Scientific Excellence • Resource Protection & Conservation • Benefits for Canadians
Excellence scientifique • Protection et conservation des ressources • Bénéfices aux Canadiens

Procedures for Collecting and Processing British Columbia Herring Samples

L. Hamer

Department of Fisheries and Oceans
Biological Sciences Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

September 1989

Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2030

Fisheries and Oceans Pêches et Océans

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 901-1425 were issued as Manuscript Reports of the Fisheries Research Board of Canada. Numbers 1426-1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

821

Canadian Manuscript Report of

Fisheries and Aquatic Sciences No. 2030

September 1989

PROCEDURES FOR COLLECTING AND PROCESSING BRITISH COLUMBIA HERRING SAMPLES

by

L. Hamer

Department of Fisheries and Oceans

Biological Sciences Branch

Pacific Biological Station

Nanaimo, British Columbia V9R 5K6

Cat. No. Fs 97-4/2030E ISSN 0706-6473

Correct citation for this publication:

Hamer, L. 1989. Procedures for collecting and processing British Columbia herring samples. Can. MS Rep. Fish. Aquat. Sci. 2030: 27 p.

ABSTRACT

Hamer, L. 1989. Procedures for collecting and processing British Columbia herring samples. Can. MS Rep. Fish. Aquat. Sci. 2030: 27 p.

Procedures for the collection, preservation and processing of herring samples are described.

Key words: Pacific herring, sampling

RÉSUMÉ

Hamer, L. 1989. Procedures for collecting and processing British Columbia herring samples. Can. MS Rep. Fish. Aquat. Sci. 2030: 27 p.

Le rapport décrit les méthodes de cueillette, de préservation et de traitement des échantillons de hareng.

Mots clés: Hareng du Pacifique, échantillonnage

INTRODUCTION

The Pacific herring roe fishery is one of British Columbia's largest fisheries both in value and tonnage landed. A fleet of approximately 250 seine vessels and 1300 gillnet vessels participates in the herring roe fisheries.

Management of this fishery is complicated by short openings and variable fishing locations. The Department of Fisheries and Oceans' Herring Catch Sampling Program assists in the management of roe fisheries by providing detailed information on the population structure of prefishery and commercial catches. Herring samples provide data on length, weight, sex, maturity, and age, for use in annual stock assessments and forecasts. The accuracy of these assessments and forecasts is therefore dependent on the accuracy of the information collected.

Sample information, along with catch data, and area and density of spawn depositions are assessed by computer models which produce estimates of the abundance of each year-class in each stock. The Catch Sampling Program is essential for the effective management of British Columbia's roe herring fishery.

SAMPLING DESIGN

Samples are collected from three main sources: pre-fishery charter vessels, commercial fishery landings, and Department of Fisheries and Oceans (DFO) research cruises.

Pre-fishery charter vessels provide the majority of samples processed at the Pacific Biological Station. Approximately 12 seine boats are chartered to conduct test fishing each year. Charter timing is set to ensure that the vessels are available before and during major spawnings in each area. All major stocks are assessed for the roe fisheries using echo sounding and catch sampling techniques. A general sampling guideline for the charter vessels is to obtain three or four samples per week from each major statistical area, and one or two samples per week from each minor statistical area (Armstrong 1987). Major statistical areas have been defined as those areas that can regularly support roe fisheries. DFO staff aboard the charter vessels collect samples from the test sets.

Commercial samples are obtained from roe fisheries, as well as food and bait fisheries. A sampling plan is designed for each roe fishery to ensure that the sample series collected represents the catch in terms of gear distribution, time, and statistical area. The gear and catch distribution information is obtained from DFO personnel on the fishing grounds, fishermen, port samplers, and industry representatives. When fisheries are of short duration (i.e., less than a day), time is not an important factor in sample collection. Roe fisheries are sampled with the goal of obtaining at least ten

samples from each seine fishery and six samples from each gillnet fishery. This number of samples has been determined to be the minimum number necessary to obtain a representative estimate of the biological structure of the catch (Stocker 1984; Schweigert and Sibert 1983). Fewer samples are required from gillnet catches than from seine catches because gillnets catch fish selectively, and therefore gillnet-caught herring generally vary less in size than seine-caught herring. The food and bait fisheries are currently very small both in quota and the number of vessels licensed to participate (Chalmers 1987). Consequently, each vessel that fishes for food herring is expected to supply a biological sample.

Research samples are collected whenever a DFO vessel is on a research cruise and catches herring. As well, commercial fishing vessels are occasionally chartered to conduct special research cruises.

SAMPLE COLLECTION

Samples may be collected from the gear, from the hold of a vessel, or from a processing plant.

The preferred method of collecting a sample is to get it directly from the gear. This method ensures the fish will have been handled the least, and consequently retain more of the preferred scales used for ageing. As well, there is little chance of getting incorrect catch information if the sample is collected from the gear because of the proximity to the source. To collect a representative sample from a seine set made by a research or pre-fishery charter vessel the net should be dried up only as much as is necessary to obtain samples. A dip net or brailer is pushed vertically down into the seine, and pulled up quickly through a "boil" of fish, so as to get a representative sample of the fish in the set (Armstrong 1987). Trawl or gillnet caught fish may be sampled by filling a bucket after the fish have been brought aboard. Gillnet samples should be collected from separate punt deliveries.

Samples from commercial fisheries are frequently collected from landings made to processors, where they should be collected from the hold of a vessel. It is preferable to get a sample from a vessel landing its own catch rather than from a packer, because the possibility of getting unreliable catch information, or of getting a sample made up of the catch from more than one vessel is increased with a packer. However, while many seine vessels deliver their own catch very few gillnet vessels do, and therefore most gillnet samples are collected from a packer.

When a packer must be used, samples should be collected from separate holds, after ascertaining that no one catch was carried in two or more holds. The sampler must ensure the catch information is correct when collecting from a packer - extra effort may be required to confirm the location. The sample should be dipnetted directly from the hold of the vessel, before pumping. A sample taken from anywhere within a load should be

representative of the fish in that load (Humphreys and Hourston 1978), but care should be used to take the sample from the main body of fish, rather than from the fish that may be floating on top of the load.

Representative samples may be taken at any point during the unloading procedure (Humphreys and Hourston 1978). However, the least desirable place to take a sample is in the processing plant. The possibility of getting unreliable catch information is increased because it is difficult to keep track of which fish came from a particular vessel. In addition, the fish will have lost preferred scales during the pumping procedure.

Samples should be collected from a landing so that: 1) there are at least 120 herring in the sample; 2) most of the herring in the sample have scales intact in the preferred area (Fig. 1); and 3) accurate catch information accompanies each sample. Where the herring in the sample are large (>23 cm), two buckets may be required to obtain more than 100 fish.

SAMPLE PRESERVATION AND STORAGE

The preferred storage container for samples is a 31-cm square plastic bucket (27 litre), with a snap-on lid. When buckets are not available, waxed cardboard boxes or heavy gauge plastic bags may be used to store samples. However, these containers are more susceptible than buckets to leakage and damage during handling.

Two labels (Fig. 2) should accompany each sample - one placed inside the bucket, and the other tied to the handle of the bucket. If "stick-on" labels are used for the outside, they should be glued to the side of the bucket. Using two labels (one inside and one outside), ensures that the necessary information will accompany each sample. The outside label provides easily accessed information about the sample, and should it get torn off, the second label is still secure inside the bucket. Each label should contain the following information: name of the catching vessel; location and statistical area of the catch; date and time of the set; gear type; and name of the person taking the sample.

Freezing is the preferred preservation method for samples. If a freezer is not available, samples may be preserved in a 10% formalin solution.

DOCUMENTATION

Sampling data are recorded on a form coded for keypunching and subsequent EDP processing (Fig. 3). Information on the whole sample is presented in the top line, called the "header record". This includes: sample number (assigned in numerical order at the time of processing); year, month and date of capture; locality number (coded from Haist and Rosenfeld 1988);

CFV number (coded from the "Commercial Fishing Licence Directory" updated annually by DFO); and gear, source, and preservation (Table 1).

The length, weight, sex, maturity, and gonad weight are recorded for individual specimens on the main body of the coding sheet.

SAMPLE PROCESSING

In preparation for processing, samples of fish should be thawed just to the stage where they can be easily separated. Soaking fish as a method of thawing should be avoided. The sample may be rinsed lightly to remove any dirt and loose scales that may be present. It is then transferred into a suitable container together with the sample label. (Keeping the label with the fish during the entire sampling procedure reduces the risk of error if several samples are being processed at the same time.)

Some of the information from the sample label (specifically: vessel name, location, statistical area, date of capture, time of set, and gear type) is transcribed neatly onto the labels of each of the four glass microscope slides normally used for the scales from one sample (Fig. 4). Slides are also labelled with first and last fish number on that slide, sample number, and slide letter (A, B, C, or D).

Scales are arrayed in five rows of five on a 7.5 x 5.0 cm microscope slide, with the hooks pointing up and the flat side (i.e., the side that touches the fish) down. The baseline of the scale should be parallel to the bottom of the microscope slide. Placement of the scales begins in the upper left hand corner (fish one), extends along the first row to the upper right hand corner (fish five), and then begins at the left side with the second row (fish six), and so on (Fig. 4). The fish number on the slide should be checked against the fish number on the sampling tray at the end of each slide row to be sure they correspond.

When all the scales for a sample have been taken the slides should be checked for dirt, excess glue, air bubbles, etc., and cleaned. In the event a fish was sampled for which there was no scale available, a black waterproof felt pen should be used to mark the fish number on the slide. A fifth microscope slide is used as a cover for the slides with scales mounted on them, and the bundle is taped together.

After a scale is taken, the fish is placed on a "sampling tray" (Fig. 5). Each tray is numbered to correspond with the slide number (i.e., scales on slide A are taken from the fish on tray A). Each fish is placed to correspond with the scale number on the slide (e.g., the first scale on the slide is taken from the first fish on the tray). The fish are arrayed in two rows, starting with fish one in the bottom left corner, fish two directly above fish one, and so on until fish 15 is placed at the top left corner of the tray. The second row on the tray begins with fish 16 in the bottom right corner, followed by fish 17 directly above, and so on until the tray contains

25 fish. The number of fish on the tray should be checked against the scale number at least every five fish to make sure they correspond. In the event of a mismatch, scales and fish should be discarded.

Specimen data must be recorded in the order that the fish were placed on the tray so that age data may be added later by fish number. Before processing begins, the fish on the tray are counted to ensure there are 25 fish. Any odd number of fish should be verified before proceeding. The specimen number on the coding sheet should be checked against the number of the fish on the tray at least every 10 fish to make sure they correspond. Again, if there is a mismatch any scales or fish which cannot positively be matched to the other specimen data should be discarded.

The following information is taken for each fish, in the manner indicated:

1. LENGTH is measured in millimetres from the tip of the snout to the end of the silvery portion of the body, after the scales have been scraped clear of this area (i.e., modified standard length - Fig. 1).

2. WEIGHT is measured to the nearest gram, using an electronic balance. The balance should be zeroed before each measurement, and have an accuracy of one-tenth of a gram.

3. SEX is coded as: 1 - male; 2 - female; 3 - unknown or immature.

4. MATURITY is classified according to a scale adapted from Parrish and Saville (1965), and revised in 1987 (Table 2).

5. GONAD WEIGHT is measured to the nearest gram on a zeroed electronic balance. (Both gonads are weighed together.)

6. A SCALE is taken from each fish. The preferred scales for ageing herring are located on the left side of the fish, in the area covered by the pectoral fin, approximately three to four scales from the fin origin (Fig. 1). If there are no scales in this area, the "preferred area" on the right side of the fish may be used. If this area is also descaled, a reasonably large and regularly shaped scale may be taken from near this area. Hook-shaped scales in the preferred area are best for age determination because they exhibit a regular, uniform growth pattern. Small, irregularly shaped scales should be avoided as they make age determination difficult or impossible. The scale is cleaned by rubbing it gently between thumb and forefinger to remove any silver pigmentation or other foreign material, and by rinsing it in clean water. Care should be used, as vigorous scrubbing can easily tear the scale. The scale is next examined for a regenerate centre, which appears crystalline when the scale is held in front of a light. A regenerate scale (Fig. 6a) cannot be aged, and must be replaced by a non-regenerate scale (Fig. 6b). The scale is then dipped in a mucilage solution (two to three drops stationary mucilage to one litre water). Excess mucilage solution is removed by dabbing the scale on a paper towel. After placing the scale on the microscope slide a paper towel is again used as

a blotter, as excessive amounts of dried mucilage, or air bubbles can blur the pattern of the scale. Blotting also removes any dirt that may have collected on the slide.

Other specimen data such as those listed below may be required in special circumstances:

1. GONAD LENGTH is the maximum length measured to the nearest millimetre. Undeveloped gonads are easily stretched and care should be taken to approximate their natural shape when measuring.

2. OTOLITHS may be required for age determination when the fish are badly scaled, or for special projects. The procedure for taking otoliths (Hourston, 1968) may be summarized as follows:

   a) Remove the gills.
   b) Lay the fish on its back.
   c) Depress the gill covers laterally, exposing a triangular ridge on the underside of the skull.
   d) Cut down through this ridge, but not completely through the head (Fig. 7a). Bending the head back exposes, near the posterior end of the cut, a triangular bony structure pointing backwards. On either side of this is an oval opening to a deep cavity (the exposed underside of the inner ear). The otoliths are raised from these depressions with forceps (Fig. 7b). It should be noted that the sampler is trying to break through the ampullae and not to cut through them. Care must be exercised, as once the otolith is dislodged from its original position, it sinks in the cavity and may be impossible to recover without considerable further dissection. After the otolith is removed, it is inspected for breakage and washed in a petri dish of fresh water. Any "crystalline" otoliths, which are distinguishable because they are almost translucent, should be discarded together with the fish because they are unageable. The clean pair of otoliths is placed in the appropriate compartment of an "otolith tray" (Fig. 8). These trays are white plastic, 35 by 8 by 3 cm, with 5 rows of 20 compartments. The required sample information is recorded on the lid as well as the bottom of the tray, using a fine tipped felt pen. The otoliths are covered with a glycerin solution (0.5 litre glycerine, 0.5 litre water, and 5 ml thymol).

ACKNOWLEDGMENTS

The current sampling procedures are the result of the working experiences of several groups of people: the ageing unit and the herring section at the Pacific Biological Station, and various groups of contractors. Tideview Services in particular contributed substantially to the revisions of the previous sampling procedure publication (Hourston and Miller 1980).

P. Bentley and E. Warnerbolt took the photographs, and F. Winters drafted the figures.

REFERENCES

Armstrong, R. W. 1987. The 1987 Roe Herring Charter Vessel Monitoring and Sampling Program. Can. Ind. Rep. Fish. Aquat. Sci. 181: 79 p.

Pacific Region Commercial Fishing Licence Directory. 1988. Government of Canada publication.

Chalmers, D. D. 1987. Review of the 1986-87 British Columbia Herring Fishery and Spawn Abundance. Can. Ind. Rep. Fish. Aquat. Sci. (In press).

Haist, V. and L. Rosenfeld. 1988. Definitions and Codings of Localities, Sections, and Assessment Regions for British Columbia Herring Data. Can. MS Rep. Fish. Aquat. Sci. 1994: 123 p.

Hourston, A. S. 1968. Age determination of herring at the Biological Station St. John's, Newfoundland. Fish. Res. Board Can. Tech. Rep. 49: 24 p.

Hourston, A. S. and D. C. Miller. 1980. Procedures for sampling herring at the Pacific Biological Station. Can. MS Rep. Fish. Aquat. Sci. 1554: 23 p.

Humphreys, R. D. and A. S. Hourston. 1978. Sampling design for assessing the biological characteristics of British Columbia herring stocks. Fish. Mar. Ser. Tech. Rep. 848: 7 p.

Schweigert, J. F. and J. R. Sibert. 1983. Optimizing survey design for determining age structure of fish stocks: an example from British Columbia Pacific herring (Clupea harengus pallasi). Can. J. Fish. Aquat. Sci. 40: 588-597.

Stocker, M. 1984. "Sampling Pacific herring for estimating various population parameters". Unpublished.

Table 1. Codings for British Columbia herring sampling data.

A. Gear		B. Source	
19	Gillnet	0	Roe fishery
29	Seine	1	Bait fishery
20	Salmon seine	2	Research - inshore
21	Other seine	3	Research - offshore
70	Beach seine	4	Other
50	Other trawl	5	Pre-fishery charter
59	Herring trawl	6	Food fishery
01	Other		
C. Preservation		**D. Sex**	
0	Frozen	1	Male
1	Fresh	2	Female
2	Salted	3	Immature or Unknown
3	Other		
4	Brined		

Table 2. Maturity stages for Pacific herring (Revised May, 1987). These descriptions are intended as general guidelines. Length of time samples have been frozen, thawing time, and different handling procedures may alter the colour of the gonads. Therefore, the texture of the gonad is also used to assess maturity. The timing description is also a general guideline due to the wide range in spawn timing on the British Columbia coast.

Stage	State of maturity	Gonad appearance	Description	Timing
I	Undeveloped	Thread-shaped	Virgin herring with small gonads, less than 2 mm broad. Accurate macroscopic determination of sex not possible. Fat is visible in the body cavity.	Year-round for young herring usually less than 150 mm in length. (However, some herring as small as 125 mm may have mature gonads.)
II	Starting	Ribbon-shaped	Gonads increased in breadth to 3-5 mm. Sex determination difficult. Testes reddish-grey coloured and knife-shaped. Ovaries reddish-wine coloured and bullet-shaped at tip. (The gonads of virgins and some repeat spawners cannot be differentiated macroscopically.) Fat is visible in the body cavity.	Late spring and early summer.
III	Developing	Tube-like	Gonads thickened, increased in breadth (5-15 mm) and elongated, but not extending full length of body cavity. Ovaries red to reddish-orange, granular in appearance, and bullet-shaped at the tip. Tests reddish-grey, smooth in appearance, and knife-shaped.	Usually late summer to early fall, but may extend into winter and early spring.

Table 2 (cont'd.)

Stage	State of maturity	Gonad appearance	Description	Timing
IV	Maturing	Prominent	Gonads extend full length of body cavity. Ovaries reddish-orange to yellow; eggs distinguishable, opaque, variable in size and separate. Testes mostly grey, firmer, and will ooze milt if sliced with a knife. Blood vessels often clearly visible in the ovary and testes walls.	Usually late fall and winter, but may extend to as late as March. (Slightly earlier in males than females.)
V	Mature	Bulging	Few or no blood vessels visible in gonad walls. Walls of body cavity thin. Ovaries gold-yellow, firm and will often break into sections. Eggs mostly transparent and uniform in size. Testes usually milk-white, soft and plump; and sperm will flow under pressure.	Mid winter to late spring.
VI	Ripe	Running	Gonads do not hold their shape. Ovaries look and feel gelatinous. Segmentation is lost. Eggs are transparent and sticky to the touch. Testes runny, and have a curdled appearance. Sperm flows easily without external pressure.	A few days prior to spawning (usually in late winter to spring.)

Table 2 (cont'd.)

Stage	State of maturity	Gonad appearance	Description	Timing
VII	Spent	Baggy	Gonads slack. Sex determination difficult. Ovaries may contain a few residual eggs. Tests limp and bloodshot. Body wall thin and no fat present; blood in body cavity.	Spring for the first few weeks following spawning.
VIII	Recovering	Compressed	Gonads wine-coloured and usually longer, fuller and not as slack as Stage VII. Blood vessels prominent. Little or no fat in the body cavity.	Late spring and early summer.

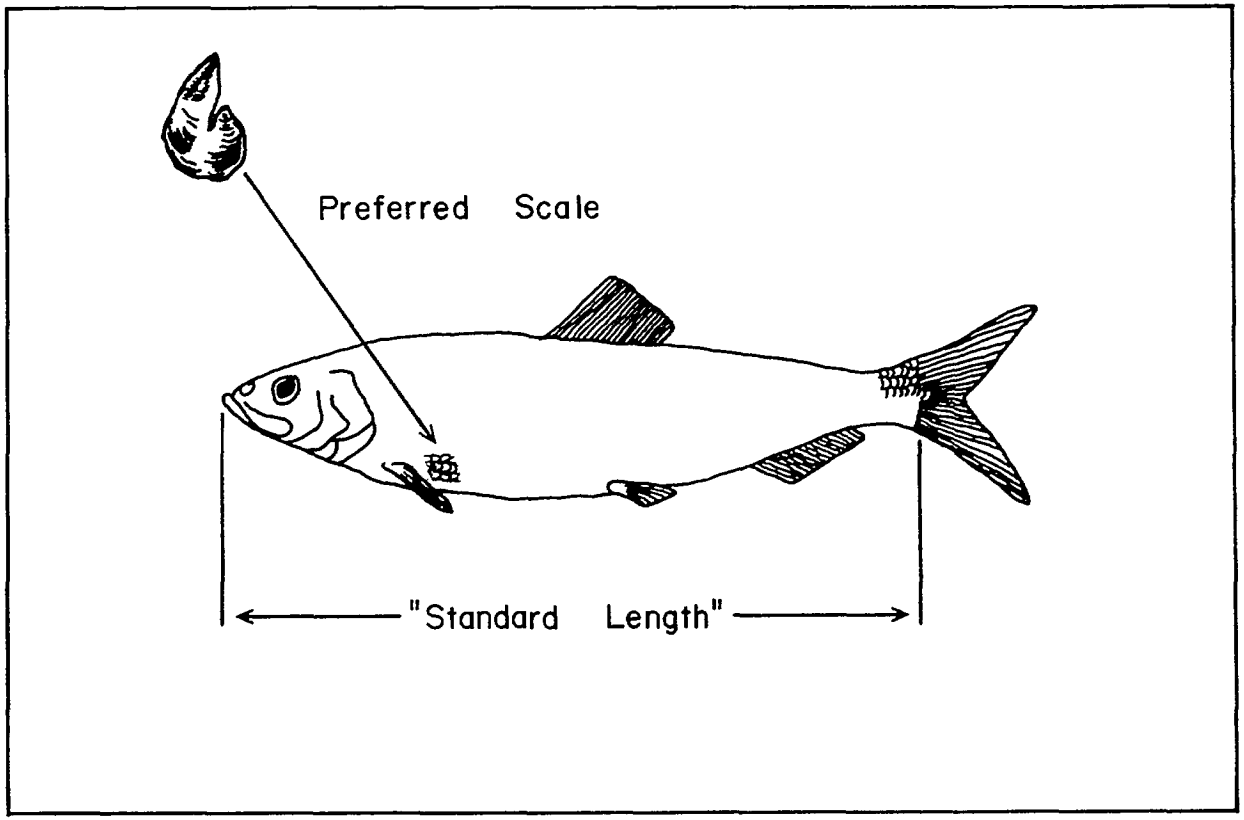

Fig. 1. Standard length used for herring at the Pacific Biological Station, and area of preferred scales for age determination.

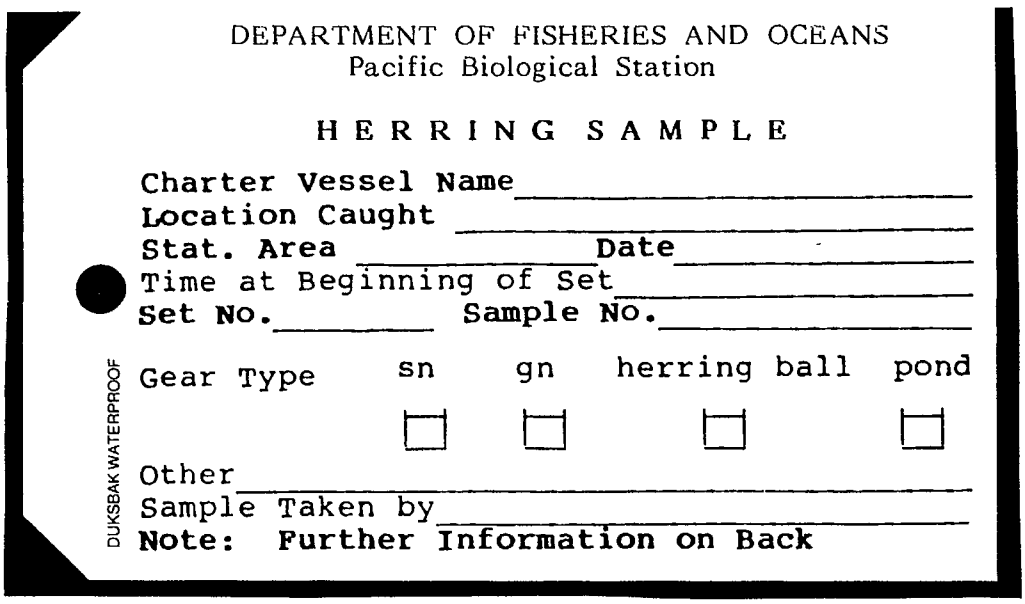

Fig. 2. Label for herring sample.

HERRING SAMPLE

YEAR _____ DAY _____
SAMPLE NO _____ BOAT _____
AREA _____ GEAR _____
LOCATION _____ SOURCE _____
MONTH _____ PRESERVATION _____

INDEX	YR	SAMP NO	LOC	MON	DAY	CFV	GR	SOURCE	P	
H										

INDEX	FISH NO	LENGTH	WGT	SEX	MAT	AGE	
S	0 0 1						
S	0 0 2						
S	0 0 3						
S	0 0 4						
S	0 0 5						
S	0 0 8						
S	0 0 7						
S	0 0 8						
S	0 0 9						
S	0 1 0						
S	0 1 1						
S	0 1 2						
S	0 1 3						
S	0 1 4						
S	0 1 5						
S	0 1 6						
S	0 1 7						
S	0 1 8						
S	0 1 9						
S	0 2 0						
S	0 2 1						
S	0 2 2						
S	0 2 3						
S	0 2 4						
S	0 2 5						
S	0 2 6						
S	0 2 7						
S	0 2 8						
S	0 2 9						
S	0 3 0						
S	0 3 1						
S	0 3 2						
S	0 3 3						
S	0 3 4						
S	0 3 5						
S	0 3 6						
S	0 3 7						
S	0 3 8						
S	0 3 9						
S	0 4 0						
S	0 4 1						
S	0 4 2						
S	0 4 3						
S	0 4 4						
S	0 4 5						
S	0 4 6						
S	0 4 7						
S	0 4 8						
S	0 4 9						
S	0 5 0						

INDEX	FISH NO	LENGTH	WGT	SEX	MAT	AGE	
S	0 5 1						
S	0 5 2						
S	0 5 3						
S	0 5 4						
S	0 5 5						
S	0 5 6						
S	0 5 7						
S	0 5 8						
S	0 5 9						
S	0 6 0						
S	0 6 1						
S	0 6 2						
S	0 6 3						
S	0 6 4						
S	0 8 5						
S	0 6 6						
S	0 6 7						
S	0 6 8						
S	0 6 9						
S	0 7 0						
S	0 7 1						
S	0 7 2						
S	0 7 3						
S	0 7 4						
S	0 7 5						
S	0 7 6						
S	0 7 7						
S	0 7 8						
S	0 7 9						
S	0 8 0						
S	0 8 1						
S	0 8 2						
S	0 8 3						
S	0 8 4						
S	0 8 5						
S	0 8 6						
S	0 8 7						
S	0 8 8						
S	0 8 9						
S	0 9 0						
S	0 9 1						
S	0 9 2						
S	0 9 3						
S	0 9 4						
S	0 9 5						
S	0 9 6						
S	0 9 7						
S	0 9 8						
S	0 9 9						
S	1 0 0						

Fig. 3. Herring sampling form.

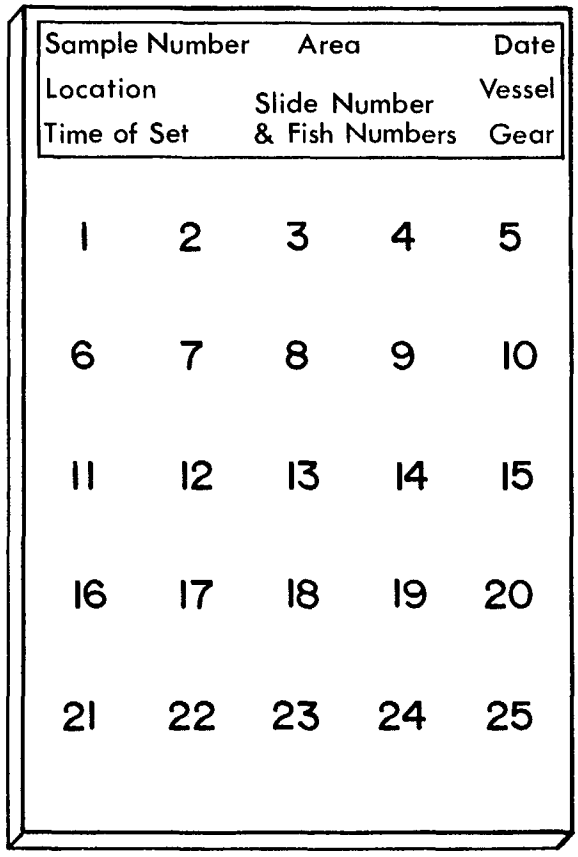

Fig. 4. Illustration of microscope slide, showing scale positions and information required on label.

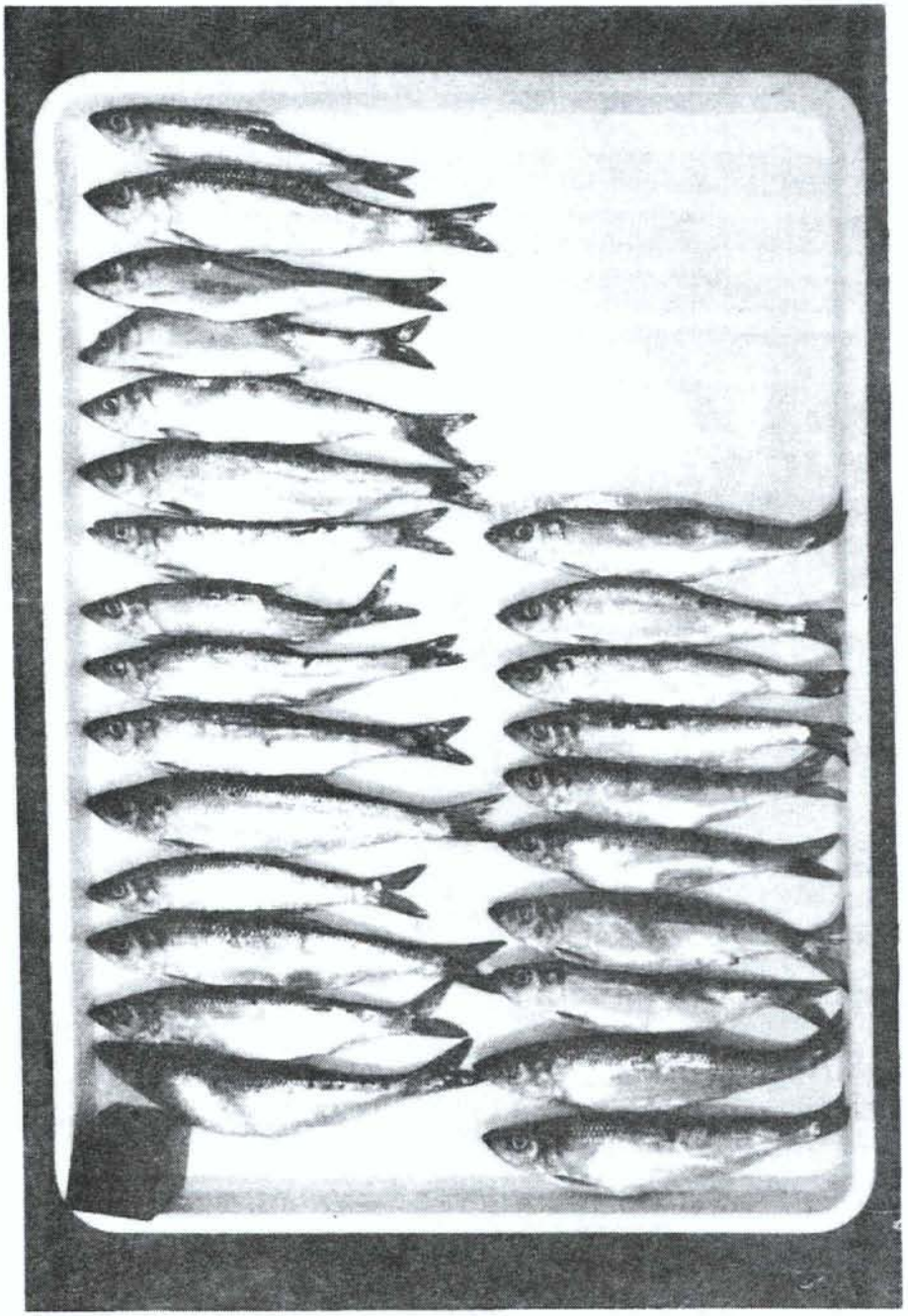

Fig. 5. Sampling tray containing 25 fish.

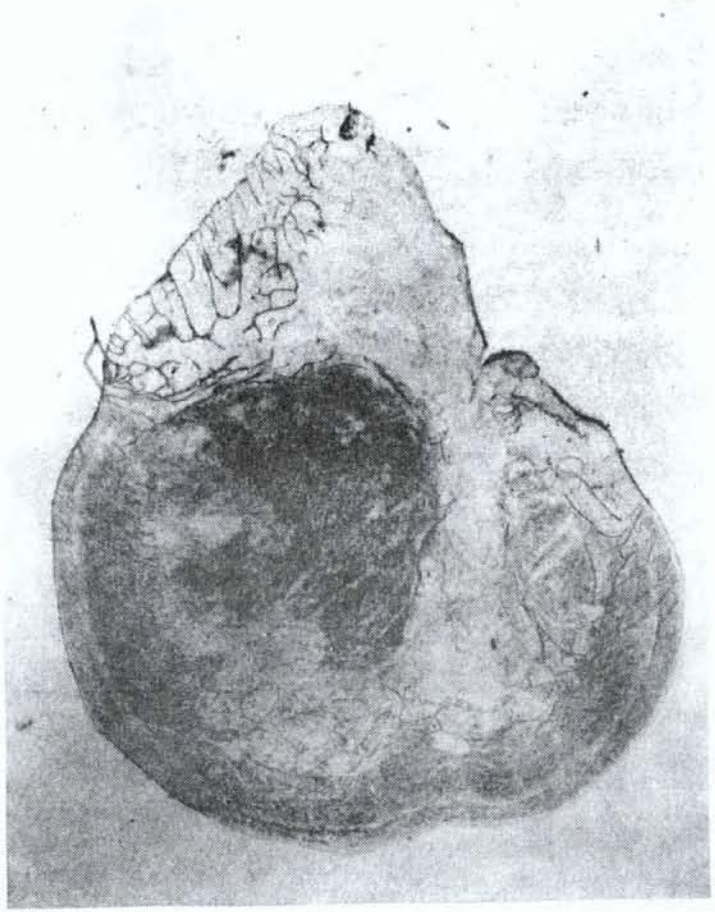

Fig. 6a. Regenerate herring scale (Note crystalline centre).

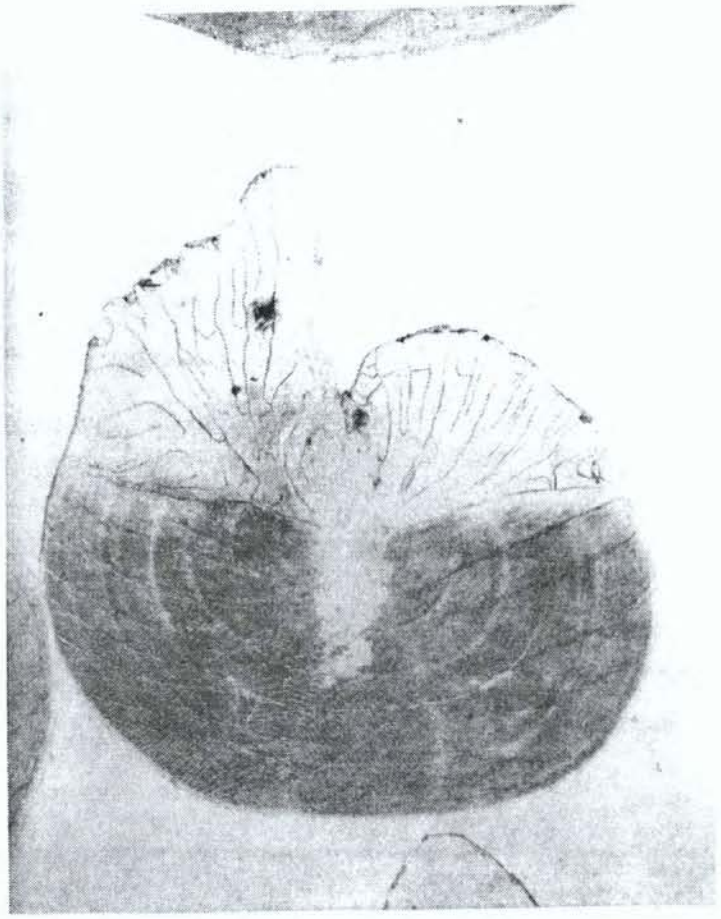

Fig. 6b. Preferred herring scale showing well defined annulus.

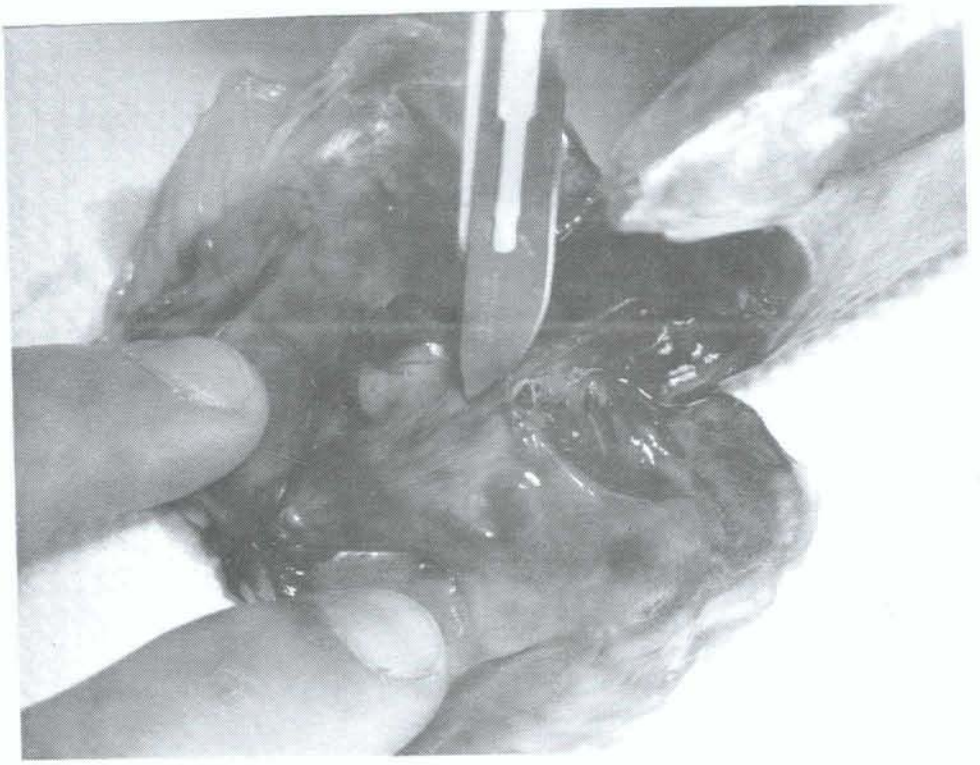

Fig. 7a. The initial cut for otolith removal.

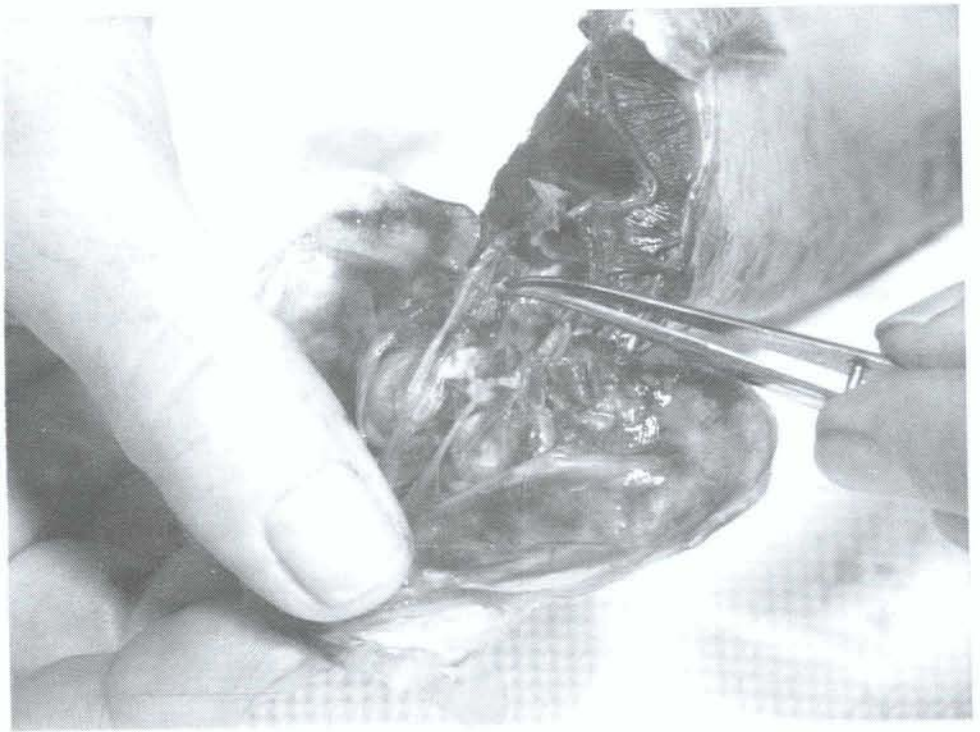

Fig. 7b. Removing the otolith.

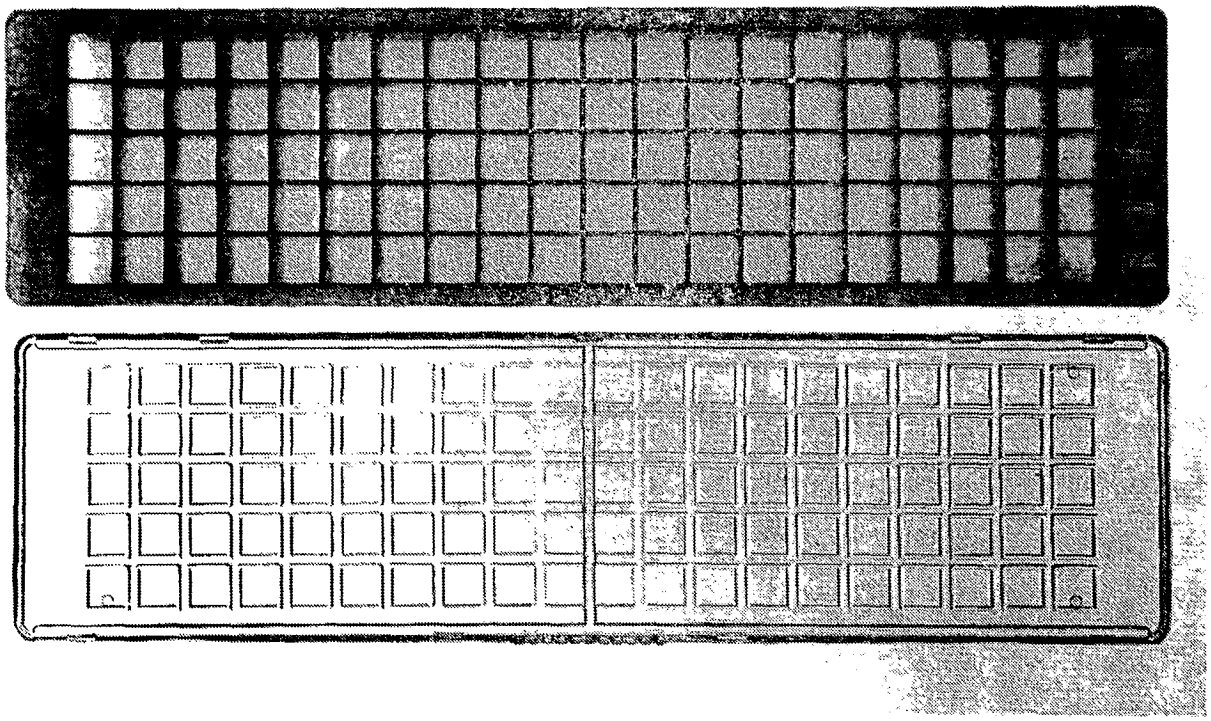

Fig. 8. Otolith tray.