

# Note on Observations of Daily Rings on Otoliths of Deepwater Snappers

**F. Brouard**  
**R. Grandperrin**  
**M. Kulbicki**  
**J. Rivaton**

This report is presented as received by IDRC from project recipient(s). It has not been subjected to peer review or other review processes.

This work is used with the permission of ICLARM.

© 1984, International Center for Living Aquatic Resources Management (ICLARM).

- 9 JAN. 1985

O. R. S. T. O. M. Fonds Documentaire

N° : 16419, ex 1

Cote : B

## Introduction

To encourage the development of deep-sea fishing in Vanuatu, the Office de la Recherche Scientifique et Technique d'Outre Mer (ORSTOM) is studying growth in some of the major species: *Etelis carbunculus*, *E. coruscans*, *Pristipomoides multidens* and *P. flavipinnis*. Traditional techniques for estimating age from rings on hard structures (otoliths, scales and dorsal spines) cannot be used, because seasonal rings, if they exist, are not easily discernible and because the environment (temperature, salinity, oxygen level and concentration of other salts) varies little at depths between 200 and 300 m in the tropics.

We were unable to differentiate age groups of these fish by modal progressions in size distribution. Therefore, we decided to study rings on thin sections of otoliths. This technique, first suggested by Pannella (1971), is being used successfully in the tropics, notably in Hawaii (Uchida et al. 1982; Uchiyama, pers. comm.; Ralston 1976). The major difficulty lies in establishing the frequency at which the rings are laid. Results shown here depend on the validity of the hypothesis that the rings observed are produced daily.

## Methods and Equipment

Otoliths observed were from fish caught by the Fisheries Department in 1982 off Port-Vila. Fish were measured, weighed and sexed; the growth stage was identified and gonads were weighed. Otolith samples were taken only from the sagittas, not from the other two pairs of otoliths. As the catches were to be sold, otoliths were taken from the interior of the skull, after gills had been removed, so that the fish were not damaged. Otoliths were cleaned and kept dry in small paper bags without any other special care.

There were three stages in preparing otoliths: embedding, sectioning and acidification. A polyester resin (100 ml of PolyLite 61203 resin and 4 ml methylethylketone catalyst), which hardens sufficiently in 24 hours, was used for embedding. Each embedded otolith was stuck to a glass slide (Plate 1).

A diamond saw (Plate 2) was used to make 100- $\mu$ m sections. Hydrochloric acid in 10% solution was then added for some thirty seconds to increase contrast between light and dark lines and so make counting easier.

The strongest magnification of the compound microscope (lens x 100) was used; a camera connected to a television screen facilitated observation of rings when they were wider than the definition of the televised picture; if not the observation was made directly through the microscope.

Rings were counted from the nucleus to the otolith's edge. They generally could not be counted in a straight line because all rings on the surface of the slide were not visible. If while counting, an opaque area appeared, there were two possibilities:

- a) If an area of visibility was found following the last ring, counting could continue
- b) If there was none, the unmarked area was measured and an estimate of rings made using the number of rings per unit length at the edge of the opaque area.

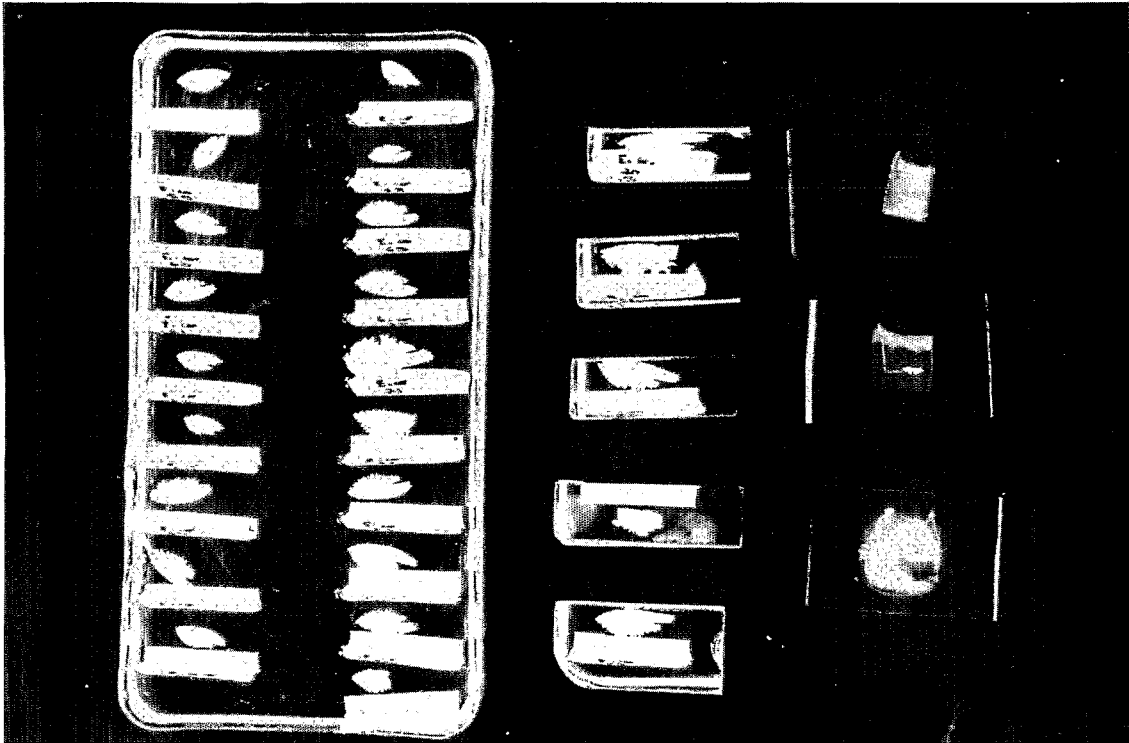


Plate 1. Otoliths prepared for sectioning. Various stages in the preparation of thin sections of otoliths after embedding in resin.

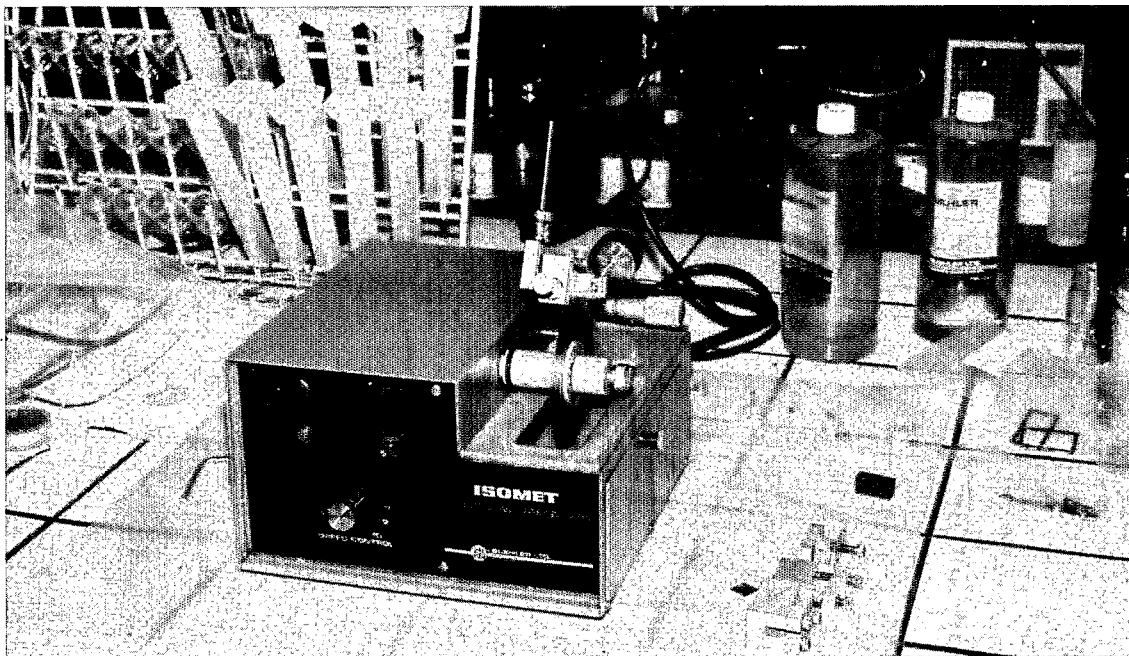


Plate 2. Circular saw with diamond blade.

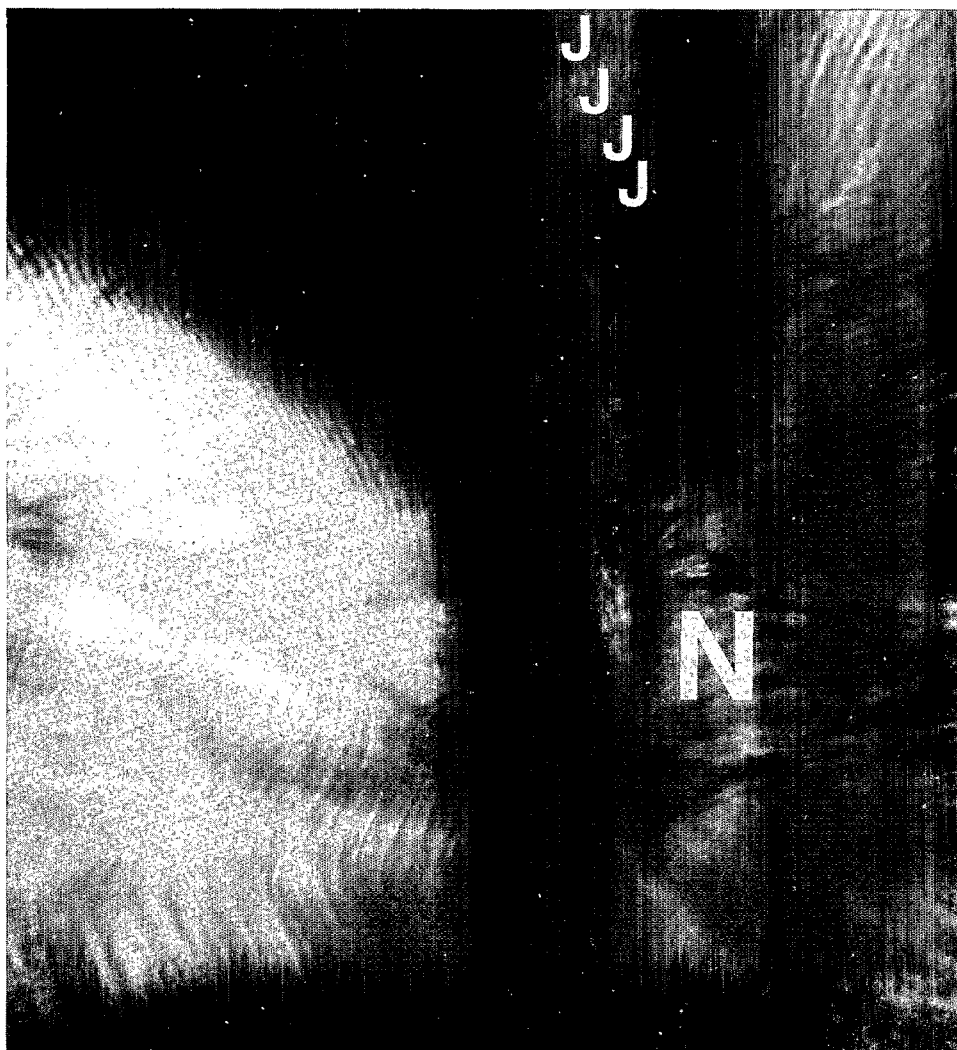


Plate 3. Thin cross section of otolith of *Etelis carbunculus* observed in central zone. The nucleus (N) and, to the left, the beginning of the sulcus can be seen. Daily growth rings (J) are wide and clear. Scale: 25 mm = 20  $\mu$ m.

### Observations

Two zones were distinguished on otoliths in these observations:

- a) Zones exhibiting regular rings (Plates 3-6). These rings are thought to be laid down daily; their thickness decreases progressively from the nucleus to the edge of the otolith. However, superimposed on this general tendency are alternate increases and decreases of ring thickness (Plate 6). This phenomenon has not yet been analyzed, but might relate to lunar cycles, as described by Pannella (1980).



Plate 4. Thin cross section of otolith of *Etelis carbunculus* (same section as in Plate 3 and same scale) as seen at the thousandth ring. Rings are much wider near the nucleus. Scale: 25 mm = 20  $\mu$ m.

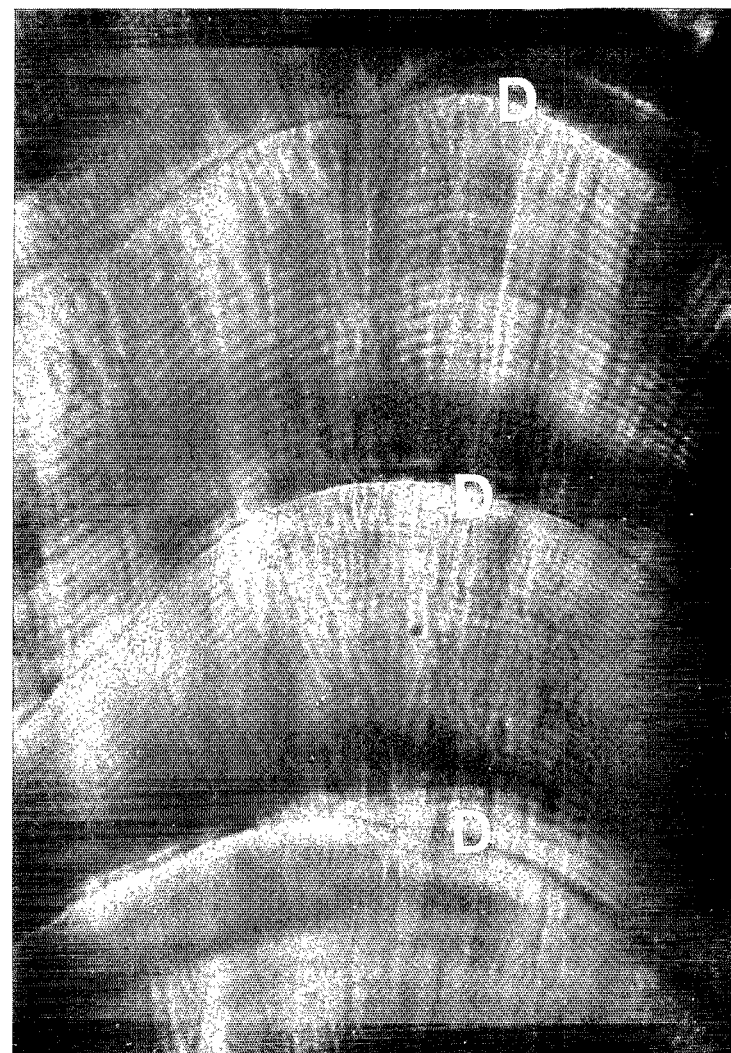


Plate 5. Thin cross section of otolith of *Etelis coruscans*. Areas of discontinuity (D) separate the series of daily growth rings. These marks may relate to spawning periods or other forms of stress. Scale: 25 mm = 20  $\mu$ m.

- b) Zones of discontinuity (Plates 5, 6). It was observed that there were occasional dark marks separating zones of daily rings which no longer appeared to be strictly parallel. The alignment of the daily rings was different in the areas of discontinuity. In these cases, it became difficult to count daily rings since the usual regularity was masked. When such areas were found, they were followed to where the succession of rings returned to its former direction.

The periodicity of discontinuous areas is being studied. It may be that they correspond to periods of spawning, but any major stress may be the cause. It is very difficult to decide how to distinguish various causes which may lead to the formation of such areas.

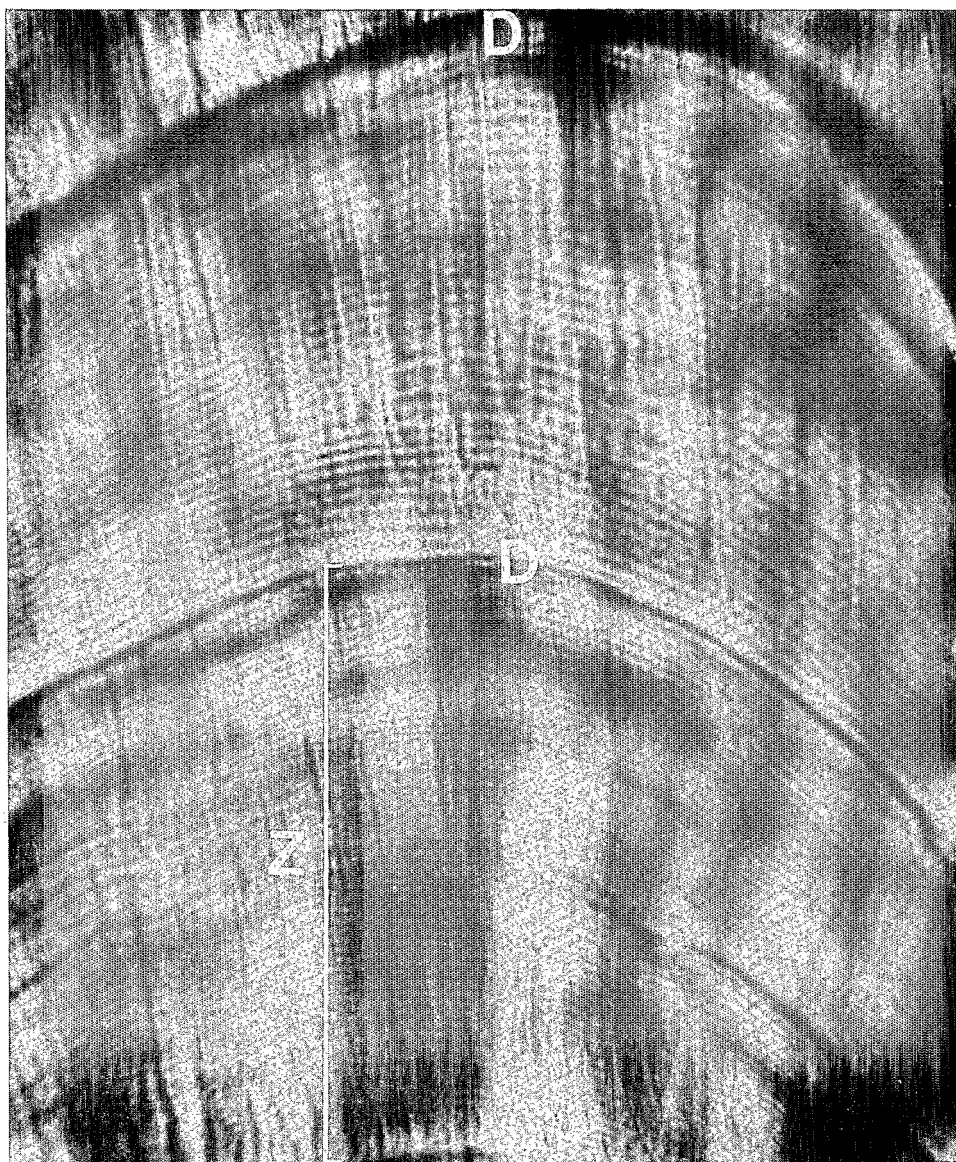


Plate 6. Thin cross section of otolith of *Pristipomoides flavipinnis*. Discontinuous areas (D) can be clearly seen as can an area (Z) within which the thickness of daily growth rings decreases and increases alternately. Scale: 25 mm = 20  $\mu$ m.

## Growth Parameters

Growth curves for four deepwater snapper species have been obtained from observing daily rings, *Etelis carbunculus*, *E. coruscans*, *Pristipomoides multidentis* and *P. flavipinnis*. Figs. 1 and 2 show these curves.

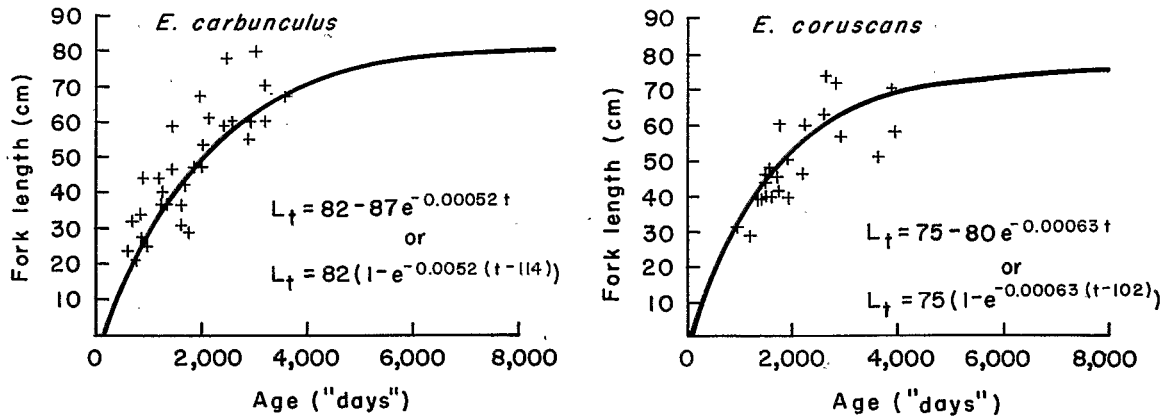


Fig. 1. Von Bertalanffy growth curves for *Etelis carbunculus* (left) and *E. coruscans* (right) with two forms of the von Bertalanffy growth equation, in which length (L) is in cm and time (t) is in days.

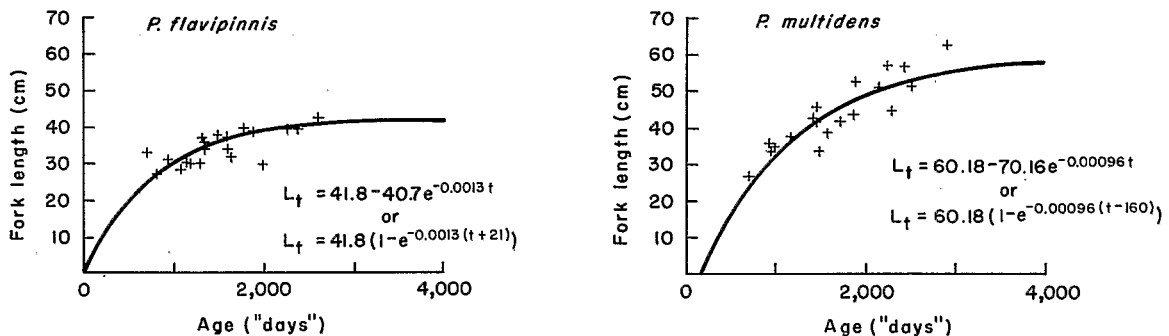


Fig. 2. Von Bertalanffy growth curves for *Pristipomoides flavipinnis* (left) and *P. multidentis* (right) with two forms of the von Bertalanffy growth equation, in which length (L) is in cm and time (t) is in days.

## Conclusion

Ageing fish by examination of hard parts, especially the study of otoliths, appears to be a particularly valuable source of information. The age of the fish may be established and information obtained which helps to provide parameters of its life history. This study is only beginning; it is continuing in a tripartite analysis: counting daily rings on larger numbers and more species; analyzing various categories of rings and their periodicity; and comparing the technique of using daily rings with other methods for estimating the age of fish. Growth parameters obtained are provisional, but furnish the first indispensable data for a study of the stocks.



### Acknowledgements

The authors would like to thank the Fisheries Department of Vanuatu and especially its Director, Mr. J. Crossland for his very close cooperation and the helpfulness he has always shown.

### References

- Pannella, G. 1971. Fish otoliths: daily growth layers and periodical patterns. *Science (Wash.)* 173(4002): 1124-1127.
- Pannella, G. 1974. Otolith growth patterns: an aid in age determination in temperate and tropical fishes, p. 28-39. *In* T.B. Bagenal (ed.) *The ageing of fish*. Unwin Brothers Ltd., Old Woking, Surrey, England.
- Ralston, S. and G.T. Miyamoto. 1981. Estimation of the age of a tropical reef fish using the density of daily growth increments, p. 83-88. *In* E.D. Gomez, C.E. Birkeland, R.W. Buddemeier, R.E. Johannes, J.A. Marsh, Jr. and R.T. Tsuda (eds.) *The reef and man. Proceedings of the fourth international coral reef symposium, vol. 1*. Marine Sciences Center, University of the Philippines, Quezon City.
- Uchida, R.N., D.T. Tagami and J.H. Uchiyama. 1982. Results of bottom fish research in the north-western Hawaiian Islands. South Pacific Commission 14th Regional Technical Meeting on Fisheries, Background Paper No. 2, 14 p. SPC, Noumea, New Caledonia.

### Additional Reading

- Barkman, R.C. 1978. The use of otolith growth rings to age young Atlantic silversides, *Menidia menidia*. *Trans. Amer. Fish. Soc.* 107: 790-792.
- Brothers, E.B. 1980. Age and growth studies on tropical fishes, p. 119-136. *In* S.B. Saila and P.M. Roedel (eds.) *Stock assessment for tropical small-scale fisheries. Proceedings of an international workshop held September 19-21, 1979 at the University of Rhode Island, Kingston, R.I.* International Center for Marine Resource Development, Univ. of Rhode Island, Kingston.
- Brothers, E.B., C.P. Mathew and R. Lasker. 1976. Daily growth increments in otoliths from larval and adult fishes. *Fish. Bull. (U.S.)* 74(1): 1-8.
- Brothers, E.B., D. McB. Williams and P.F. Sale. 1983. Length of larval life in twelve families of fishes at "One Tree Lagoon", Great Barrier Reef, Australia. *Mar. Biol.* 76: 319-324.
- Gjøsaeter, J. and I-M. Beck. 1980. Age determination of fish species from Mozambique using daily rings in otoliths FI: Moz./77/001, Mimeo, FAO, Rome. 10 p.
- Kawamura, G. and N. Washiyama. 1984. Age determination of wild-captured milkfish larvae as indicated by daily growth increments of otolith. *Bull. Jap. Soc. Sci. Fish.* 50(1): 171.
- Le Guen, J.C. 1976. Utilisation des otolithes pour lecture de l'âge des Scianides intertropicaux, marques saisonnières et journalières. *Cah. O.R.S.T.O.M. Ser. Océanogr.* 14(4): 331-338.
- Methot, R.D. Jr. and D. Kramer. 1979. Growth of northern anchovy *Engraulis mordax* larvae in the sea. *Fish. Bull. (U.S.)* 77(2): 413-423.
- Mugiya, Y. and J. Muramatsu. 1982. Time marking methods for scanning electron microscopy in goldfish otoliths. *Bull. Jap. Soc. Sci. Fish.* 48(9): 1225-1232.



- Mugiya, Y., N. Watanabe, J. Yamada, J.M. Dean, D.G. Dunkelberger and M. Shimizu. 1981. Diurnal rhythm in otolith formation in the goldfish, *Carassius auratus*. *Comp. Biochem. Physiol.* 68A: 659-662.
- Pannella, G. 1980. Growth patterns in fish sagittae, p. 519-556. *In* D.C. Rhoads and R.A. Lutz (eds.) *Skeletal growth of aquatic organisms: biological records of environmental change*. (Topics in geobiology series, vol. 1). Plenum Publ., New York.
- Ralston, S. 1976. Age determination of a tropical reef butterflyfish utilizing daily growth rings in otoliths. *Fish. Bull. (U.S.)* 74(4): 990-994.
- Schmidt, R.E. 1980. Daily growth rings on otoliths for aging young-of-the-year largemouth bass from a wild population. *Prog. Fish-Cult.* 42(2): 78-79.
- Steffensen, E. 1980. Daily growth increments observed in otoliths from juvenile Baltic sea cods. *Dana* 1: 29-37.
- Tanaka, K., Y. Mugiya and J. Yamada. 1981. Effects of photoperiod and feeding on daily growth patterns in otoliths of juvenile *Tilapia nilotica*. *Fish. Bull. (U.S.)* 79(3): 459-465.
- Taubert, B.Ø. and D.W. Cable. 1977. Daily rings in otoliths of three species of *Lepomis* and *Tilapia mossambica*. *J. Fish. Res. Board Can.* 34: 332-340.
- Timola, O. 1977. Scanning electron microscope studies on the growth patterns of smelt, *Osmerus eperlanus* (L.), otoliths. *Aquilo, Ser. Zool.* 17: 57-60.
- Townsend, D.W. and R.F. Shaw. 1982. Daily growth increments in otoliths of blue whiting, *Micro-mesistius poutasson* (Risso), from above the arctic circle. *Sarsia* 67: 143-147.
- Tsuji, S. and T. Aoyama. 1982. Daily growth increments observed in otoliths of the larvae of Japanese Red Sea bream *Pagrus major* (Temminck and Schlegel). *Bull. Jap. Soc. Sci. Fish.* 48(11): 1559-1562.
- Wilson, K.H. and P.A. Larkin. 1980. Daily growth rings in the otoliths of juvenile sockeye salmon (*Oncorhynchus nerka*). *Can. J. Fish. Aquat. Sci.* 37: 1495-1498.
- Wilson, K.H. and P.A. Larkin. 1982. Relationship between thickness of daily growth increments in sagittae and change in body weight of sockeye salmon (*Oncorhynchus nerka*) fry. *Can. J. Fish. Aquat. Sci.* 39(10): 1335-1339.
- Worthman, H. 1980. The early growth stages of the pescada (*Plagioscion monti* Soares). *Arch. Fischerei-wiss.* 30(2/3): 145-156.