REPORT BY CORRESPONDENCE OF THE

BALTIC HERRING AGE READING STUDY GROUP

September 1997

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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1 INTRODUCTION

1.1 Terms of Reference

According to resolutions adopted at 1996 Annual Science Conference, 84th Statutory Meeting (C.Res. 1996/2:45), a Baltic Herring Age Reading Study Group (BHARSG) will be established (Chairman: Mr G. Kornilovs, Latvia) and will work by correspondence in 1997 to:

1. establish a Baltic herring otolith exchange programme on a regular basis between laboratories involved;

2. establish a reference collection of otoliths from different sub-divisions, seasons and length groups of Baltic herring to reach a common interpretation of otolith structure;

3. establish a protocol for the age determination of otoliths using diagrams and photographs to illustrate age-reading criteria;

4. prepare a detailed programme for a Study Group meeting (5 days) to be held in 1998 to:

   a) intercalibrate the age reading and age determination methodology of Baltic herring and describe a protocol for handling Baltic herring otoliths,
   b) organize a comparative age determination of otoliths and evaluate results using the methods described by the Working Group on Sampling Strategies for Age and Maturity,
   c) in the light of the Study Group meeting results, identify new research and actions needed to improve the consistency of age reading,
   d) prepare a manual of standard procedures on Baltic herring age-reading.

1.2 Participation

The nominated members of the Study Group are the following:

Fetter, M.	Latvia
Gröger, J.	Germany
Gröhsler, T.	Germany
Jernberg, C.	Sweden
Kornilovs, G. (Chairman)	Latvia
Krasovskaia, N.	Russia
Ojaveer, H.	Estonia
Parmanne, R.	Finland
Raid, T.	Estonia
Spilev, H.	Estonia
Wyszynski, M.	Poland

2 REVIEW OF THE WORK IN 1997

2.1 Plan of the Work

After the nomination of the members of the Study Group which was completed by the beginning of February 1997 a letter with suggested plan of the work in 1997 was sent to all the members and the plan was as follows:

According to resolutions adopted at the 1996 Annual Science Conference, 84th Statutory Meeting a Baltic Herring Age Reading Study Group (BHARSG) is established (Chairman: Mr G. Kornilovs, Latvia) and will work by correspondence in 1997. The Study Group will report to the 1997 Annual Science Conference. In order to fulfil the tasks of the Study Group it is necessary to prepare and to get agreement on the work plan for the period till the 1997 Annual Science Conference where BHARSG should present a Report. The suggestions for the work plan in connection with the terms of reference are as follows:

a) establish a Baltic herring otolith exchange programme on regular basis between laboratories involved;

A sample of otoliths prepared by each participating country is circulating clockwise between the countries (Sweden - Finland - Estonia - Latvia - Russia - Poland - Germany) so that every participant gets acquainted with the samples from all other countries. During the work of the Study Group it would be desirable to carry out the first exchange of otoliths in a period till the 1ˢᵗ of June 1997 in order to:

- *evaluate the results;*
- *include the results in 1997 Study Group Report*
- *analyse them during the Workshop in 1998.*
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The set of otoliths for exchange should contain 100 otoliths collected from herring in the first half of the year preferably during the spawning period in the economical zone of each country. As You see these otolith sets can be formed only on the base of otoliths (desirably from years 1996 or 1995) You have already in Your laboratories. The otoliths should be put in plastic bags and accompanied with a form of analysis containing the data on place and time of collection of the otoliths, and herring length. The results of age reading should be sent Latvian Fisheries Research Institute.

The determined age should indicate the age of herring taking into account that on the 1ˢᵗ of January herring becomes one year older. Thus if for herring caught in 1996 we put the age of 3 years it means that this herring was born in 1993.

Concerning the area from which herring otoliths have to be taken it is proposed that the efforts should be concentrated on Central Baltic Herring stock in Sub-divisions 25-29 (including Gulf of Riga) and Sub-division 32. This stock is common for almost all Baltic states and the age determination is already taking place in the laboratories. In relation to herring in the Western Baltic and Sub-divisions 30 and 31 possibly there could be organized some Sub-groups dealing with this herring and this question could be decided during our correspondence.

As we have only five months for six separate exchanges each set of otoliths should be kept in each laboratory not longer than two and a half weeks, but taking into account that all of us have some pressure of business trip, survey, etc. the time for treatment of the samples is even shorter.
The second otoliths exchange could take place in the second half of 1997 till the Workshop in 1998. This pattern of otolith exchange (but with a period of circulation of 1-1.5 years) between specialists could be maintained also after the work of the Study Group thus revealing the state of herring age determination on a whole and indicating the situation when other ways of coordination between age readers are necessary.

b) establish a reference collection of otoliths from different sub-divisions, seasons and length groups of Baltic herring to reach a common interpretation of otolith structure;

During 1997 each country should prepare a collection of otoliths covering important fishing regions, seasons and length groups of Baltic herring in their economical zone. The collections should be presented at the Workshop and on the base of these collections a reference collection should be made. The questions on number, type, etc., of otoliths that should be collected we could discuss during our correspondence

c) establish a protocol for the age determination of otoliths using diagrams and photographs to illustrate age-reading criteria;

Each country should prepare a description of otolith age reading methodology that will serve as a base for protocol for the age determination of otoliths. This description should include the following questions: otoliths' treatment technique, light conditions, magnification, chemicals used, as well as the explanation of the criteria of otolith structure You use for the age determination. This question we will also discuss more in detail during our correspondence.

d) prepare a detailed programme for a Study Group meeting (5 days) to be held in 1998...;

This point should be discussed during our further correspondence. Please send Your proposals about the possible time and place of this meeting. Likely this meeting could take place in the first half of 1998 and the inviting Institute should ensure sufficient amount of microscopes for the members of the Study Group as well as other facilities necessary for the work of the Study Group.

The work plan was accepted by the Study Group members in general. Each participating country prepared a protocol for the age determination of otoliths and a sample of otoliths from sub-divisions of their economic zones thus covering all Sub-divisions of the Baltic sea except the western ones (21-23). The otolith exchange started in March.

3 TERMINOLOGY AND ELEMENTS OF STRUCTURE OF HERRING OTOLITHS

Herring otoliths have the following basic elements of their outer structure: rostrum, antirostrum, postrostrum and pararostrum. Ventral (between rostrum and postrostrum) and dorsal (between antirostrum and pararostrum) edges of the otolith have rather pronounced dentation. The outer side of otolith is relatively smooth. The acoustic groove (sulcus acusticus) dividing the otolith into ventral and dorsal parts is seen on the inner side turned to the brain.

Age group:

The group of fishes that are of the same age, e.g. 3-year-old group. The age value assigned to each fish is the "ring count". When the correct "ring count" is subtracted from the year in which herring was killed (the date of capture), the result will normally be the year the herring was spawned (its year class).

Winter (hyaline) zone:

The translucent or hyaline growth zone on the herring otolith. The winter zone (ring) appears dark when the otolith is viewed by reflected (falling) light against a black background. The winter growth zones are formed during the period of slow growth of fishes. The first winter zone has not often clearly distinctive contour and it could be detected by small differences in optical density of neighbouring zones.

Summer (opaque) zone:

The opaque growth zone on the herring otolith. Summer zones (rings) appear white in contrast with winter zones when the otolith is viewed by reflected light against a black background.

4 PROTOCOLS FOR THE AGE DETERMINATION OF OTOLITHS

4.1 Estonia

4.1.1 Sampling and storing

Samples of otoliths (sagittae) are stored in paper envelopes. One sample includes 100 pairs of herring otoliths with the protocol of standard biological data. Min. 3 samples are taken every month in each ICES sub-division (28, 29, 32).

4.1.2 Equipment and preparation of otoliths

Otoliths are examined in reflecting light using the magnification 8*4. During the examination the otoliths are immersed into ethanol. Usually the outer concave surface of otolith is used for age reading.

4.1.3 Age reading criteria

In the first half of the year the age is determined as the number of opaque (summer) zones. In the second half-year the age is determined as the number of hyaline (winter) zones. In the Gulf of Riga (Sd 28.5) on the base of otolith structure two populations of Baltic herring are determined - gulf herring and open sea herring which enters the Gulf of Riga during the spawning season.

4.2 Finland

4.2.1 Sampling and storing

Samples of herring otoliths are taken from commercial trap net, bottom trawl and pelagic trawl catches. Otoliths (one per fish) are put into holes of a clear plastic plate. The convex side of the otolith with longitudinal furrow is downwards and the rostrums point to the same direction. A drop of Canada balsam in xylene or a drop of boat lacquer is placed into every hole. The whole otolith must be within the liquid in order to avoid harmful light reflections from the surface of the otolith. One sample consists of 50 herring otoliths with the protocol of standard data (year, month, species, ICES statistical rectangle, gear, weight, length). Altogether about 250 samples (12 500 herring) have been taken per year from the Finnish fishery in the Baltic sea.

4.2.2 Equipment and preparation of otoliths

Herring otoliths are examined under a stereo microscope in reflected light against a dark background. The otolith plate is turned horizontally so that the rostrums point away from the direction of the light, which comes at an angle of about 45 degrees to the otolith. Magnification is usually 10*2.3, but especially for older herring also bigger magnifications, up to 10*3.5, are used. The age is determined from the concave side of the otolith. If this side is not upwards, as it should be, it is necessary to turn the otolith plate upside down and read the age from the bottom side of the clear plate.

4.2.3 Age reading criteria

In herring age reading, the number of hyaline zones are counted. At the beginning of the year the age is the number of hyaline zones plus the outer edge of the otolith. In reflected light against dark background the hyaline zones are dark and the broader opaque zones can be seen milky. Usually the reader begins counting from the innermost hyaline zone and then continues towards the edge of the otolith.

The hyaline zone closest to the nucleus, and also the next hyaline zone, are usually poorly visible in rostrum, but are more distinct in other parts of the otolith, especially between antirostrum and pararostrum. The third and the next hyaline zones are visible in rostrum, antirostrum and pararostrum, often these zones can be seen around the whole otolith. The outermost zones of an old individual are narrow and can often be distinguished only in rostrum.

In doubtful cases the change of focusing may help age reading.

The determination of the growth during the latest year can be problematic, especially by older herring. In young specimens, the formation of new opaque zone begins in early summer. Instead of that, in the otolith of old specimens new opaque zone starts to form in late summer or in autumn, the time varies between years and specimens.

In autumn it is sometimes difficult to determine, if an old herring has already started to grow, or have the outermost opaque and hyaline zones formed during the previous year. To some extent difficulties can be reduced by ageing samples taken in the course of the year in chronological order. Thus the reader gets acquainted with the formation period of the growth zones in various age groups.

January 1 is regarded as the date on which the age designation changes, whether or not the new hyaline zone is yet recognizable on the otolith.

4.3 Germany

4.3.1 Sampling and storing

The herring samples are delivered from two different sources:

- market samples (trawl, trapnet or gillnet fishery respectively),
- survey samples (trawl fishery by "FFK Solea").

For herring it is tried to achieve at least quarterly 10 market samples per 20 kg in Sub-division 24 and 5 market samples per 20 kg in Sub-division 22. For the herring spring spawning season from March to May in Sub-division 24 (during the last years the main place of German fisheries activity since more than ca. 80% of the landings are generally caught within this period) 10 monthly market samples in Sub-division 24 stem from the waters around Rügen Island (in the last years about 80% of the total German landings). For Sub-division 22 the herring market samples are quarterly collected at Kiel and consist of 4 different gillnet samples (= 4 herring-categories) and one trawl sample. The proportion of herring caught by trawl is generally far lower than that caught by gillnet.

Herring survey samples taken during the German "Young Fish Survey" (with bottom trawl in November, Sub-division 22, 24 and 25), "Bottom Trawl Survey" (in February, Sub-division 22, 24 and 25) and "Hydroacoustic Survey" (pelagic fishery in October, Subdivision 21, 22, 23 and 24) with "FFK Solea" are used in addition to the market samples.

For market samples the individual total length (0.5 cm below) is measured. Also overall fish numbers and weights (in g) per length-class are determined. The numbers of fish per length-class used for age reading are not fixed by a constant figure. The variable numbers per length-class are delivered from an optimising programme (*Oeberst, R.: The accuracy of age compositions and estimation of optimum sample size. Working paper. ICES Workshop on Evaluation of Baltic Fish Data, Gdynia: 7.-11.6.1993*), which uses the results of the last year. In case of herring additionally sex data and maturity-rates (8-number-scale corresponding to Heincke) are taken.

During the survey on board, in case of smaller catches the total length (0.5 cm below) of each herring caught is determined. In case of larger catches a representative sub-sample is taken. While fish numbers and weights (in g) per length-class are determined on board, preparation of otoliths and age reading will be done in the home laboratory (for this purpose a sample is frosted). The numbers of fish per length-class used for age reading are fixed, in correspondence to the market samples (see above). Additionally sex data and maturity rates (see above) are taken in the laboratory.

The samples of herring otoliths (pair of sagittae) either from market or survey samples are put on black plastic trays. It is possible to store 100 pairs of sagittae in numbered cavities on one plate. The plates will be stored after age determination.

4.3.2 Equipment and preparation of otoliths

Herring otoliths (pairs of sagittae) are examined under a stereo (binocular) microscope in reflected light against the black background of the trays. The magnification is set to x25. One or both otoliths are examined, depending on the clarity of the individual growth zones. To obtain a clear image, the otoliths are immersed into water. The outer concave surface of the otolith is used for age reading, because on this side the nucleus and the hyaline zones are most clearly seen. When required the position of the examined otolith may be changed by means of a pincers in order to obtain the clearest view of the growth zones.

4.3.3 Age reading criteria

The number of winter rings visible on the axis nucleus to rostrum and nucleus to postrostrum are counted.

The correct "ring count" is determined by assigning all fish s birthday on the 1st January. The age determination differs in different seasons:

Fish caught in the first half of the year (1 January - 30 June)
In this period the "ring count" is the total number of winter rings generally adding one final winter ring on the edge of the otolith, whether this ring is visible or not.

Fish caught in the second half of the year (1 July - 31 December)
In this period the "ring count" is the total number of winter rings, excluding any incomplete and visible winter ring at the edge of the otolith.

For fish older than 2 years the first two winter rings must be clearly visible on the examined axis (see above). Further counted winter rings might only be visible in the rostrum.

4.4   Latvia

4.4.1   Sampling and storing

Samples of herring otoliths (sagittae) are taken from commercial catches and during research cruises. The otoliths are put into paper envelopes in which they will be stored after age determination. One sample consists of 100 pairs of herring otoliths with the protocol of standard biological data (length, weight, sex etc.). 3-6 random samples of herring are taken monthly in each of two regions of Latvian economic zone (28.1-4 and 28.5).

4.4.2   Equipment and preparation of otoliths

Herring otoliths are examined under a stereo (binocular) microscope in reflected light against a black background. Magnifications of 8*4 or 8*2 are usually adequate for otoliths reading. One or both otoliths are placed on the object concaved glass. To obtain a clear image of otoliths they should be immersed into ethanol or xylol.

The outer concave surface of otolith is normally used for age reading because on this side of the otolith a nucleus and hyaline zones are most clearly seen. When required, the otolith examined may be turned upside down by means of scalpel or pincers, or its position may be changed in order to obtain the clearest image of the growth zones. This could be helpful examining thick otoliths of older herring, or for detection of the first winter zone which is often not quite visible from the outer (concave) side of the otolith.

4.4.3   Age reading criteria

The age determination differs in different seasons. In the first half of the year the age is determined as the number of opaque rings because the last hyaline ring becomes visible only in March-June. It would be the same if we would count the hyaline rings and add one year for the invisible hyaline ring on the edge of the otolith. The first winter zone has not often clearly distinctive contour and it could be detected by small differences in optical density with the neighbouring opaque zones.

In the second half of the year the age is determined as the number of hyaline rings. Usually it is the most difficult period of age reading. The formation of a new opaque summer zone for herring in the Latvian economic zone takes place in the second half of the year and depends on hydrometeorological and feeding conditions and age of the fish. At first the opaque zone appears for one year old herring and then subsequently for older herring. Especially for older herring it is possible to mistake the opaque zone of the previous year as a new opaque zone and vice versa. Therefore it is necessary to have more or less regular sampling of herring in the period from July till September. The reading of the number of growth zones is performed as on the rostrum as well as on the postrostrum of the otolith. In the last decade the age determination for older herring in the Latvian economic zone is mainly possible only on the rostrum because the growth rate of herring is very slow that has influenced also the size of otoliths and growth zones.

In the Gulf of Riga (Sd 28.5) and in the Baltic Proper (Sd 28.1-4) on the base of otolith structure two populations of Baltic herring are determined - gulf herring and open sea herring which enters the Gulf of Riga during the spawning season. In the last years the stock size of the gulf herring has strongly increased and in late summer-autumn period it makes a feeding migrations to the Baltic Proper mainly to the parts which are close to the Gulf of Riga (Sd 28.2 and 28.3).

4.5   Poland

4.5.1   Sampling and storing

Samples of otoliths (sagittae) of herring are collected from both commercial catches and research surveys. 2-3 monthly samples are collected from fishing cutter catches in each of the Sub-divisions of the Polish EEZ (Exclusive Economic Zone) - Sub-divisions 24, 25 and 26. In the period March-May, 2-3 samples are also taken from boat catches in each of the above-mentioned Sub-divisions and in the Vistula Lagoon. In Polish landings of herring from cutters, two length assortments of fish occur: S - medium herring (16-22 cm TL), and D - large herring (over 22 cm TL). For this reason each sample contains two subsamples taken from each of these assortments. Cyclically repeated sampling from research surveys occurs during young fish surveys in January and February-March, and during hydroacoustic survey in October. Each sample and subsample consists of pair of

otoliths taken from 4-6 specimens of herring in each 0.5 cm fish length-class. This generally constitutes 100-150 pairs of otoliths in a sample.

To each sample a protocol on the measurement of length frequency of herring is attached, along with a protocol on the standard biological analysis containing data relative to total length and weight of fish, their sex, gonad maturity stage, degree of fullness of the stomach, age of fish and the spawning group (population) that they belong to: coastal spring herring, open sea spring herring and autumn herring.

After drying, otoliths are placed in the indentations of plates made of polypropylene tinted black, and coated with eukitt or Canada balsam. In this manner they are prepared for age reading and storage.

4.5.2 Equipment and preparation of otoliths

Herring otoliths coated with eukitt or Canada balsam on plastic plates with a black background are examined under a stereo microscope in a reflected light. Magnifications of 12*1 or 15*0.7 to 4 are used for otolith reading.

On plates the otoliths are placed with the outer (concave) side up, on which the visibility of the nucleus and hyaline rings is highest. Eukitt or Canada balsam, well known mounting reagents for the microscopic technic, perform the task of increasing the sharpness of the otolith morphological structure and preventing otoliths from being damaged during storage.

4.5.3 Age reading criteria

Hyaline fully closed winter rings count, taking into account a different time of ring formation on the otolith edge, has been adopted as a criterion for age determination. In herring reproducing within Polish EEZ (coastal herring), the hyaline ring on the edge of the otolith is visible in most individuals in January, and in March - in all the fish. Among this herring population, the formation of hyaline ring on the otolith edge has a beginning in November, earlier in herring from most young age groups. The hyaline ring existing on the edge of otolith from November to the end of December is not counted as a yearly ring. In herring that have migrated into the Polish EEZ from the northern areas of the Baltic (mainly open sea herring), the winter hyaline ring on the edge of the otolith is visible considerably later (March - June). In these herring in the first half of the year age is determined by counting the rings visible and the edge of the otolith despite the fact that the hyaline ring is not visible on it.

In herring reproducing off the Polish Baltic coast the summer opaque ring on the edges of otoliths appears most quickly in young herring as the beginning of May, and in older fish in June. The beginning of formation of the opaque zone on otoliths also depends upon hydrometeorological and trophic conditions of the environment. Lack of the summer opaque ring on the edges of otoliths of some immigratory herring (open sea herring) in the Polish EEZ is observed as late as September, and even in October. In addition difficulty in age reading from otoliths particularly in this group of herring consists in the growth rate of opaque zones (rings) decreasing with the age of fish. In older fish (age 8+) opaque rings are visible solely on the rostrum of the otolith, in its other parts on the edge there is usually a slightly widened hyaline zone. In such cases age is read on the rostrum only. In spring coastal herring a similar problem arises only in sporadic cases: in the oldest fish annual growth rings are visible both on the rostrum and on the postrostrum of the otolith.

In older herring there is an additional problem of the growth of the opaque substance in the central part of the otolith and on the rostrum which slightly coneshaped may cover the nucleus and usually the first hyaline rings making them poorly visible. This can cause difficulties in their identification. Inside the first opaque ring there may occur a hyaline fry (metamorphic) ring, clearly visible particularly on the otoliths of younger fish, whose central parts are not overgrown with opaque substance. Naturally its occurrence **impedes the identification of** the first winter hyaline rings.

4.6 Russia

4.6.1 Sampling and storing

Samples of herring otoliths (sagittae) are taken from commercial catches and during research cruises. The otoliths are put into paper envelopes in which they will be stored after age determination. One sample consists of 100 pairs of herring otoliths with the protocol of standard biological data (length, weight, sex etc.). 3-4 samples of

herring are taken weekly during the spawning period (March, April, May) in the Vistula Lagoon (Sd 26.4). 4-6 samples of herring are taken from commercial catches in Sd 26. 1-3 by quarter.

4.6.2   Equipment and preparation of otoliths

Herring otoliths are examined under a stereo (binocular) microscope in reflected light against a black background. Magnifications of 8*4 or 8*2 are usually adequate for otoliths reading. One or both otoliths are placed on the object concaved glass. To obtain a clear image they should be immersed into ethanol.

The outer concave surface of otolith is normally used for age reading because on this side of an otolith a nucleus and hyaline zones are most clearly seen. When required the otolith examined may be turned upside down by means of a scalpel or pincers, or its position may be changed in order to obtain the clearest image of the growth zones. This could be helpful for examining thick otoliths of older fishes, or for detection of the first winter zone which is not quite visible from the outer (concave) side of the otolith.

4.6.3   Age reading criteria

The age determination differs in different seasons. In the first half of the year the age is determined as the number of opaque rings because the last hyaline ring becomes visible only in March-June. It would be the same if we would count the hyaline rings and add one year for the invisible hyaline ring on the edge of the otolith. The first winter zone has not often clearly distinctive contour and it could be detected by small differences in optical density of the neighbouring opaque zones.

In the second half of the year the age is determined as the number of hyaline rings. Usually it is the most difficult period of age reading. The formation of a new opaque summer zone for Baltic herring in Sd 26 takes place in the second half of the year and depends on hydrometeorological and feeding conditions and age of the fish. At first the opaque zone appears for one year old herring (in May-June) and then subsequently for older herring. Especially for older herring it is possible to mistake the opaque zone of the previous year as a new opaque zone and vice versa. Therefore it is necessary to have more or less regular sampling of herring in the period from July till September. The reading of the number of growth zones is performed on the postrostrum and sometimes on the rostrum of the otolith. In the last decade the age determination for older herring in Sd 26 is mainly possible on the rostrum because the growth rate of herring is very slow that has influenced also the size of otoliths and growth zones.

4.7   Sweden

4.7.1   Sampling and storing

Samples of herring otoliths (sagittae) are taken from commercial catches and during research cruises. The otoliths are put into plastic bags in which they will be stored after age determination. One sample consists of 50-100 pairs of herring otoliths with the protocol of standard biological data (length, weight, sex etc.). One sample of herring is taken every quarter of the year in each of the regions of Swedish economic zone (Sd 24, 25, 27 and 28, and very seldom in Sd 29S, 29N, 30 and 31) if possible. One sample from a commercial catch includes 4-5 subsamples, the herring is classified in different sizes and one subsample is taken from each size class.

4.7.2   Equipment and preparation of otoliths

Herring otoliths are examined under a stereo (binocular) microscope using incident light against a black background. Magnification 160x is used for otolith reading.

Both otoliths are placed into a small black cup immersed into alcohol, to obtain a clear image.

The outer concave surface of otoliths is normally used for age reading because on this side of otolith a nucleus and hyaline zones are most clearly seen. When required the otolith examined may be turned upside down by means of pincers or its position may be changed in order to obtain the clearest image of the growth zones. This could be helpful for examining thick otoliths of older fishes or for detection of the first winter zone which is often not quite visible from the outer (concave) side of otolith.

4.7.3 Age reading criteria

The age determination differs in different seasons. In the first half of the year we count the hyaline rings and add one year for the invisible hyaline ring on the edge of the otolith. The last hyaline ring becomes visible only in March-June. The first winter zone has not often clearly distinctive contour and it could be detected by small differences in optical density of neighbouring opaque zones.

In the second half of the year the age is determined as the number of hyaline rings. Usually it is the most difficult period for age reading. The formation of a new opaque summer zone for herring in the Swedish economic zone takes place in the second half of the year and depends on hydrometeorological and feeding conditions and age of the fish. At first the opaque zone appears for one year old herring and then subsequently for older herring. Especially for older herring it is possible to mistake the opaque zone of the previous year as a new opaque zone and vice versa. Therefore it is necessary to have more or less regular sampling of herring in the period from July till September (there is no sampling in July). The reading of the number of zones is from nucleus to postrostrum, or from nucleus to dorsal edge, or from nucleus to rostrum. The reading is repeated until agreement is reached. Where agreement cannot be reached the otoliths should be rejected as un-ageable (by optical microscopy alone).

In the last decade the age determination for older herring in the Swedish economic zone is mainly possible only on the rostrum because the growth rate of herring is very slow that has influenced also the size of otoliths and growth zones.

4.8 Summary for age determination protocols

4.8.1 Sampling and storing

The otoliths of Baltic herring are taken from the commercial and survey catches. The sampling of commercial catches in the most of the countries is performed on monthly basis covering different gears and Sub-divisions which belong to the economical zone of each country. In some countries a random sample is taken while others take samples per length-classes. The otoliths are stored in paper envelopes, plastic bags, black or clear plastic trays in which otoliths are covered with Canada balsam, eukitt or boat lacquer. The last method is more time consuming and requires good experience and skill for preparation of the samples, but ensures the best storing conditions. The shortcoming of this method is the movelessness of the otolith. Other storing methods allow to move the otolith during the ageing that is sometimes very essential to get the best image.

4.8.2 Equipment and preparation of otoliths

All laboratories involved examine the otoliths under a stereo microscope in reflected light against a dark background. The "free" otoliths are immersed in ethanol or in water while the otoliths which are placed in plastic plates and covered with Canada balsam or eukitt do not need additional preparation.

4.8.3 Age reading criteria

The age reading criteria are similar in all the laboratories. In the first half of the year the age is the total number of hyaline rings adding one hyaline ring on the edge of the otolith whether this ring is visible or not. In the second half of the year the age is the total number of hyaline rings. It was stressed by the most of the readers that in autumn it is often difficult to determine if an old herring has already started to grow or have the outermost opaque and hyaline zones formed during the previous year. This problem can be partly reduced having regular sampling of herring during the period of formation of the summer opaque zone. The formation of a new summer zone starts earlier in the southern regions of the Baltic sea and for the younger herring. In some cases for older herring it is also difficult to determine the first hyaline zones which are covered by the opaque substance in the central part of the otolith.

Three laboratories distinguish separate populations of Baltic herring within the economical zones of their countries. The distinction of populations is based on different structure of otoliths.

5   THE FIRST OTOLITH EXCHANGE

5.1   Description of the samples

The members of the study group prepared the samples of otoliths as follows:

Estonia	- 102 otoliths from Sd 32;
Finland	- 50 otoliths from Sd 29,
	- 50 otoliths from Sd 30,
	- 50 otoliths from Sd 31,
	- 50 otoliths from Sd 32;
Germany	- 100 otoliths from Sd 24;
Latvia	- 100 otoliths from Sd 28,
Poland	-63 otoliths from Sd 25,
	- 54 otoliths from Sd 26;
Russia	- 100 otoliths from Sd 26;
Sweden	- 50 otoliths from Sd 25,
	- 50 otoliths from Sd 27.

The otoliths were collected in the first half of the year in 1996. Estonia, Latvia, Russia and Sweden has put the otoliths into plastic bags. The otoliths of Finland and Poland were on a plastic plate covered with Canada balsam or eukitt, and Germany had "free" otoliths on a plate with holes. The samples have circulated clockwise between the countries: Estonia - Latvia - Russia - Poland - Germany - Sweden - Finland.

5.2   The preliminary results

The exchange is not yet completed and in the Report the results of age determination received till the 1st of June 1997 are presented (Tables 5.1.1-5.7.1.2). The age determination of the samples was performed by two readers from Latvia (independent results) and by one reader from other countries.

Inter-reader bias was examined for each sample using Wilcoxon signed ranks test and t-test as it was recommended in the report of the Workshop on Sampling Strategies for Age and Maturity (Anon. 1994). The results of inter-reader bias tests are presented in Tables 5.2.1-5.7.4. The comparison of results between Wilcoxon signed ranks test and t-test shows that t-test is a little bit severe in indication of the bias. The difference between both tests was revealed in 11 cases from 192.

The results of Wilcoxon signed ranks test show that from 192 combinations for all the samples in 93 cases (48.4%) a significant bias between the readers was observed. The percent of disagreement between the readers was especially high for Russian sample from Subdivision 26 (100%), German sample from Subdivision 24 (78.6%) and Latvian sample from Sd 28 (73.3%). The highest percent of agreement was obtained for otolith samples coming from the southern and central parts of the Baltic sea - Subdivisions 25-27.

The calculated mean age for each reader and each sample and coefficients of variation (CV) (Table 5.8) for each sample are in agreement with the results of Wilcoxon signed ranks test. The lowest coefficients of variation are received for Polish and Swedish samples coming from the southern and central parts of the Baltic sea where the size of the herring is higher as compared with herring from the eastern and northern parts, correspondingly the otoliths of this herring are bigger and easier readable. The highest coefficient of variation is for herring in Subdivision 24 that is not surprising because this herring comes from the western part of the Baltic sea and is not familiar for the largest part of the readers working in the central and north-eastern parts of the Baltic sea.

The preliminary results of the first otolith exchange show that significant differences exist between readers who determine the age of the Baltic herring. The reasons for these differences should be discussed at the Workshop and a common interpretation of age reading criteria should be obtained.

6   FURTHER PLANS OF THE STUDY GROUP

1. The second otolith exchange:

a) the second otolith exchange will be started on the 1st of September and should be completed till February 1998;

b) the samples will include otolith from herring caught during the hydroacoustic surveys in October or in the same period by the countries which do not perform hydroacoustic surveys;

c) this period was selected:
- to make closer the age determination of herring from the hydroacoustic surveys the results of which are used for the assessment of the common stock in the Central Baltic (Sd 25-29, 32),
- to compare the age reading during a period of herring growth and a maximum mixing between herring stocks;
- the countries should cover the same Sub-divisions as in the first exchange;

2. Plan for the Workshop:

a) it was decided by the members of the Study Group that the Workshop will take place in Riga in the end of February 1998;

b) the participants should prepare a review of Baltic herring biology taking into account the peculiarities of different regions in the Baltic sea;

c) the participants should prepare a reference collection of otoliths from different sub-divisions, seasons and length groups of Baltic herring covering their economic zones to reach a common interpretation of otolith structure;

d) the participants should analyse the results of two otolith exchanges they would have been completed till the Workshop:
- to determine the reasons for differences in age determination,
- to establish a common interpretation of age reading criteria;

e) the participants should discuss what material is necessary for the establishment of the protocol for the age determination of otoliths which could illustrate age-reading criteria.

3. The most of the Study group members consider that taking into account the existing differences in age determination it will be very difficult to solve all the problems and to complete all the tasks during one Workshop and propose to put in the plan of the Study Group the organization of the second Workshop in 1999.

7   REFERENCES

Anon., 1994. Report of the workshop on sampling strategies for age and maturity. ICES CM 1994/D:1, 1–21.

Table 5.1.1 Age reading results of Estonian otolith sample, Sd 32

N	Reader						
	1	2	3	4	5	7	8
1	4	5	-	4	5	4	-
2	4	6	-	4	5	5	-
3	5	5	5	5	6	5	5
4	5	4	4	4	5	4	3
5	4	4	4	4	5	4	4
6	4	4	4	4	4	4	3
7	5	5	5	5	6	5	5
8	2	2	2	2	3	2	2
9	4	4	3	4	4	4	3
10	4	4	4	3	4	4	3
11	5	5	5	4	6	5	3
12	7	7	6	5	7	6	4
13	8	6	6	6	8	7	4
14	4	4	4	4	5	4	4
15	5	4	3	4	4	4	-
16	4	4	4	4	4	4	3
17	4	4	4	3	4	5	4
18	7	5	5	5	5	7	3
19	5	5	5	5	5	5	4
20	4	4	4	3	4	4	3
21	5	5	5	5	6	5	5
22	6	6	6	6	6	6	3
23	6	6	5	5	5	6	4
24	3	3	3	2	3	3	2
25	7	5	6	6	7	6	3
26	4	3	4	3	4	4	3
27	3	3	4	3	3	3	2
28	7	7	6	5	6	7	3
29	3	3	4	3	3	3	3
30	3	3	3	3	3	3	2
31	2	2	3	2	3	2	2
32	4	4	4	3	3	4	-
33	5	5	5	5	5	5	4
34	6	6	5	6	6	6	4
35	3	3	3	3	4	3	3
36	3	3	4	3	5	3	3
37	4	4	4	4	4	4	3
38	4	4	4	4	5	4	4
39	3	3	4	2	3	3	2
40	5	4	5	5	4	6	3
41	5	5	5	5	4	5	4
42	4	4	4	4	4	4	3
43	7	5	6	6	6	7	4
44	5	5	5	4	5	5	3
45	4	4	4	4	5	4	4
46	4	4	4	4	4	4	3
47	7	7	6	7	6	7	4
48	4	4	4	4	4	4	3
49	5	5	5	5	5	5	3
50	5	5	5	5	5	5	3
51	4	4	4	4	4	4	3

Table 5.1.1 (continued)

N	Reader						
	1	**2**	**3**	**4**	**5**	**7**	**8**
52	2	2	3	2	2	2	2
53	4	4	4	4	4	4	4
54	4	4	4	4	4	4	3
55	4	4	4	4	4	4	3
56	4	6	4	4	6	5	3
57	7	7	7	7	7	7	5
58	7	8	6	6	7	7	3
59	4	4	4	4	5	4	3
60	9	9	8	7	11	9	4
61	2	2	2	2	2	2	2
62	4	4	4	4	5	4	4
63	4	4	4	4	4	4	3
64	4	4	4	4	5	4	4
65	5	5	5	5	6	5	3
66	6	7	6	6	6	6	3
67	4	4	4	4	4	4	4
68	6	5	5	5	5	6	4
69	7	8	7	7	7	8	7
70	7	6	5	6	6	6	4
71	4	4	4	4	4	4	3
72	3	3	3	3	3	3	2
73	5	4	4	4	5	5	3
74	4	4	4	4	4	4	3
75	4	4	4	4	4	4	3
76	3	3	3	3	3	3	3
77	5	5	5	5	5	5	4
78	5	5	6	5	6	5	4
79	7	7	5	6	6	6	4
80	5	4	5	5	5	5	3
81	3	3	3	3	3	3	3
82	4	4	4	4	3	4	3
83	3	3	4	3	3	3	3
84	3	3	3	3	3	3	2
85	4	4	5	3	4	4	3
86	5	7	5	5	5	6	4
87	7	7	7	6	6	7	4
88	7	7	7	6	7	7	6
89	4	4	4	4	4	4	3
90	6	6	6	6	5	6	4
91	4	4	4	4	4	4	3
92	4	5	5	5	4	4	3
93	6	5	6	6	6	6	4
94	3	3	3	3	4	3	3
95	2	2	3	2	2	2	2
96	4	4	4	4	4	4	4
97	3	3	3	3	3	3	3
98	3	3	3	3	3	3	3
99	10	5	5	4	6	6	3
100	6	6	6	6	5	6	4
101	4	3	3	2	3	3	2
102	3	3	3	3	3	3	3

Table 5.1.2 Inter-reader bias test (Wilcoxon test) of Estonian sample (Sd 32) (n=102)

Reader	1	2	3	4	5	7	8
1		97(23)	143(31)	12(30)	355.5(39)	45(15)	0(64)
2	-		224(31)	60(28)	333.5(43)	85.5(21)	0(69)
3	*	-		90(31)	322.5(45)	155(31)	0(74)
4	**	**	**		143.5(47)	13(30)	19(61)
5	-	-	*	**		345(41)	0(81)
7	-	-	-	**	-		0(75)
8	**	**	**	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.1.3 Inter reader bias test (t-test) of Estonian sample (Sd 32) (n=102)

Reader	1	2	3	4	5	7	8
1		1.48	2.20	4.69	0.37	1.09	11.20
2	-		0.45	4.34	2.07	1.10	10.18
3	*	-		3.68	1.20	1.93	12.56
4	**	**	**		5.26	5.52	10.00
5	-	*	-	**		1.24	11.88
7	-	-	-	**	-		10.98
8	**	**	**	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.2.1.1 Age reading results of Finnish otolith sample, Sd 29

N	Reader					
	1	**2**	**4**	**5**	**6**	**7**
1	4	4	4	4	4	4
2	6	6	5	6	6	6
3	4	4	4	5	4	4
4	2	2	2	2	2	2
5	5	5	5	6	5	5
6	6	5	5	7	6	5
7	3	3	3	4	3	3
8	5	5	5	6	5	5
9	5	5	5	7	5	5
10	6	6	6	6	6	5
11	7	7	7	8	7	7
12	3	3	3	4	3	3
13	4	4	4	6	4	4
14	6	7	7	7	7	7
15	6	6	7	7	7	6
16	6	6	6	7	6	6
17	6	4	4	7	6	5
18	3	3	3	4	3	3
19	7	6	5	8	7	6
20	5	6	6	7	4	5
21	4	4	4	5	4	4
22	6	5	5	6	6	5
23	4	3	3	4	3	3
24	8	5	7	8	8	7
25	3	3	3	4	3	3
26	6	5	5	7	7	6
27	4	4	4	5	4	4
28	6	6	6	7	6	4
29	6	5	6	6	6	6
30	4	5	5	6	5	6
31	5	5	5	6	5	5
32	5	5	5	5	5	5
33	4	4	4	4	4	4
34	4	4	4	6	4	4
35	4	4	4	5	4	4
36	7	5	7	7	6	7
37	5	5	5	6	5	5
38	3	3	3	4	3	3
39	4	4	4	5	4	4
40	4	4	4	5	4	4
41	8	6	7	8	9	7
42	5	5	5	5	5	5
43	8	7	7	7	7	9
44	4	4	4	4	4	4
45	5	6	5	7	7	7
46	5	5	4	6	5	4
47	5	6	6	7	5	6
48	8	7	7	8	8	8
49	12	10	9	10	12	10
50	3	3	3	4	3	3

Table 5.2.1.2 Age reading results of Finnish otolith sample, Sd 30

N	Reader					
	1	**2**	**4**	**5**	**6**	**7**
1	4	4	3	6	4	4
2	7	7	6	9	8	6
3	4	4	4	4	4	4
4	6	6	6	8	6	6
5	4	3	4	5	4	4
6	5	5	5	6	5	5
7	4	4	4	6	4	4
8	3	3	3	4	3	3
9	3	2	2	3	2	3
10	7	9	9	10	10	9
11	3	3	3	3	3	3
12	4	3	4	5	4	4
13	2	2	2	3	2	2
14	4	4	4	6	4	4
15	5	5	5	7	5	5
16	5	7	5	7	7	5
17	2	2	2	3	2	2
18	7	-	5	9	6	8
19	6	6	5	8	5	5
20	6	6	6	8	7	6
21	2	2	2	3	2	3
22	3	3	3	4	3	3
23	7	7	7	9	8	7
24	4	5	4	6	6	5
25	5	6	5	6	5	5
26	4	4	4	4	4	4
27	4	4	4	6	4	4
28	7	6	7	7	8	7
29	5	4	4	5	5	4
30	3	3	3	6	3	4
31	5	5	5	6	5	5
32	2	2	2	2	2	2
33	4	3	4	6	4	4
34	5	6	5	6	5	5
35	5	5	5	6	5	4
36	2	2	2	3	2	2
37	4	5	5	7	5	7
38	5	5	5	6	5	4
39	4	4	4	5	4	4
40	5	5	5	6	5	5
41	6	6	5	7	6	6
42	3	3	3	6	3	3
43	4	4	4	6	4	5
44	5	4	5	5	5	5
45	4	4	4	5	4	5
46	2	2	2	2	2	2
47	6	6	6	7	6	6
48	3	2	3	4	3	3
49	6	6	6	6	6	6
50	4	2	3	4	3	4

Table 5.2.1.3 Age reading results of Finnish otolith sample, Sd 31

N	Reader					
	1	**2**	**4**	**5**	**6**	**7**
1	1	1	1	1	1	1
2	3	-	2	2	2	2
3	2	2	1	2	2	2
4	2	2	1	2	2	2
5	4	3	3	3	3	3
6	3	4	3	3	3	3
7	4	4	4	4	4	4
8	2	3	2	3	2	3
9	2	2	2	2	2	3
10	3	3	3	4	3	3
11	2	2	2	2	2	2
12	5	5	5	5	5	5
13	2	2	2	4	2	2
14	6	7	6	7	7	7
15	2	2	1	2	2	2
16	4	4	4	6	4	3
17	4	4	4	6	4	4
18	6	6	6	7	6	6
19	2	2	2	3	2	2
20	4	4	4	5	4	4
21	3	3	2	3	3	2
22	2	2	2	2	2	2
23	2	2	2	2	2	2
24	2	2	2	3	2	2
25	2	2	2	3	2	2
26	2	2	2	3	2	3
27	2	2	2	4	2	3
28	2	2	2	2	2	2
29	3	3	3	5	3	3
30	2	2	1	2	2	2
31	2	3	2	5	2	3
32	3	3	3	4	3	4
33	2	2	2	2	2	2
34	2	2	2	3	2	3
35	2	2	2	3	2	2
36	4	4	4	5	4	4
37	2	2	2	3	2	3
38	4	4	4	5	4	4
39	2	2	2	2	2	3
40	2	2	2	2	2	2
41	2	2	2	3	2	2
42	2	2	2	2	2	2
43	3	3	3	4	3	3
44	2	2	2	3	2	2
45	2	2	2	3	2	2
46	4	4	4	5	4	4
47	6	-	5	8	6	4
48	6	6	6	7	8	6
49	6	6	5	6	5	5
50	10	8	9	10	9	9

Table 5.2.1.4 Age reading results of Finnish otolith sample, Sd 32

N	Reader					
	1	2	4	5	6	7
1	3	3	3	4	3	3
2	3	3	3	4	3	4
3	4	4	4	4	4	4
4	4	-	4	4	4	3
5	3	-	3	4	3	3
6	3	3	3	4	3	3
7	4	4	4	6	4	4
8	5	5	4	6	5	4
9	4	4	4	6	4	4
10	5	3	3	5	4	4
11	2	2	2	2	2	2
12	4	4	3	5	4	4
13	2	2	2	3	2	2
14	5	4	4	5	5	4
15	5	3	4	6	4	5
16	5	5	5	7	5	5
17	4	4	3	4	4	4
18	5	5	4	6	4	4
19	5	4	4	5	4	4
20	4	4	4	5	4	4
21	4	4	4	4	3	3
22	2	2	2	2	2	2
23	3	3	3	4	3	4
24	4	3	3	4	4	4
25	4	4	3	5	3	4
26	5	4	4	5	5	4
27	2	2	2	2	2	2
28	3	3	3	3	3	3
29	2	2	2	2	2	3
30	5	4	4	5	5	4
31	5	3	4	6	5	4
32	7	6	5	7	5	5
33	3	3	2	2	2	2
34	4	-	4	4	5	3
35	3	3	3	3	3	3
36	7	5	5	7	5	7
37	5	5	5	6	5	5
38	5	5	4	5	5	5
39	4	4	4	5	4	4
40	5	4	5	4	5	4
41	2	2	2	2	2	2
42	4	4	4	5	4	4
43	3	3	3	3	3	3
44	4	4	4	5	4	4
45	2	2	2	2	2	2
46	1	1	1	1	1	1
47	2	2	2	3	2	2
48	4	3	4	5	4	4
49	5	5	4	6	4	5
50	4	4	4	6	4	5

Table 5.2.2 Inter-reader bias test (Wilcoxon test) of Finnish sample A (Sd 29) (n=50)

Reader	1	2	4	5	6	7
1		35(18)	40(18)	45.5(35)	20(10)	48.5(16)
2	*		20.5(10)	0(39)	16.5(14)	29(14)
4	*	-		0(38)	20.5(15)	28.5(13)
5	**	**	**		44(33)	31(36)
6	-	*	*	**		43.5(17)
7	-	-	-	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.2.3 Inter-reader bias test (t-test) of Finnish sample A (Sd 29) (n=50)

Reader	1	2	4	5	6	7
1		2.37	2.20	6.49	0.83	1.14
2	*		0.49	12.29	3.09	1.37
4	*	-		9.33	2.46	1.29
5	**	**	**		5.86	7.29
6	-	**	*	**		1.70
7	-	-	-	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.2.4 Inter-reader bias test (Wilcoxon test) of Finnish sample B (Sd 30) (n=50)

Reader	1	2	4	5	6	7
1		54(15)	14(10)	0(39)	20(12)	30(13)
2	-		52.5(15)	0(40)	24(16)	73(20)
4	-	-		0(42)	0(11)	12(13)
5	**	**	**		13.5(39)	0(37)
6	-	*	**	**		78(18)
7	-	-	*	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.2.5 Inter-reader bias test (t-test) of Finnish sample B (Sd 30) (n=50)

Reader	1	2	4	5	6	7
1		0.40	1.52	9.84	1.60	1.36
2	-		0.47	11.00	2.67	1.31
4	-	-		9.60	3.46	2.58
5	**	**	**		8.50	9.11
6	-	**	**	**		0.36
7	-	**	*	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.2.6 Inter-reader bias test (Wilcoxon test) of Finnish sample C (Sd 31) (n=50)

Reader	1	2	4	5	6	7
1		7.5(5)	0(10)	24(30)	9(6)	68(17)
2	-		6(11)	10.5(27)	3(5)	26(12)
4	**	*		0(35)	0(8)	17(16)
5	**	**	**		11.5(29)	22(27)
6	-	-	**	**		37(13)
7	-	-	**	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.2.7 Inter-reader bias test (t-test) of Finnish sample C (Sd 31) (n=50)

Reader	1	2	4	5	6	7
1		0.35	3.51	5.86	0.33	0.44
2	-		2.91	6.15	0.46	1.15
4	**	**		8.30	2.90	3.29
5	**	**	**		6.36	4.92
6	-	-	**	**		0.68
7	-	-	**	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.2.8 Inter-reader bias test (Wilcoxon test) of Finnish sample D (Sd 32) (n=50)

Reader	1	2	4	5	6	7
1		0(12)	0(18)	23(26)	5(11)	25.5(17)
2	**		28(13)	12(32)	45(15)	35(15)
4	**	-		11(35)	6.5(12)	34(17)
5	**	**	**		22(31)	13(32)
6	*	-	**	**		68(16)
7	*	-	*	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.2.9 Inter reader bias test (t-test) of Finnish sample D (Sd 32) (n=50)

Reader	1	2	4	5	6	7
1		3.66	4.88	5.20	2.86	2.62
2	**		1.32	7.02	0.94	1.81
4	**	-		8.10	3.13	2.33
5	**	**	**		6.32	7.25
6	**	-	**	**		0
7	**	-	*	**	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.3.1 Age reading results of German otolith sample, Sd 24

N	Reader							
	1	2	3	4	5	6	7	8
1	3	3	3	3	5	2	4	3
2	2	2	2	2	4	2	4	2
3	2	2	2	2	5	2	4	2
4	2	3	2	2	5	2	4	2
5	2	2	2	2	4	2	2	2
6	3	3	3	3	6	3	4	3
7	3	3	3	4	5	2	4	3
8	2	2	2	2	6	2	4	2
9	4	3	4	3	6	2	4	3
10	4	4	4	3	5	2	5	3
11	4	3	3	3	6	3	5	3
12	3	3	3	3	-	2	4	3
13	3	3	3	3	5	2	3	3
14	5	4	4	4	6	3	5	3
15	3	3	3	3	6	2	4	3
16	7	5	3	6	7	2	6	3
17	3	3	3	3	5	2	4	3
18	4	4	3	3	6	3	5	3
19	4	3	3	3	4	3	5	4
20	3	3	3	3	5	2	4	3
21	3	3	3	3	5	3	4	3
22	4	3	4	3	5	2	4	3
23	3	3	3	3	6	2	4	3
24	3	3	3	3	6	2	4	3
25	4	3	4	4	5	3	4	3
26	4	3	4	3	6	3	5	4
27	4	3	3	3	6	3	4	3
28	3	3	3	3	6	2	4	3
29	3	3	3	3	6	3	4	3
30	4	3	4	4	6	2	4	3
31	3	3	3	3	6	3	4	4
32	4	3	4	3	7	3	5	3
33	3	3	3	3	6	3	4	3
34	4	5	4	3	6	3	5	4
35	4	3	3	3	6	2	5	3
36	3	2	3	2	6	2	3	3
37	3	3	3	3	6	3	4	3
38	4	3	3	2	6	2	5	3
39	4	3	4	3	7	3	5	4
40	8	6	7	5	8	4	7	4
41	3	3	4	4	7	3	5	3
42	4	3	4	3	7	2	4	3
43	4	3	3	3	6	3	4	3
44	3	3	4	2	7	3	6	3
45	3	3	3	3	6	2	5	3
46	5	4	4	3	8	3	5	4
47	4	3	4	4	8	3	5	3
48	6	6	4	4	8	3	6	4
49	3	3	3	3	-	2	4	2
50	3	3	3	2	6	2	4	3

Table 5.3.1 (continued)

N	Reader							
	1	2	3	4	5	6	7	8
51	6	6	6		7	5	5	4
52	4	6	4		6	3	6	4
53	4	3	4		7	2	5	4
54	4	3	4		7	3	5	3
55	4	3	4		7	3	5	4
56	4	4	4		7	3	5	4
57	3	3	3		7	3	5	4
58	6	6	6		8	5	6	5
59	4	3	4		7	3	4	3
60	5	4	4		6	3	5	4
61	3	4	3		6	3	4	4
62	4	4	4		6	3	5	4
63	3	2	4		6	2	4	3
64	5	6	6		7	6	7	5
65	4	4	4		7	4	4	4
66	3	3	4		6	3	4	3
67	6	5	6		8	5	5	4
68	8	7	7		8	7	8	7
69	4	3	4		8	3	4	4
70	6	3	7		8	5	6	5
71	6	5	6		7	5	7	8
72	5	6	5		8	5	5	5
73	5	5	6		7	4	5	4
74	5	4	5		7	5	5	4
75	4	4	4		6	3	4	3
76	5	3	5		7	4	4	4
77	5	4	5		8	5	5	5
78	6	6	6		8	6	6	5
79	6	6	6		7	5	6	5
80	5	5	5		7	5	5	5
81	5	5	5		7	5	5	6
82	6	7	6		8	6	6	5
83	6	6	6		7	6	6	6
84	5	5	6		8	5	6	5
85	5	4	6		7	5	5	4
86	5	5	6		7	5	5	6
87	5	5	5		6	5	5	5
88	5	5	5		7	5	5	5
89	7	7	7		7	7	7	7
90	6	6	6		7	6	6	4
91	5	5	9		7	8	5	6
92	6	6	6		7	5	6	5
93	6	7	6		8	6	7	6
94	8	8	6		8	6	7	5
95	6	6	7		9	8	6	5
96	6	7	6		8	6	6	6
97	5	8	7		8	5	5	6
98	9	8	6		9	5	10	5
99	9	10	10		9	9	9	12
100			10			9		9

* age reader 4 has determined the age only for the first 50 otoliths

Table 5.3.2 Inter-reader bias test (Wilcoxon test) of German sample (Sd 24) (n=100)

Reader	1	2	3	4	5	6	7	8
1		279(47)	205.5(30)	22(25)	0(89)	134.5(63)	141(56)	229(50)
2	**		369(46)	45(16)	8.5(92)	233.5(55)	229(74)	377(46)
3	-	-		23(16)	37(95)	27(64)	348.5(67)	170(46)
4	**	-	*		0(48)	12(26)	0(44)	95(19)
5	**	**	**	**		4.5(95)	32(89)	61.5(96)
6	**	**	**	**	**		118(79)	349(54)
7	**	**	**	**	**	**		225.5(83)
8	**	-	**	-	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (P<0.01)
figures in the cells: T value (number of differences)

Table 5.3.3 Inter-reader bias test (t-test) of German sample (Sd 24) (n=100)

Reader	1	2	3	4	5	6	7	8
1		3.27	0.56	4.81	21.80	7.38	7.09	4.25
2	**		2.22	1.29	19.84	5.20	8.65	1.80
3	-	*		2.29	20.91	10.72	5.65	4.82
4	**	-	*		20.83	5.23	11.86	0.19
5	**	**	**	**		24.58	17.42	22.20
6	**	**	**	**	**		10.55	3.75
7	**	**	**	**	**	**		9.90
8	**	-	**	-	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (P<0.01)
figures in the cells: t value

Table 5.4.1 Age reading results of Latvian otolith sample, Sd 28

N	Reader					
	1	2	3	4	5	8
1	6	5	5	5	5	4
2	4	4	4	4	4	3
3	6	6	6	5	6	4
4	6	6	6	6	7	4
5	4	4	4	4	4	4
6	5	5	5	5	5	4
7	2	2	3	2	2	2
8	7	5	5	6	6	4
9	6	6	5	5	6	3
10	6	6	6	6	6	4
11	5	5	5	5	6	5
12	7	7	7	7	7	4
13	3	3	3	3	4	3
14	6	6	6	6	5	4
15	5	5	5	5	5	4
16	5	5	5	5	5	3
17	4	4	4	4	4	4
18	4	4	4	4	5	4
19	4	4	4	3	3	3
20	5	5	5	4	5	4
21	4	4	4	4	4	3
22	4	4	4	3	5	3
23	6	5	5	5	6	4
24	6	5	6	6	6	4
25	4	4	4	4	5	4
26	5	5	4	5	6	4
27	8	8	5	7	8	-
28	2	2	3	2	2	2
29	6	6	5	6	6	3
30	5	5	5	5	5	3
31	5	6	5	5	5	4
32	2	2	3	2	2	2
33	7	6	6	6	6	4
34	6	6	6	6	6	5
35	5	5	5	5	5	4
36	6	6	5	6	6	5
37	5	5	5	5	5	4
38	12	12	9	10	8	9
39	7	6	6	6	6	6
40	7	7	6	5	7	4
41	5	5	5	6	5	6
42	3	3	3	3	3	3
43	4	4	4	4	5	4
44	4	4	4	4	4	4
45	6	6	5	6	6	4
46	3	3	3	3	3	3
47	6	6	6	6	6	3
48	2	2	2	2	2	2
49	4	4	4	4	4	4
50	7	7	8	5	8	4

Table 5.4.1 (continued)

N	Reader					
	1	**2**	**3**	**4**	**5**	**8**
51	9	8	6	7	9	4
52	6	5	7	6	6	4
53	8	7	7	8	9	-
54	4	4	4	4	5	4
55	6	6	6	6	7	5
56	4	4	4	4	4	4
57	11	11	8	9	10	7
58	3	3	3	3	4	3
59	6	6	6	7	7	4
60	6	6	5	5	6	4
61	5	5	5	4	5	4
62	7	7	7	7	7	6
63	7	7	7	7	7	6
64	6	6	6	6	6	4
65	2	2	3	2	2	2
66	5	5	5	5	5	4
67	4	4	4	4	5	4
68	5	5	5	5	5	4
69	4	4	5	4	4	3
70	5	5	5	5	6	5
71	2	2	3	2	2	2
72	4	4	4	4	5	4
73	2	2	2	2	2	2
74	2	2	3	2	3	2
75	2	2	2	2	2	2
76	8	8	7	7	7	3
77	2	2	2	2	2	2
78	7	7	6	6	7	4
79	7	7	8	7	7	3
80	9	8	7	7	6	5
81	10	9	7	8	8	5
82	7	7	6	6	6	5
83	7	7	7	7	7	5
84	7	7	7	7	8	7
85	7	7	6	6	6	5
86	3	3	3	3	3	3
87	8	8	7	7	8	5
88	7	7	6	7	6	4
89	5	5	5	6	5	4
90	4	4	4	4	4	4
91	6	6	7	6	6	6
92	3	3	3	3	3	3
93	2	2	2	2	2	2
94	4	4	4	4	4	4
95	7	7	7	7	7	5
96	3	3	4	3	4	3
97	4	4	4	4	4	4
98	7	6	6	6	7	4
99	4	4	4	4	5	4
100	4	4	4	4	4	5

Table 5.4.2 Inter-reader bias test (Wilcoxon test) of Latvian sample (Sd 28) (n=100)

Reader	1	2	3	4	5	8
1		6.5(13)	192(38)	34.5(29)	320(34)	23(61)
2	**		197(33)	87.5(28)	236.5(38)	26(58)
3	**	-		256(33)	273(46)	37(65)
4	**	**	-		124(39)	13(71)
5	-	-	**	**		55.5(70)
8	**	**	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.4.3 Inter-reader bias test (t-test) of Latvian sample (Sd 28) (n=100)

Reader	1	2	3	4	5	8
1		3.19	2.95	4.69	0.13	8.99
2	**		1.75	2.95	1.71	8.76
3	**	-		0.60	3.38	9.53
4	**	**	-		4.49	8.80
5	-	-	**	**		10.33
8	**	**	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.5.1.1 Age reading results of Polish otolith sample, Sd 25

N	Reader						
	1	2	3	4	6	7	8
1	2	2	2	2	2	2	2
2	2	2	3	2	2	2	2
3	4	4	4	4	4	4	4
4	2	3	3	2	2	3	3
5	3	3	4	3	3	3	3
6	2	2	3	2	2	3	2
7	5	5	5	5	5	5	4
8	4	4	4	4	4	4	4
9	5	5	6	5	5	5	5
10	4	5	5	3	5	5	4
11	5	5	5	5	5	4	5
12	6	5	6	5	5	4	6
13	4	4	5	4	4	4	4
14	6	5	6	5	6	5	5
15	6	6	6	6	6	6	6
16	4	4	4	4	4	4	5
17	7	6	7	5	7	6	5
18	4	4	5	4	4	5	4
19	6	5	5	6	5	5	5
20	6	6	6	6	7	6	6
21	6	6	6	6	6	5	5
22	5	6	5	4	6	5	6
23	4	3	5	3	4	4	3
24	5	6	6	5	5	6	-
25	4	4	4	4	4	4	4
26	5	4	6	4	5	4	5
27	3	4	4	4	4	4	4
28	4	4	4	4	4	4	4
29	5	5	5	5	6	5	5
30	5	5	5	5	5	5	6
31	4	4	5	4	4	4	4
32	4	4	5	4	5	4	5
33	4	4	4	4	4	4	4
34	3	3	4	3	3	3	4
35	5	5	5	5	6	6	5
36	4	4	5	6	8	7	5
37	4	4	5	4	4	4	4
38	4	4	4	4	4	4	4
39	3	4	5	4	5	5	5
40	4	6	6	5	6	6	6
41	5	6	6	6	6	6	6
42	7	7	7	7	7	7	7
43	8	7	7	7	8	8	8
44	4	4	4	4	4	4	4
45	4	5	5	4	5	4	4
46	4	6	6	6	6	5	5
47	5	5	5	5	5	5	5
48	4	4	5	4	4	4	4
49	4	4	4	4	4	4	4
50	7	7	7	7	7	7	7
51	3	4	-	4	4	4	-

Table 5.5.1.1 (continued)

N	Reader						
	1	2	3	4	6	7	8
52	4	6	6	6	7	6	6
53	4	4	5	4	4	4	4
54	7	8	9	9	9	8	9
55	7	7	7	7	7	7	7
56	6	6	6	6	6	6	6
57	7	7	7	7	7	7	7
58	5	6	6	6	7	6	5
59	4	6	4	4	4	6	4
60	4	4	4	5	4	4	5
61	4	4	5	4	4	4	4
62	4	4	5	4	4	4	4
63	3	3	4	3	3	3	3

Table 5.5.1.2 Age reading results of Polish otolith sample, Sd 26

N	Reader						
	1	2	3	4	6	7	8
1	4	4	5	4	4	4	4
2	5	5	5	5	5	4	4
3	6	-	-	4	5	5	-
4	4	4	4	4	4	4	4
5	6	6	6	5	6	6	4
6	8	8	7	9	5	7	7
7	6	-	-	6	5	6	-
8	6	6	6	6	6	6	5
9	5	4	4	4	4	4	4
10	4	4	4	4	4	4	4
11	5	5	6	5	5	5	5
12	4	4	4	4	4	4	4
13	4	4	5	4	4	4	4
14	6	5	5	5	5	5	5
15	5	5	5	5	5	5	5
16	4	4	4	4	4	4	4
17	5	4	5	4	4	4	4
18	7	6	6	5	8	6	5
19	7	6	7	5	8	7	6
20	4	4	5	4	4	4	4
21	9	8	7	9	9	8	6
22	3	3	4	3	3	4	3
23	6	6	6	6	6	6	6
24	4	4	4	4	4	4	4
25	3	3	4	3	3	3	3
26	5	5	6	5	5	5	4
27	5	5	4	5	5	5	5
28	6	6	6	6	6	6	6
29	3	3	5	3	3	4	3
30	6	6	6	6	6	6	5
31	5	5	5	5	10	5	5
32	5	5	5	5	5	5	5
33	6	5	5	5	5	6	6
34	5	5	5	5	5	5	5

Table 5.5.1.2 (continued)

N	Reader						
	1	**2**	**3**	**4**	**6**	**7**	**8**
35	6	6	6	5	5	5	5
36	5	5	5	5	5	5	5
37	6	5	6	5	5	5	5
38	4	4	5	4	4	4	4
39	7	6	7	7	7	6	6
40	6	5	6	6	7	6	5
41	5	5	6	6	6	5	5
42	5	4	6	5	5	5	5
43	4	5	4	4	4	4	5
44	5	5	6	5	5	5	5
45	6	6	6	6	7	6	5
46	5	5	5	5	6	5	5
47	6	6	6	6	6	6	6
48	6	6	6	6	7	7	6
49	5	6	5	6	6	6	6
50	4	4	5	5	4	7	5
51	4	4	5	4	4	4	4
52	5	5	5	5	5	5	5
53	4	4	4	4	4	4	4
54	5	5	5	5	5	4	4

Table 5.5.2 Inter-reader bias test (Wilcoxon test) of Polish sample (Sd 25) (n=63)

Reader	1	2	3	4	6	7	8
1		66.5(22)	28(32)	69.5(19)	13(19)	78(24)	61.5(21)
2	-		35.5(25)	24(12)	32(17)	53(14)	85.5(19)
3	**	**		40.5(30)	121.5(27)	75(27)	67.5(28)
4	-	-	**		16(19)	70(21)	54(18)
6	**	*	-	**		67(21)	54(20)
7	*	-	**	-	-		100(20)
8	-	-	**	-	-	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.5.3 Inter-reader bias test (t test) of Polish sample (Sd 25) (n=63)

Reader	1	2	3	4	6	7	8
1		2.11	6.02	1.03	3.61	2.27	2.05
2	*		4.22	1.23	2.26	0.63	0.43
3	**	**		5.11	1.54	3.19	4.94
4	-	-	**		3.75	1.73	1.55
6	**	*	-	**		2.45	2.12
7	*	-	**	-	*		0.18
8	*	-	**	-	*	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.5.4 Inter-reader bias test (Wilcoxon test) of Polish sample (Sd 26) (n=54)

Reader	1	2	3	4	6	7	8
1		14(13)	80.5(21)	24(14)	85(18)	51(17)	19(21)
2	*		57.5(24)	32.5(12)	23(14)	32.5(13)	19.5(14)
3	-	**		60(22)	256.5(27)	80.5(23)	58(31)
4	-	-	*		20(12)	46.5(15)	21(15)
6	-	-	-	-		58.5(17)	34.5(20)
7	-	-	-	-	-		6(14)
8	**	*	**	*	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: T value (number of differences)

Table 5.5.5 Inter-reader bias test (t test) of Polish sample (Sd 26) (n=54)

Reader	1	2	3	4	6	7	8
1		2.54	1.31	1.93	0.28	0.97	3.40
2	*		3.05	0.55	1.71	1.06	2.24
3	-	**		2.52	0.38	2.15	4.90
4	-	-	*		1.43	0.81	2.37
6	-	-	-	-		0.95	2.84
7	-	-	*	-	-		3.46
8	**	*	**	*	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01); figures in the cells: t value

Table 5.6.1 Age reading results of Russian otolith sample, Sd 26.

N	Reader			
	3	**4**	**5**	**8**
1	5	5	6	5
2	8	7	7	4
3	5	5	5	5
4	4	4	5	4
5	3	3	3	3
6	2	2	2	2
7	3	3	4	3
8	3	3	3	3
9	4	3	4	3
10	6	5	7	5
11	5	5	5	3
12	4	3	4	3
13	3	3	3	3
14	4	4	4	3
15	5	5	5	5
16	6	6	6	4
17	3	3	3	3
18	5	4	6	4
19	7	6	8	5
20	4	3	5	3
21	4	4	6	4
22	3	3	4	3
23	3	3	3	3
24	4	4	4	4
25	3	3	3	3
26	5	4	7	4
27	3	3	3	3
28	2	2	2	2
29	3	3	5	3
30	4	4	6	4
31	3	3	3	3
32	4	4	4	4
33	5	5	6	5
34	3	2	2	2
35	3	3	3	3
36	6	5	6	4
37	3	3	3	3
38	4	4	4	3
39	4	4	4	4
40	5	4	5	4
41	5	5	6	4
42	5	5	6	5
43	3	3	3	5
44	3	3	3	3
45	3	3	5	3
46	7	6	8	6
47	6	5	6	5
48	8	5	9	5
49	4	4	4	4
50	8	6	7	5
51	5	6	7	4
52	7	8	9	5

Table 5.6.1 (continued)

N	Reader 3	4	5	8
53	4	4	5	4
54	2	2	2	2
55	4	4	5	4
56	6	5	6	6
57	1	1	1	1
58	6	7	7	5
59	5	4	5	4
60	6	6	7	5
61	8	8	8	5
62	4	3	4	3
63	2	2	2	2
64	7	9	8	5
65	3	3	3	3
66	2	2	3	2
67	6	5	7	5
68	3	3	3	3
69	2	2	2	2
70	5	5	5	5
71	5	5	5	4
72	4	4	5	3
73	5	5	6	4
74	6	6	6	5
75	5	5	5	4
76	3	2	2	2
77	8	8	9	5
78	5	6	6	4
79	5	5	6	4
80	3	2	5	2
81	5	5	5	4
82	5	5	8	5
83	5	5	5	4
84	7	7	8	6
85	6	6	7	5
86	2	2	2	2
87	3	3	3	3
88	4	4	5	3
89	4	4	5	4
90	7	6	9	5
91	4	4	5	4
92	7	7	8	5
93	5	5	5	5
94	4	4	4	4
95	7	8	8	6
96	4	5	5	5
97	4	4	4	4
98	4	3	4	3
99	6	5	6	4
100	6	5	6	5

Table 5.6.2 Inter-reader bias test (Wilcoxon test) of Russian sample (Sd 26) (n=100)

	3	4	5	8
3		120.5(32)	70(44)	61.5(52)
4	**		18.5(51)	35(34)
5	**	**		39.5(65)
8	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01)
figures in the cells: T value (number of differences)

Table 5.6.3 Inter-reader bias test (t-test) of Russian sample (Sd 26) (n=100)

	3	4	5	8
3		3.08	6.76	7.28
4	**		7.87	5.00
5	**	**		10.00
8	**	**	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01)
figures in the cells: t value

Table 5.7.1.1 Age reading results of Swedish otolith sample, Sd 25

N	Reader				
	1	2	6	7	8
1	2	2	2	2	2
2	2	2	2	2	2
3	2	2	2	2	2
4	2	2	2	2	2
5	3	3	3	3	3
6	5	5	2	5	4
7	3	3	3	3	3
8	2	2	2	3	2
9	2	3	3	3	2
10	1	1	2	2	1
11	2	2	2	2	2
12	4	4	4	5	4
13	5	4	5	5	4
14	4	4	2	4	4
15	2	2	2	4	3
16	2	2	2	3	2
17	3	3	3	4	3
18	4	4	4	4	4
19	4	4	4	4	4
20	5	5	5	5	5
21	4	4	4	4	4
22	4	4	4	4	4
23	3	3	3	4	3
24	4	4	4	4	4
25	4	4	4	4	4
26	3	3	3	3	3
27	5	5	5	5	5
28	6	6	6	6	6
29	4	5	5	5	4
30	4	4	4	4	4
31	6	6	6	6	6
32	3	3	3	4	3
33	7	7	7	7	7
34	6	6	6	6	5
35	6	6	6	5	4
36	8	7	8	7	7
37	6	6	6	7	5
38	3	3	3	4	3
39	5	5	5	5	5
40	3	3	3	5	4
41	8	9	11	8	5
42	3	3	3	4	3
43	6	6	7	5	7
44	6	7	8	7	6
45	4	4	4	4	4
46	3	3	3	3	3
47	6	6	6	6	6
48	7	7	6	5	6
49	5	6	5	6	6
50	4	4	4	4	4

Table 5.7.1.2 Age reading results of Swedish otolith sample, Sd 27

N	Reader				
	1	2	6	7	8
1	2	2	2	2	2
2	3	3	3	2	3
3	2	2	2	2	2
4	3	3	3	3	3
5	3	3	3	3	3
6	3	3	3	3	3
7	3	3	3	3	3
8	4	4	4	4	4
9	4	4	4	4	4
10	3	3	3	3	3
11	3	3	3	3	3
12	4	4	4	3	4
13	3	3	3	3	3
14	6	6	6	6	5
15	3	3	3	3	3
16	3	3	3	3	3
17	4	4	4	4	4
18	4	4	4	4	4
19	5	5	5	5	5
20	4	4	4	4	4
21	6	6	6	5	6
22	5	5	4	5	4
23	6	6	5	6	5
24	7	8	9	8	6
25	6	8	6	6	5
26	6	7	5	5	4
27	7	7	7	5	5
28	6	5	5	5	4
29	10	11	10	10	9
30	6	6	6	6	6
31	7	8	6	6	5
32	9	8	8	8	6
33	7	7	7	7	7
34	8	8	8	8	8
35	9	9	8	8	8
36	10	10	10	10	10
37	2	2	2	2	2
38	2	2	2	2	2
39	3	3	3	3	3
40	4	5	4	4	4
41	3	3	3	3	3
42	3	3	3	3	3
43	8	7	8	7	8
44	8	8	8	7	8
45	6	6	6	6	6
46	5	5	5	5	5
47	9	8	8	8	9
48	9	8	8	8	8
49	8	7	7	7	8
50	12	9	10	12	9

Table 5.7.2 Inter-reader bias test (Wilcoxon test) of Swedish sample (Sd 25) (n=50)

Reader	1	2	6	7	8
1		8(7)	18(9)	46(20)	22(12)
2	-		26.5(10)	38.5(17)	16.5(12)
6	-	-		66(20)	41.5(15)
7	*	-	-		30.5(22)
8	-	-	-	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (P<0.01)
figures in the cells: T value (number of differences)

Table 5.7.3 Inter-reader bias test (t test) of Swedish sample (Sd 25) (n=50)

Reader	1	2	6	7	8
1		1.13	0.54	2.55	1.47
2	-		0.00	2.02	1.87
6	-	-		1.46	1.28
7	*	*	-		3.74
8	-	-	-	**	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (P<0.01)
figures in the cells: t value

Table 5.7.4 Inter-reader bias test (Wilcoxon test) of Swedish sample (Sd 27) (n=50)

Reader	1	2	6	7	8
1		42(13)	11.5(12)	7.5(15)	0(14)
2	-		13.5(11)	12(12)	15(16)
6	*	-		18.5(10)	10(12)
7	**	*	-		56(18)
8	**	**	*	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (P<0.01)
figures in the cells: T value (number of differences)

Table 5.7.5 Inter-reader bias test (t test) of Swedish sample (Sd 27) (n=50)

Reader	1	2	6	7	8
1		0.40	2.47	3.68	4.42
2	-		1.83	2.20	2.99
6	*	-		1.00	2.47
7	**	*	-		1.43
8	**	**	*	-	

- : no sign of bias (p>0.05); * : possibility of bias (0.01<p<0.05); ** : certainty of bias (P<0.01)
figures in the cells: t value

Table 5.8 The mean age obtained by readers for the samples and the coefficient of variation (CV) for each sample

Reader						Sample						
	Estonian Sd 32	Finnish Sd29	Finnish Sd 30	Finnish Sd 31	Finnish Sd 32	German Sd 24	Latvian Sd 28	Polish Sd 25	Polish Sd 26	Russian Sd 26	Swedish Sd 25	Swedish Sd 27
1	4.63	5.16	4.33	3.00	3.85	4.43	5.17	4.56	5.13		4.10	5.32
2	4.48	4.88	4.29	3.02	3.51	4.15	5.06	4.72	4.96		4.16	5.28
3	4.47					4.38	4.95	5.08	5.27	4.51		
4	4.26	4.92	4.24	2.83	3.40		4.88	4.64	5.00	4.31		
5	4.66	5.90	5.55	3.69	4.38	6.60	5.17			5.01		
6		5.22	4.51	3.00	3.60	3.65		4.95	5.21	3.84	4.16	5.12
7	4.57	5.04	4.43	3.10	3.66	4.98		4.77	5.06		4.36	5.04
8	3.34					3.98	3.93	4.75	4.77		3.96	4.88
Mean age	4.38	5.19	4.56	3.11	3.73	4.60	4.86	4.78	5.06	4.42	4.15	5.13
CV	0.110	0.072	0.109	0.096	0.094	0.212	0.097	0.037	0.033	0.110	0.035	0.035
Mean length (cm)	16.0	17.4	16.6	15.3	14.2	24.3	16.4	24.4	24.8	19.6	20.6	18.2