in the northern Gulf of Biscay (ICES zone). In this study, they found that the growth rate of specimens between 13-58 cm (210 + 0.91 cm/year), is almost double that estimated so far by reading otoliths in the same region. This new estimate coincides with preliminary analysis of the micro structure of otoliths, presumably related to the formation of daily rings for young in the age group zero in Spanish Atlantic waters (Piñeiro *et al.*, 2004). Despite numerous studies focusing on the biology of *M. merluccius* (Piñeiro and Saınza, 2003), many gaps remain in our knowledge on the species.

The aim of the present work was to provide information on growth, mortality and exploitation rates to define the present status of the *M. merluccius* population in the Moroccan coast of Northeast Atlantic.

2. Materials and Methods

2.1. Study area and sampling

Fish samples were collected from the port of Larache, obtained from commercial catch in the Northeast Atlantic Moroccan Sea, during January 2006 to December 2006. The catch was mainly landed from the trawlers of mesh size range from 28 to 40 mm. A total of 4440 specimens were utilized for length frequency studies. The total length (TL) of each fish was recorded to the nearest mm from the tip of the snout to the tip of the caudal fin and weighed up to nearest gram using specific weight balances depending on the size of the fish. Monthly length frequency data were compiled from sample. Length measurements were grouped at 2.0 cm length intervals, for the study of length frequency distribution.

2.2. Length-weight relationship

Length-weight relationship was calculated by applying exponential regression $W=aL^b$, where W is the total weight (g) and L the total length (TL)(cm).

2.3. Growth parameters

Fish growth was assumed to follow the von Bertelanffy growth function (VBGF), which has the basic form: $L_t=L_\infty(1-exp^{-K\,(t-t0)})$

Estimates of the von Bertelaffy growth parameters, the asymptotic length (L_∞) and the growth coefficient (K), for *M. merluccius* were derived using the ELEPHAN routine in the FISAT programs (Gayanilo *et al.*, 1995). The theoretical age at length at zero (t_0) was obtained from Pauly's (1979) equation:

$$\text{Log}_{10}(-t_0) = -0.392 - 0.275 \log_{10} L_\infty - 1.038 \log_{10} K$$

2.4. Longevity and growth performance

Longevity was calculated from Pauly's equation: $t_{max}=3/K$. Pauly's (1984) growth performance index (or phi-prime) was computed from the equation:

$$\varphi' = \log_{10} K + 2 \log_{10} L_\infty \ .$$

2.5. Mortality parameters

Total annual instantaneous mortality rates *Z*, were estimated by constructing linearized length-converted catch curves (Sparre and Venema, 1992).

Natural mortality (*M*) was estimated using the general regression equation of Pauly (1980):

$$\text{Log}_{10}M = 0.0066 - 0.279\ \text{Log}_{10}L_{\infty} + 0.6543\ \text{Log}_{10}K + 0.4634\ \text{Log}_{10}T$$

Where, L_{∞} and K are the parameters of the von Bertalanffy equation. Parameter T is the annual mean water temperature (ºC), which was 18 ºC for the given sampling area. The instantaneous rate of fishing mortality (*F*) was estimated as the difference between *Z* and *M*. The exploitation rate (*E*) was determined according to Gulland (1971): *E=F/Z*.

3. Results and Discussion

3.1. Length-weight relationship

The total length of 4440 *M. murluccius* specimens caught in Northeast Atlantic Moroccan Sea ranged from 9.5 to 70.2 cm. The length weight relationships for combined sexes of *M. merluccius* was $W=3.10^{-6}L^{3.1317}$ (Figure 1) indicated allometric growth. The length–weight relationships of *M. merluccius* in Moroccan coastal water were estimated as $W = 3.10^{-5} \times L^{2.73}$ for males, $W = 2.10^{-5} \times L^{2.81}$ for females and $W = 8.10^{-6} \times L^{2.98}$ for the sexes combined (FAO, 2007). The present estimates are quite similar to the estimates of Piñeiro and Sainza (2003) and Lucio *et al.* (2000) for the southern stocks.

Figure 1. Length-weight relationship of *M. merluccius* (combined sexes, N=1090)

3.2. Growth parameters

The von Bertelanffy growth equations estimated growth parameters as L_{∞} = 72.45 cm, K= 0.28 /years and t_0 = -0.72 years. The growth curves produced with those parameters are shown over its restructured length distribution (Figure 2). The asymptotic length, 72.45 cm is realistic since the largest specimen sampled was 70.2 cm. Piñeiro and Sainza (2003) estimated von Bertalanffy growth parameters of males were L_{∞} = 70 cm, K = 0.18 /year, and t_0 = -0.97 year, and those of females were L_{∞} = 89 cm, K = 0.13 /year, and t_0 = -1.15 year and for combined sexes were L_{∞} = 88 cm, K = 0.128 /year, and t_0 = -1.17 year for the Southern stocks. The present estimates of L_{∞} = 72.45 cm is smaller than the estimates of de Pontual *et al.* (2006), Gracia-Rodriguez and Esteban (2002), Lucio *et al.* (2000) (Table 1). In contrast, the estimated growth coefficient K = 0.28 is higher than the previous estimates for this species (de Pontual *et al.*, 2006; Piñeiro and Sainza, 2003; Garcia-Rodriguez and Esteban, 2002; ICES, 1991). Meiners (2007) demonstrated that the growth of hake is higher in the Northeast Atlantic, followed by South ICES (waters of the Atlantic Iberian Peninsula), the western Mediterranean, and the Moroccan coast. The differences between the sizes of the same age vary depending on climatic condition, but tend to stabilize after the third year. On the average, the Northwest African (Moroccan) hake are 32%, 25% and 20% respectively smaller than the hake of the same age in the Bay of Biscay, Atlantic waters of the Iberian peninsula (the South area of ICES) and in the Northwest Mediterranean (Meiners, 2007).

Using the estimated value of the average growth coefficient (K = 0.28), the longevity, $t_{max}= 3/K$, was calculated as about 10 years. A summary of the parameters that describe growth in length and derived growth performance index (φ') is provided in Table 1. The length frequency analysis applied to *M. merluccius* from the Moroccan waters revealed that the species is fast-growing and this result supports the fast-growing hypothesis of Piñeiro *et al.* (2007).

The debate about whether hake is a fast- or a slow-growing species has been going on since the 1930s (Hickling, 1933; Belloc, 1935). Studies since those days in various areas have reported very different growth estimates for hake in both the Northeast Atlantic (Bagenal, 1954; Guichet *et al.*, 1973; Robles *et al.*, 1975; Descamps and Labastie, 1978; Iglesias and Dery, 1981; Lucio *et al.*, 2000a; Piñeiro and Sainza, 2003; Piñeiro *et al.*, 2007) and the Mediterranean (Aldebert and Recasens, 1996; Morales-Nin and Aldebert, 1997; Garcia- Rodriguez and Esteban, 2002). It is important to assess whether such diversity is biologically meaningful or whether it reflects bias in the estimation methods.

3.3. Mortality and Exploitation

The instantaneous total mortality rate, Z was estimated as 1.80 /year (Figure 3). The instantaneous natural mortality M, was calculated as 0.50 /year (Pauly). The reliability of the estimated M was confirmed using the M/K ratio, which has been reported to be within the range of 1.12-2.25 for most fishes (Beverton and Holt, 1959). The M/K ratio (1.78) in the present study falls within the acceptably defined range. Thus, the average instantaneous fishing mortality F, (F=Z-M) was calculated as 1.31 year^{-1} and the exploitation ratio E, (E=F/Z) as 0.73 (Figure 3). The estimated fishing mortality (F=1.31) seems to be fairly high, and together with the current exploitation rate of 0.73, it indicates a high fishing pressure on the stock of *M. murluccius* in the Moroccan waters.

Table. 1. Parameters of the von Bertalanffy growth equation (K, L_∞ and t_0) for southern stocks of *M. murliccius* obtained by different authors.

Authors (years)	Sexs	Methods	K	L_∞	t_0	ϕ
de Pontual *et al.*, (2006)	Combined	Otoliths	0.362	89.9	-	-
Pinerio and Sainza (2003)	Combined	Otoliths	0.128	88	-1.174	-
Lucio *et al.* (2000a)	Combined	Otoliths	0.12	110	-0.452	-
	Males		0.181	80	-0.724	
	Females		0.122	110	-0.619	
Gracia-Rodriguez and Esteban (2002)	Combined	FiSAT (ELEPHAN)	0.21	108	0.115	3.39
Godinho *et al.* (2001)	Combined	Otoliths	0.089	110.6	-0.97	2.99
The present study (Belcaid and Ahmed, 2008)	Combined	FiSAT (ELEPHAN)	0.28	72.45	-0.72	3.16

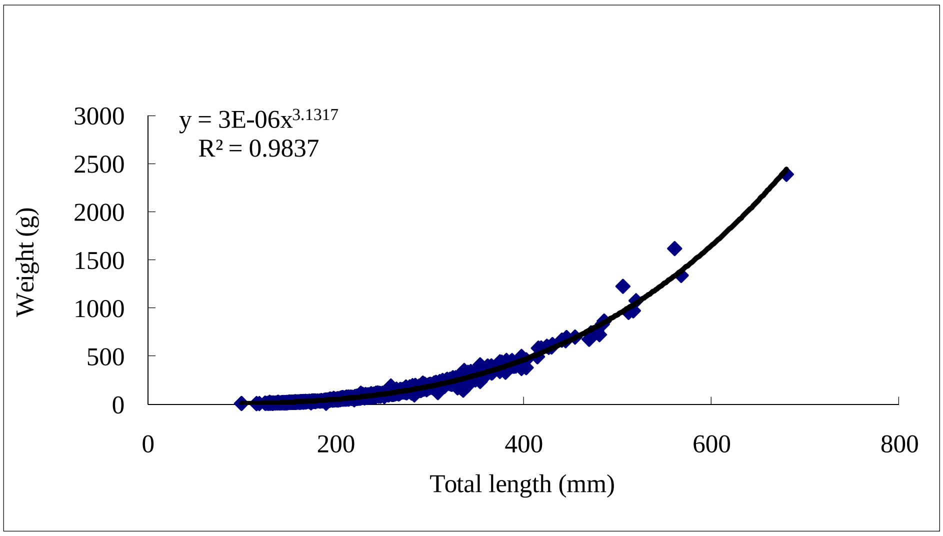

Figure 1. Length-weight relationship of *M. merluccius* (combined sexes, N=1090)

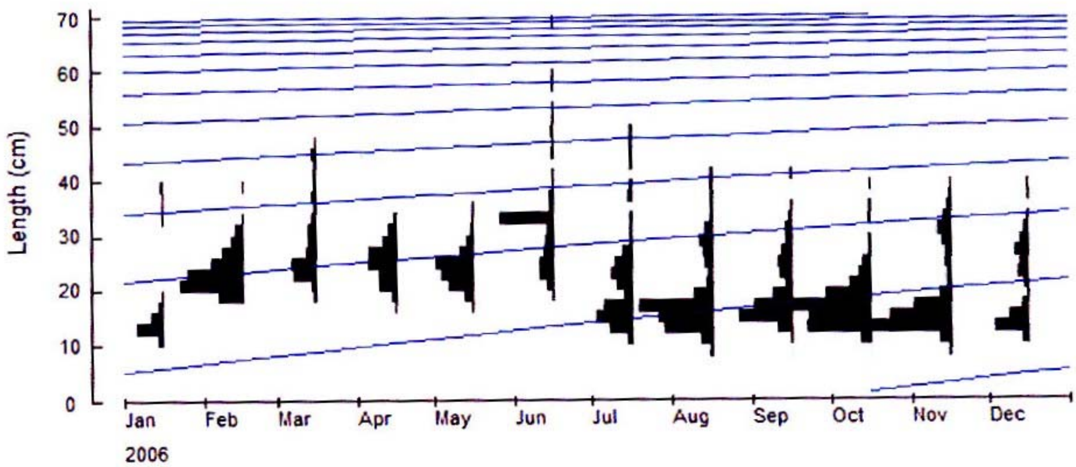

Figure 2. von Bertalanffy growth curve of *M. marluccius* from the North Atlantic Moroccan sea by ELEPHAN I (L_∞ = 72.45 cm and K = 0.28 /year).

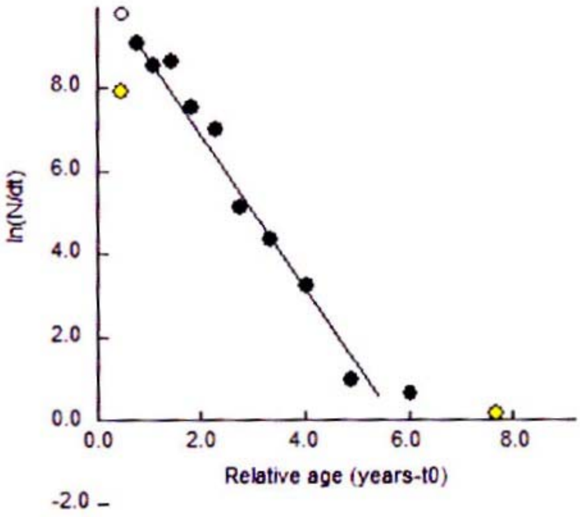

Figure 3. Length converted catch of *M. merluccius*.

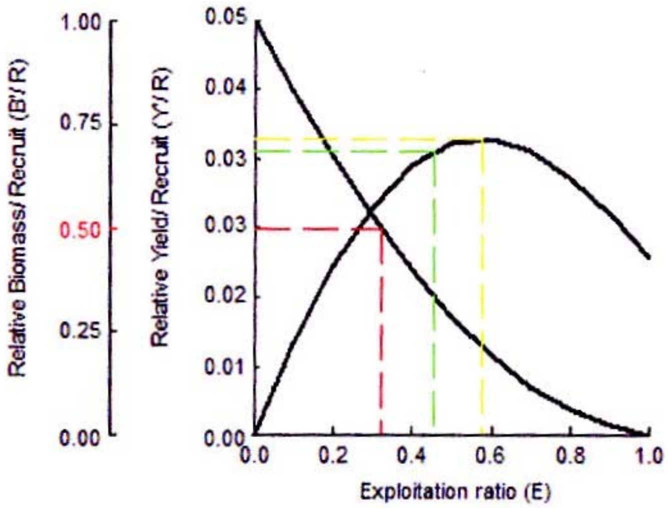

Figure 4. Relative yield per recruit(Y/R) and relative biomass per recruit of *M. merluccius*.

Acknowledgements

The present study was carried out under the project of biological monitoring and exploitation of the European hake led by the Regional Center of the National Institute of Fisheries Research in Tangier. The authors also like to thank the team of scientific laboratory of fishery resources of the Regional Center of the INRH in Tangier.

References

AtlantNIRO : 1978, Les merlus (*Merluccius* spp.) de la côte nord ‑ ouest de l'Afrique. *En*: Report of the ad hoc working group on hakes (*Merluccius merluccius*, *M. senegalensis*, *M. cadenati*) in the northern zone of CECAF. IEO, Sta. Cruz de Tenerife, Canary Islands, Spain. 5-9 June 1978. *FAO CECAF/ECAF Ser. 78/9* App. 6, pp. 43-64.

Aldebert, Y., Recasens, L.: 1996, Comparison of methods for stock assessment of European hake *Merluccius merluccius* in the Gulf of Lions (Northwestern Mediterranean). *Aquatic Living Resources*, 9: 13-22.

Bagenal, T.B.: 1954, Growth rate of the hake (*Merluccius merluccius* L.) in the Clyde and other Scottish areas. *Journal of Marine Biological Association,* 33: 69-95.

Belloc, G.: 1935, Etude monograhique du merlu *Merluccius merluccius* L. 3`eme partie. Review of Trav. Off. Pêches marit, 8: 145–202.

Beverton, R. J. H. and Holt, S. J.: 1959, A review of the lifespans and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. In: G. E. Wostenholme, M. O_Connor (eds), Ciba foundation colloquium on ageing. Churchill, London: pp. 142–180.

Casey, J. and Pereiro J.: 1995. European Hake (*M. merluccius*) in the North East Atlantic. *In*: J. Alheit and T. Pitcher (eds), Hake: Biology, fisheries and markets. Chapman and Hall, London: pp. 125-147.

Caverivière, A., Thiam, A., Thiam, D. and López‐Abellán, J.L.: 1986, Rapport de synthèse des quatre campagnes conjointes hispano‐senegalaises de chalutages sur les stocks profonds du Senegal (1982‐1984). Archive Centre de Recherche Océanographique. Dakar-Thyaroye.

de Pontual, H., Groison, A.L., Pineiro, C. and Bertignac, M.: 2006, Evidence of underestimation of European hake growth in the Bay of Biscay, and its relationship with bias in the agreed method of age estimation. *ICES Journal of Marine Science,* 63: 1674–1681.

Descamps, P. and Labastie, J.: 1978, Note sur la lecture et l'interpretation des otoliths du merlu. ICES C.M. 1978/:41: 7 pp.

El Ouairi, M.: 1990, La pêcherie mixte 'merlu‐crevettes' des côtes atlantiques marocaines. *En:* Rapport du groupe de travail sur les merlus et les crevettes d'eaux profondes dans la zone nord du *COPACE. FAO COPACE/PACE Séries 90/51,* Roma, Italia, pp. 55‐70.

FAO.: 2007, CECAF, Demersal Species Working Group Meeting. Banjul, Gambia 5-17 November 2007.

García‐Rodríguez and Esteban, A.: 2002, How fast does hake grow? A study on the Mediterranean hake (*Merluccius merluccius* L.) comparing whole otoliths readings and length frequency distribution data. *Scientia Marina*, 66: 145-156.

Gayanilo, F. C., Jr. Sparre, P. Pauly, D.: 1995, FAO-ICLARM stock assessment tools (FISAT) user's manual. FAO Computerized Information Series (Fisheries), 8: 126 pp.

Godinho, M. L.; Afonso, M. H. and Morgado, C.: 2001, Age and growth of hake *Merluccius merluccius* Linnaeus, 1758 from the northeast Atlantic (ICES division Ixa), *Oceanography*, 17(3-4): 255-262.

Goñi, R.: 1983, Growth studies on European hake (*Merluccius merluccius* L.) from the Northwest African shelf. *ICES CM* 1983/G, 10, Copenhaguen, Dinamarca, 16pp.

Guichet, R., Quero, J. C. and Labastie, J.: 1973, Estimation de la composition du stock du merlu au nord et a` l'ouest de l'Irlande. ICES Document CM 1973/G: 5.

Gulland, J.: 1971, The Fish Ressources of the Oceans, FAO Fishing News (Books) Ltd., 255 pp.

Hickling, C. F.: 1933, The natural history of hake. 4. Age determination and growth rate. UK Ministry of Agriculture, Fisheries and Food, Investigation Series 2, 13(2): 120 pp.

ICES: 1979, Report of the Working Group on Assessment of Hake Stocks. ICES CM 1979/G: 27. 65 pp.

ICES.: 1991, Report of the Working Group on the Assessment of the Stocks of Hake. ICES CM 1991/Assess: 20. 181 pp.

ICES.: 2003, Report of the Working Group on the Assessment of Southern Stock of hake, Monk and Megrim, ICES CM 2003/ACFM:01.

ICES.: 2006, Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES C.M. 2006/ACFM: 29.

Iglesias, S. and Dery, L.: 1981, Age and growth studies of hake (*Merluccius merluccius* L.) from ICES Divisions VIIIc and IXa. ICES C.M. 1981/G:38: 6 pp.

INRH.: 1982-2007, rapports relative aux campagnes de prospections demersales dans l'Atlantique marocain.

Lucio, P.; Murua, H. and Santurtun, M.: 2000, Growth and reproduction of hake (*Merluccius merluccius*) in the Bay of Biscay during the period 1996–1997. *Ozeanografika*, 3: 325–354.

Maurin, C.: 1954, Les merlus du Maroc et leur pêche. *Bulletin Institute de Pêches aritimes du Maroc*, 2: 7‐65.

Meiners, C. G.: 2007, Importancia de la variabilidad climática en las pesquerías y iología de la merluza europea Merluccius merluccius (Linnaeus, 1758) de la costa oroccidental Africana. Tesis Doctoral, Universidad Politécnica De Cataluña.

Morales-Nin, B. and Aldebert, Y.: 1997, Growth of juvenile *Merluccius merluccius* in the Gulf of Lions (NW Mediterranean) based on otolith microstructure and length frequency analysis. *Fisheries Research*, 30: 77–85.

Nichy, F.E. 1977. Thin sectioning fish ear bones. *Sea Technology*. February, 27 pp.

Pauly, D.: 1979, Theory and management of tropical multispecies stocks: A review with emphasis on the Southeast Asian demersal fisheries. ICLARM Study Review, 1: 35pp.

Pauly, D.: 1980, On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. *Conseil Permanent International pour l'Exploration de la Mer,* 39(2): 175–192 .

Pauly, D.: 1984, Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Study Review, 8: 325pp.

Piñeiro, C.: 2000, Report on 1st international workshop on hake otolith age reading, (June 23‐27, Vigo, Spain) EFAN Report 6-2000.

Piñeiro, C. and Saínza, M.: 2002, Report of 3rd Exchange on European hake age readings (SAMFISH). Instituto Español de Oceanografía IEO, Vigo, Spain. Annex in the Finnal Report of EUContract No. 99/009 (Improving Sampling of Western and Southern European Atlantic Fisheries-SAMFISH).

Piñeiro, C. and Saìnza, M. 2003, Age estimation, growth and maturity of the European hake (*Merluccius merluccius* Linnaeus, 1758) from Iberian Atlantic waters. *ICES Journal of Marine Science*, 60: 1086–1102.

Piñeiro, C. and Saínza, M.: 2004, Report of 4th exchange on European hake age readings. Working Document ICES, WGHMM 2004.

Piñeiro, C.; Saínza, M.; Morgado, C.; De Pontual, H.; Hoey, S.; Beattie, S.; Lucio, P.; Afonso, M.H.; Marín, M.; Labastie, J; Warnes, S.; Easey, M.; Dores, S.; Maceira, A.; Maertens, B.; Hansen, F.; Rey, J.; Perez J.L. and Latrouite, A.: 2004, Report of the 3rd workshop on European hake age reading. Instituto Español de Oceanografía Centro Oceanográfico de Vigo, Spain, 18-22 of October 2004.

Piñeiro, C.; Afonso, M. H.; Arego, S.; Bellail, R.; Labastie, J.; Loureiro, I.; Lucio, P.; Marecos, L.; McCormick, H.; Moguedet, Ph.; Morgado, C.; Sainza, M.; Santurtún, M.; Trujillo, V.; Watson, T. and Woods, F.: 2000, Report on the 2nd workshop on hake otolith age reading (February 15 - 19, 1999. Vigo, Spain) EFAN Report 8-2000.

Piñeiro, C., Rey J., de Pontual, H. and Go˜ni, R.: 2007, Tag and recapture of European hake (*Merluccius merluccius* L.) off the Northwest Iberian Peninsula: First results support fast growth hypothesis. *Fisheries Research*, 88: 150-154.

Rami, M.: 1979, Mise au point d´une technique pour la lecture d´âge de *Merluccius merluccius*. Documento de Trabajo. *Dév. Pêche Maroc*. 25, 9 pp.

Robles, R., Pereiro, J. A., Iglesias, S. and Pereiro, F. J.: 1975, Étude sur la croissance du merlu (*Merluccius merluccius* L.) du NW de l'Espagne. ICES C.M. 1975/G:8: 17 pp.

Sparre, P., Ursin, E. and Venema, S. C.: 1992, Introduction to tropical Fish Stock Assessments. FAO Fisheries Technical Paper. No 306.1. Rome, 377pp.

Turner, J. and El Ouari, M.: 1986, State of the explotation of *Merluccius merluccius* off the coast of Northern Morocco. *En:* Rapport du Premier Groupe de travail spécial sur les pêcheries de merlus et de crevettes profondes dans la zone nord du COPACE. *COPACE/PACE Séries., 86/33,* FAO, Roma, Italia, pp. 51-71.