DESCRIPTION OF A PROJECTION DEVICE FOR USE IN AGE DETERMINATION FROM FISH SCALES

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Many scale reading devices of varied design have been reported by workers engaged in fishery research, however, most of those described or used have had serious disadvantages affecting the ease of operation or the accuracy of the results obtained. Consequently, it appears useful to describe in detail the instrument which has proved very satisfactory in the study of the ages of the California sardine or pilchard. The original unit was developed in 1938 and 1939 concurrently with the investigation of the readability of the sardine scales and otoliths by the Fish and Wildlife Service in California. This instrument was a major factor in the development of a successful method of determining age from the difficult markings on the scales of this species.

The original instrument has been substantially improved from time to time by the addition of certain refinements to provide a clearer image and brighter field. During the course of the sardine program, similar instruments were constructed for workers in Monterey and Terminal Island, Calif. so that at present there are three such units in use on the sardine studies, each calibrated to the same magnification.

The success achieved with this apparatus in determining the age of the sardine sugested its suitability for age determination in other species.

The instrument described in the following paragraphs was constructed by the author at the Seattle Laboratory for the Alaska Fishery Investigations for age determination of salmon and herring. It has been patterned after the one in use in the sardine investigation.

The unit consists essentially of a microscope of suitable power; a 90° prism ½ to ¾ inch long, silvered on the largest face; an 8- by 10-inch plate glass mirror; a piece of white celluloid or white paper upon which the image is projected; and a suitable light source. When a large number of scales are to be examined, it is desirable to equip the microscope with a mechanical stage in order to bring the various scales rapidly and precisely into the field of the objective.

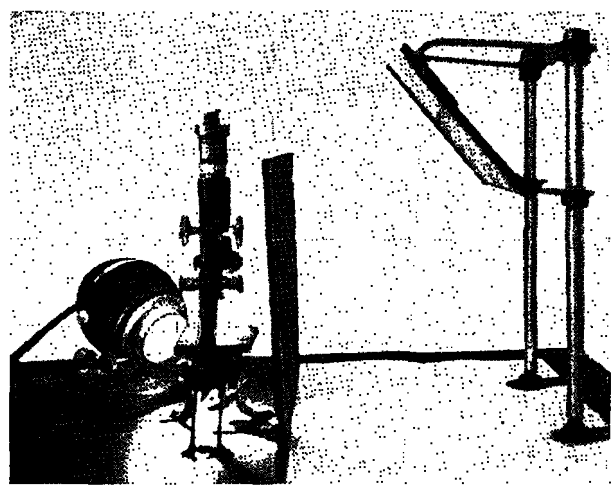

FIGURE 1.—Microprojector in operation, viewed from the operator's position. Note location of the controls of the microscope and lamp in relation to the projected image.

The proper magnification of the adult salmon scales which are approximately 4 to 8 mm. in diameter requires the use of a 40-mm. objective with a 6-power eyepiece, or equivalent. Using a 25-mm. objective with the same ocular gives a satisfactory image for use with the 1- to 3-mm. diameter scales of juvenile salmon. For larger scales such as herring and sardines, a lower power of ocular or objective, or both, will be required. The optimum magnification to use with any particular fish scale can best be determined through experiment, keeping in mind that too great a magnification tends to enlarge the details of the scale surface to the point where they obscure the annular marks and too small magnification will not reveal the annuli clearly. There is a relatively narrow range of magnifications wherein the annuli appear to the best advantage. For most scales examined, the optimum results were obtained when the projected image of the sculptured portion was around 150 mm.

Any microscope of the desired power with corrected optical parts will be adequate for this purpose. Coated optics in a double or triple nosepiece, fine adjustment, condenser, iris diaphragm, and mechanical stage will prove convenient but are not essential to satisfactory operation of the instrument. The microscope incorporated into the present unit is an old one, but the results have been very satisfactory. A good plate-glass mirror is required. A common glass mirror should not be used as the flaws will cause severe distortions which will render the unit inaccurate for measurement of the image. On the other hand, more expensive types, such as the first surface ophthalmic mirrors, have been tried with the conclusion that they are not superior to those of plate glass. The light source is one of the most important items in the projector. It must provide a bright, clear light with a flat field. The best lamps for this purpose are some of the newer types designed for microprojection.

In constructing the device, a piece of ⅝- to ¾-inch plywood, approximately 18 by 36 inches is required for the base. Two metal rods or pipes ½ to 1 inch in diameter are needed to support the mirror at the proper angle and height above the base. In the present unit this support is furnished by brass rods ⅝ by 18 inches, threaded for about 2½ inches on one end. These fit into two ⅝-inch holes drilled in the plywood base about 9 inches apart and a few inches from the right end. They are securely fastened by the use of washers and nuts.

A holder for the mirror was made from 20-gauge brass, held at the proper angle to the supports by ⅛- by 1½-inch brass straps. The mirror holder could be made of a variety of materials such as wood, plastic, or metal. The important consideration is that the mirror be held rigidly at a 45° angle to the base and at the same time be adjustable up and down on the supports in order to center the image for the height of the microscope used. In this instrument the holder is locked firmly in any desired position by means of set screws in metal collars. Once the holder is set up and adjusted for a particular microscope, it will not be necessary to change the adjustment. When the mirror has been firmly set in place, the microscope should be placed about 15 or 16 inches to the left side of the mirror. This is the most satisfactory arrangement for a right-handed person, as focusing can be done with the left hand, leaving the right hand free for the recording of data.

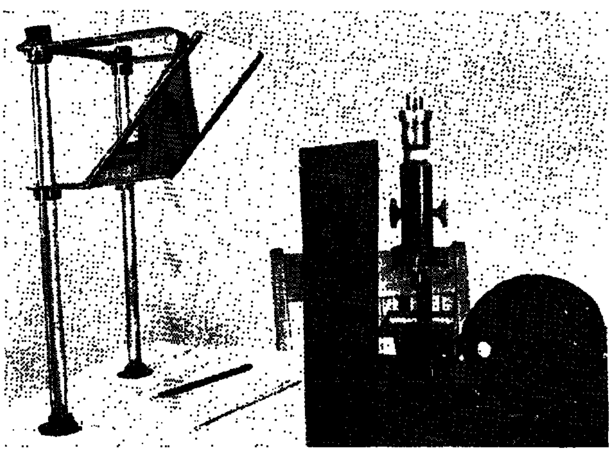

FIGURE 2.—Microprojection set-up. Illustrates the relation of parts to operator's position. Viewed from the back of the device.

A holder for the prism can be devised easily from metal tubing, wire, plastic, or other material. The prism should fit directly on the ocular of the microscope and should be attached securely so as not to shake off or become out of alignment with the microscope and mirror. The lamp is then set so as to throw its light on the microscope mirror, and the whole unit adjusted by trial and error until the projected image is clear, distinct, and properly placed for most convenient observation. When the adjustment is complete, the various instruments should be fastened in place to avoid the need for subsequent readjustment.

For best results the projector should be used in a relatively dark room. A photographic dark room is most suitable, but if this is not available, sufficient darkness can be obtained by covering the windows with heavy black curtains while using the machine. Satisfactory conditions can also be obtained by placing a cardboard or plywood box over the working area of the projector. Such a cover, as well as all other parts of the unit, should be painted a dull black to prevent reflection of light. It will also prove advantageous to place a piece of ¼-inch plywood or heavy cardboard vertically at the microscope between it and the mirror, just high enough for the prism on top of the microscope to project over it. This also should be painted a dull black on both sides to prevent stray light-rays from hitting the projected image.

If the optical items are of good quality and the adjustments are accurate, there should be very little if any distortion of the image as it is moved from one side of the field to the other.

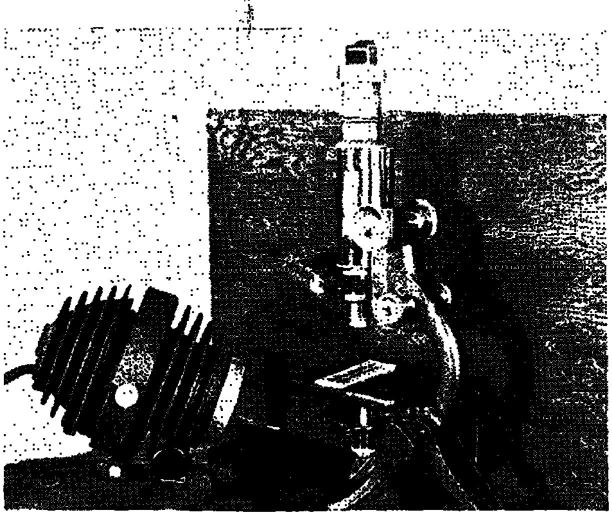

FIGURE 3.—Closeup of the microprojector, showing the relative position of the lamp, microscope, and prism. Viewed from a point to the left of the operator.

This projector can be assembled at relatively small cost, particularly if the microscope, with the necessary oculars and objectives, is on hand. The estimated cost of the prism at today's prices would be about $6 and that of the plate glass mirror about $1. The cost of miscellaneous material such as metal, plywood, washers, screws, nuts, collars, and paint is about $10; making the total outlay for accessory materials less than $20.

The advantages of this type of scale reader over the more conventional models are numerous and far outweigh the outlay of time and materials required for its construction. Advantages obtained through the use of this instrument are:

1. There is considerably less eyestrain with this unit than with direct examination of the scales through a microscope.
2. The image of the scale is clear and easily studied.
3. The image can be studied at a convenient level and in front of the operator with the controls at easy working distance.
4. The image can be measured, traced on paper, or photographed.
5. The image can be viewed by two or more workers at once which is very useful in the demonstration of scale reading, and also in arriving at proper interpretation of difficult scale markings.

The projection of the scale image provides objectivity in scale reading not ordinarily possible. Permanent records of all scales examined can be obtained by marking the base of the scale, the annuli, the margin, or other desired features on paper. These records can be used for the computation of lengths of fish at various ages, determination of growth rates, and for other purposes.

To facilitate statistical analysis it is suggested that punch cards containing a millimeter scale printed along one edge be used for recording the scale features. The "zero" mark of the ruler is placed at the base of the sculptured portion of the scale, or at the center of the nucleus, depending on the type of scale under study, and the annuli, scars, margin of the scale, and other data indicated by appropriate marks along the ruler. Data on time and locality of capture, sex, age, year class, etc., can be punched on the cards if desired. The data recorded on the cards will permit studies of such problems as racial composition, variations due to environmental factors, variations between year classes, and variations between readers, without further examination of the scales.

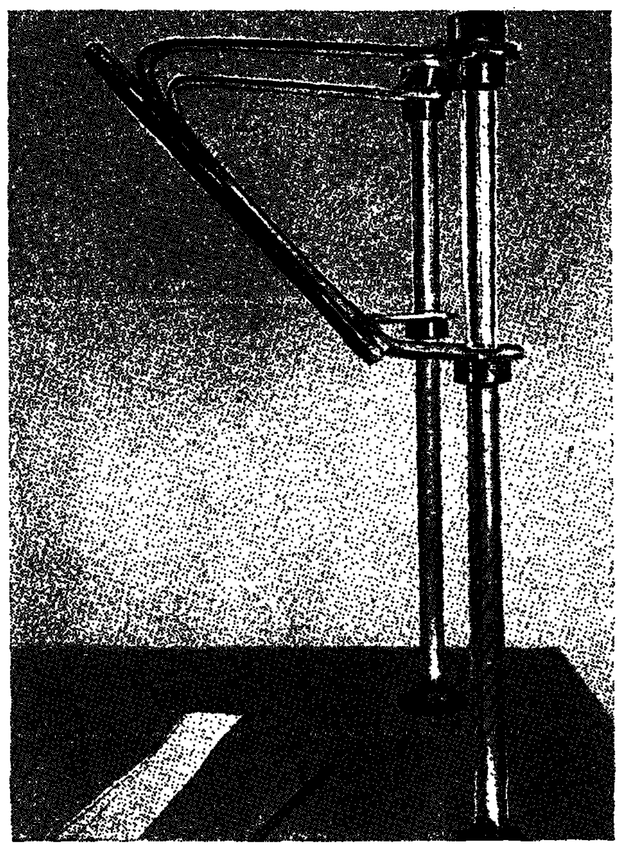

FIGURE 4.—Closeup of mirror and holder.