J. Cons. int. Explor. Mer, 43: 179–181. 1987

Short Note

The measurement of intercirculi distances on fish scales using a video camera and a microcomputer

Marie-Hélène Gandelin and Philippe Laval

UA 716 du CNRS, CEROV
Station zoologique, B. P. 28
06230 Villefranche-sur-Mer, France

The age of fish caught at sea may be estimated from readings of scales or otoliths. Scales are easier to collect than otoliths, and after some cleaning may be quickly mounted for observation. However, when growth rings (circuli) are numerous and tightly spaced, counting and measuring is a tedious process. Not many scales can be processed, unless the observer is only seeking annual growth rings (annuli) or other conspicuous transitions such as the passage from fresh water to sea water. More detailed information, which is nevertheless present in calcified structures, is not considered: intercirculi distances, for example, are frequently not taken into account in routine work, as this would require comparison of several sampling directions on one scale, and the comparison of several scales from the same fish.

Despite some attempts to render the counts easier and more accurate (for example, Fries, 1982, who used a digitizing pad and a microcomputer), an automatic or semi-automatic device, allowing statistical analyses, has still not been produced. With the availability of relatively low-cost microcomputers, which can be interfaced with video cameras, such a project is not unfeasible. This paper presents a first step towards this objective.

For testing the method, we chose fish scales with a small number of circuli, few bifurcated rings, and no complex patterns such as those which may be seen in some species (see, for example, Ruiz Dura *et al.*, 1970). In the samples kept at our oceanographic laboratory, a species having these characteristics was found: *Benthosema glaciale* (Reinhardt, 1837). This pelagic fish (Myctophidae), of no direct commercial value, may nevertheless have some importance in pelagic food chains (Roe and Badcock, 1984). The anterior zone of the scale was placed in the microscope field, this being the only part of the scale used for the measurements (Ruiz Dura *et al.*, 1970; FAO, 1981; SCAR, 1983). The hardware was an assemblage of two microcomputers and interfaces available in our laboratory. Image acquisition was made with a low-cost Panasonic video camera (Matsushita Communication Industrial Co., Ltd., Japan). The camera was interfaced to an Apple II+ microcomputer using a Dithertizer II card (Computer Station, Inc., 11610 Page Service Drive, St. Louis, Missouri 63141, USA). This card was set to only one grey level, i.e., black and white. The binary images, obtained by connecting the video camera to a binocular microscope, were stored in files on the Apple II floppy disk. After completion of the acquisition phase, the files were transferred to a more powerful Hewlett-Packard microcomputer (HP 9000 series 200, model 216) for further processing.

Specially written software, in extended HP BASIC 2.1, scans the image of the fish scale in 13 predetermined directions, starting from the focus of the scale. The focus position is first displayed on the screen as the central point midway between the edges of the scale on the bottom line of the screen; this position, if not satisfactory, may be adjusted by the operator, using a cursor button on the keyboard acting like a "mouse" device. From then on, the processing is fully automatic and takes about 20 seconds.

In each direction (Fig. 1) the intersections with the circuli are counted, and the intercirculi distances are computed. Results are printed and displayed on a flatbed plotter. The output includes histograms of the intercirculi distances (for the whole scale and along selected directions), "scalimetric plots" similar to those of Graham (1926), which help in detecting false checks (Fig. 2), and plots of intercirculi distances against distance from the focus, which show the minima more clearly.

If calcium deposition were synchronous in all directions, all counts and distances would be similar. This is, of course, rarely the case. Moreover, scale preparation may introduce artefacts. In the software all directions where the counts were below the maximum were suppressed. This is a rather simplistic attitude, which could certainly be modified for species where ring patterns are

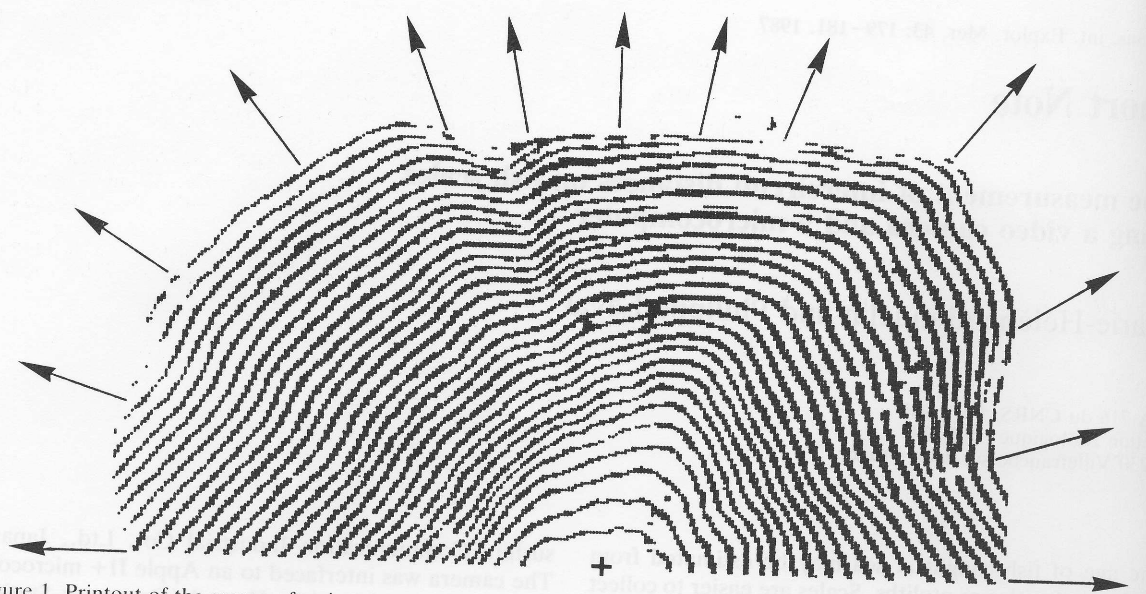

Figure 1. Printout of the screen after image acquisition. The scale belongs to the Myctophid *Benthosema glaciale*. The 13 directions in which measurements and counts are made by the computer are indicated by arrows. The small cross indicates the origin of measurements (scale focus); its location is adjustable by the operator.

better known. A standardized protocol to improve the mounting of scales would also be necessary.

Computer counts and measures are completely repeatable, contrary to "manual" measurements which vary somewhat, owing to the difficulty in following a straight path and in pinpointing each circulus. Comparison of computer counts with manual ones nevertheless shows them to be in close agreement (no significant difference at the 5 % level).

These preliminary experiments show the feasibility of low-cost image analysis of ring patterns using a microcomputer. As in every image analysis system, the acquisition phase is critical: for better results the starting optical image should be of the best quality. Once this condition is attained by carefully setting the illumination, long series of scales may be quickly processed, making further statistical analyses possible.

The drawbacks of this first experimental set-up (use of different computers, low resolution, etc.) are now being overcome in our laboratory. The use of widespread personal computers, for which video and high resolution graphic cards are readily available, allows the integration of different functions in the same microcomputer. Work is underway to improve the software and to write it in Turbo Pascal (Borland International). Otolith images are also considered for use in the automatic aging of fish. This work will be accomplished within the French national programme "Déterminisme du recrutement" (PNDR).

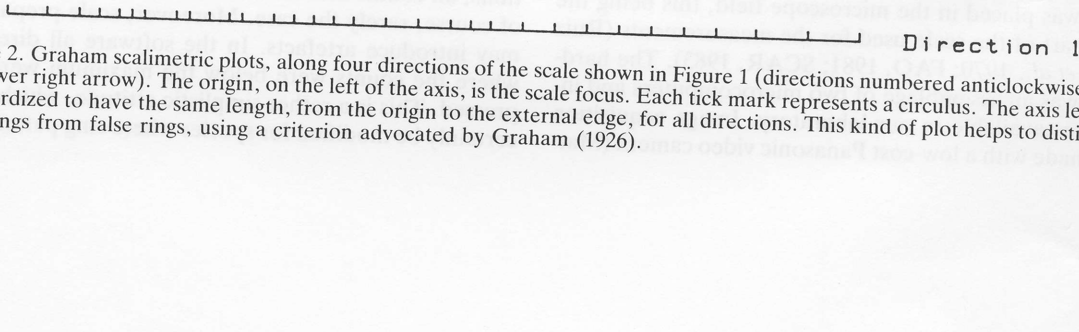

Figure 2. Graham scalimetric plots, along four directions of the scale shown in Figure 1 (directions numbered anticlockwise, from the lower right arrow). The origin, on the left of the axis, is the scale focus. Each tick mark represents a circulus. The axis length is standardized to have the same length, from the origin to the external edge, for all directions. This kind of plot helps to distinguish true rings from false rings, using a criterion advocated by Graham (1926).

Acknowledgements

We are indebted to Mrs M. Etienne who kindly made available several plotting subprograms, to J. Sardou for help in taxonomy and fish identification, and to Mrs F. Lagardère for providing some useful references.

References

FAO. 1981. Methods of collecting and analyzing size and age data for fish stock assessment. FAO Fish. Circ., 736: 100 pp.

Fries, R. V. 1982. Measurement of fish scales and back-calculation of body lengths using a digitizing pad and microcomputer. Fisheries, 7(6): 5–8.

Graham, M. 1926. A precise method for determining the first "winter" zone in cod scales. J. Cons. int. Explor. Mer, 1: 344–352.

Roe, H. S. J., and Badcock, J. 1984. The diel migrations and distributions within a mesopelagic community in the North East Atlantic. 5. Vertical migrations and feeding of fish. Prog. Oceanogr., 13: 389–424.

Ruiz Dura, M. F., Orijel Arenas, Y., and Rodriguez Hernandez, G. 1970. Lineas de crecimiento en escamas de algunos peces de México. Inst. nat. Invest. Biol. Pesq., Estudio 2: 100 pp.

SCAR/SCOR/IABO/ACMRR. 1983. Recommended methods for standardization of measurements of fish. Biomass Handb., 13: 6 pp.