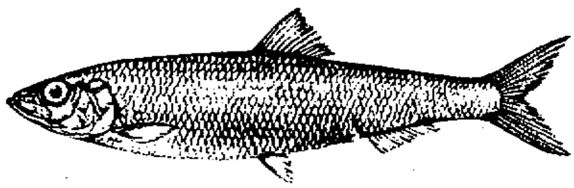
Baltic Committee **ICES CM 1998/H:2**

REPORT OF THE

BALTIC HERRING AGE-READING STUDY GROUP

Riga, Latvia

23–27 February 1998



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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

1.1 Terms of Reference

During the ICES 1997 Annual Science Conference (85th Statutory Meeting) in Baltimore, USA, it was decided that Baltic Herring Age Reading Study Group (BHARSG) should meet at the Latvian Fisheries Research Institute, Riga, Latvia from 23 to 27 February 1998 to:

1. intercalibrate the age reading and age determination methodology of Baltic herring and describe a protocol for handling Baltic herring otoliths;

2. organise a comparative age determination of otoliths and evaluate results using the methods described by the Working Group on Sampling Strategies for Age and Maturity;

3. in the light of the results of the Study Group, identify new research and actions needed to improve the consistency of age reading;

4. prepare a manual of standard procedures on Baltic herring age-reading.

1.2 Participation

The meeting was attended by:

Stina Bjørk Bilstrup	Denmark
Elena Fedotova	Lithuania
Marina Fetter	Latvia
Joachim Gröger	Germany
Tomas Gröhsler	Germany
Carina Jernberg	Sweden
Georgs Kornilovs (Chairman)	Latvia
Natalia Krasovskaya	Russia
Andrea Kuhn	Germany
Malene Lindberg	Denmark
Nikolai Nazarov	Russia
Henn Ojaveer	Estonia
Raimo Parmanne	Finland
Tiit Raid	Estonia
Heli Ðpilev	Estonia
Miroslaw Wyszynski	Poland

2 REVIEW OF BALTIC HERRING BIOLOGY

2.1 Distribution

Herring is distributed all over the whole Baltic Sea area (Sub-divisions 22–32). Distribution varies between seasons as the fish migrate between overwintering, spawning and feeding areas. Including the herring in the Skagerrak/Kattegat area, the following five spring spawning stocks are recognised at present for assessment purposes:

- Western Baltic herring (Division IIIa and Sub-divisions 22–24)

- Herring in Sub-divisions 25–29 (including Gulf of Riga) and Sub-divisions 32

- Herring in the Gulf of Riga

- Herring in Sub-division 30

- Herring in Sub-division 31

The current distribution and migration patterns are fully described by Aro (1989).

In the Baltic Sea including Division IIIa the herring migration pattern can be summarised by Division/Sub-division in the following way:

Division IIIa (Skagerrak and Kattegat)/Sub-divisions 22–24

Catches of herring in Division IIIa (Kattegat and Skagerrak) are taken from a mixture of two spawning stocks:

- the Baltic/IIIa spring spawners (Rügen herring) and
- the North Sea autumn spawners.

The **North Sea autumn spawners** enter Division IIIa (Skagerrak and Kattegat) as larvae (Anon. 1977/H:3, Bartsch *et al.* 1989, Johannesen and Moksness 1991) and migrate back to the North Sea with an age of 2–3 years (Anon. 1991/Assess:15 and Johansen 1927).

After spawning in Sub-divisions 22 and 24 on their feeding migration as 2 years of age (Aro 1989, Biester 1979 and Weber 1975) the **Western Baltic spring spawners** enter Division IIIa through the Sound and Belt Sea and spread out into the Western part of Skagerrak and the Eastern North Sea. Towards the end of summer the herrings aggregate in the Eastern Skagerrak and Kattegat before they migrate to the main wintering areas in the southern part of Kattegat, the Sound and the Western Baltic (Anon. 1991/Assess:15).

Sub-division 25 (Bornholm Basin)

Tag recaptures indicated that feeding migration during autumn and winter is confined to the Bornholm basin. However, occasional recaptures has also been reported from Sub-division 24 and north of the island Öland, i.e. in the Sub-division 27 (Otterlind 1978).

Sub-division 25 and 26 (South Eastern part of the Baltic Sea)

The spawning ground of the coastal herring are situated near the coasts from Poland till Lithuania including the Bay of Gdansk and the Vistula Bay. After spawning coastal spring spawning herring take the feeding migrations to the open waters of the Southern Baltic where they mix with open sea and autumn herring populations. A part of them migrate to the Danish Straits and North Sea. The most of these migrating part of herrings are naturally marked with nematode *Anisakis simplex,* which they infested there. After feeding period they migrate back to the traditional spawning grounds closing their biological cycle.

Sub-division 27

Results from tagging along the Swedish east coast in the 1960s revealed a distinct southbound migration towards the Bornholm basin where the Swedish spring spawning herring mix with other stocks (Otterlind 1978; Aro 1989).

Sub-division 28

Herring fishery off the Latvian coast is based on two populations:

- open sea spring spawners
- gulf spring spawners.

Large part of the open sea herring performs spawning migrations to the spawning grounds along the Lithuanian and Latvian coasts in March-April. A part of the open sea herring spawns in the Gulf of Riga. After spawning the herring returns to the open sea.

The gulf herring is wintering and spawning in the Gulf of Riga. After spawning some part of this herring migrates to the nearest parts of the open sea area for feeding. These migrations, which strongly depend on the stock size, were very intensive in the last 3–4 years.

Sub-division 29 (Archipelago Sea)

The adult stock component mainly migrate after spawning to the south to the Baltic Sea proper, and also to the north to the Bothnian Sea. Herring returns again for spawning in the next year. Part of young herring stay in the Archipelago Sea also in autumn and winter.

Sub-division 30 (Bothnian Sea)

Migrations to the south or north are scanty. Herring mainly stays the whole year in the Bothnian Sea.

Sub-division 31 (Bothnian Bay)

Herring is stationary also in this area . Some migration to the south (Bothnian Sea) may occur.

Sub-division 32 (Gulf of Finland)

A part of adult stock migrates after spawning to the Baltic Sea proper, and returns in winter for spawning in the next spring. Young herring mainly stays in the Gulf during the whole year.

2.2 Spawning

The Western Baltic area (**Division IIIa and Sub-divisions 22-24**) is mainly inhabited by a fast growing and migrating herring population with spawning sites around the Danish Islands and along the German coast. The main spawning area is the waters around the Rügen Island (Greifswalder Bodden). Depending on the ice coverage the spawning season lasts from around March to May. At the beginning of the spawning season the arriving herring shoals are characterised by bigger older and fast growing fish (Klinkhardt 1996).

The following parameters are characterising the spawning herring in the waters around Rügen island:

• Water depth for spawning	1–6 m (Klinkhardt 1996)
• Minimum salinity for spawning	4‰ (Klinkhardt 1996)
• Minimum temperature for spawning	4°C (Klinkhardt 1996)
• Fecundity	10,000–100,000 eggs (Below 1979)
• Time before hatching	about 7 days (Klinkhardt 1986)
• Length when hatching	5.5–7.3 mm (Klinkhardt 1986)
• Manifestation of first day ring on otoliths	4.5 days (Klinkhardt 1996)
• Time to spend yolk-sack	6.5 days (8°C) (Klinkhardt 1996)
• Growth of larvae	0.3 mm/day (Biester 1979)

Spring spawning at the Swedish coast (**Sub-division 25**) is concentrated to the northern archipelago of the Hano Bight during April and May. Scuba diving studies indicate that spawning is confined to temperatures between 5.5 to 15°C and occurs in very shallow waters from 0.5 to 5.5 m (Elmer 1982). Eggs are deposited mostly on *Zostera marina* but also on other phanerogams and benthic algae (e.g. *Fucus vesiculosus*). Samples from the fishery in recent years indicate a progressively lower length at first maturity and often malformed gonad development.

Further spawning grounds of spring spawning herring are accommodated along the whole Polish coast from the Pomerania Bay on the west to the Gulf of Gdansk (**Sub-division 25 and 26**), including the Vistula Lagoon. The spawning period continues from March (sometimes from the end of February depending on water temperature) mostly till the first half of May. In the western part of Polish coast it starts about two weeks earlier. The spawning fishes are caught mainly over 6 to 12 m of bottom depth. The roe is laid on the vegetation, sand, gravel, stones, and also on underwater artificial buildings and barriers. The maturation is reached in the second year of life (about 90% of year class total number) with total fish length about 14–16 cm. The growth rate of these herrings decreases eastward.

The spawning grounds of autumn herring population are localised on the slopes of Bornholm Basin (including Slupsk Bank/**Sub-division 25**) and western part of Gulf of Gdansk. These herrings spawn in deeper waters up to 20–25 m depth with more gravely and stony bottom. The main spawning period continues from September to November.

The Latvian coast of the Gulf of Riga (**Sub-division 28**) is characterised by 10 spawning grounds with areas ranging from 0.1–2.35 km^2. In Estonian part of the Gulf of Riga the most important herring spawning grounds are located in the Paernu Bay area. The spawning grounds are situated on stony grounds on which seaweeds are growing. The eggs are usually found on algae, but sometimes also on stones, sand and gravel.

Spawning takes place at a broad range of water temperature from 3.5 - 19°C. In late spring the spawning begins at 3.5–4°C. In normal terms the water temperature for spawning is reaching about 6°C. On the average the spawning period is two months long - from the end of April till the beginning of July. The highest spawning intensity is observed in the end of May - beginning of June, by water temperatures around 9.5–16.9°C (Kornilovs 1994).

Open sea herring, which differs from the gulf herring mainly by bigger length and weight at age, maturates for the first spawning usually by the second, sometimes by the third year of life. Compared to the gulf herring the open sea herring starts to spawn at lower temperatures. As temperature increases the gulf herring gradually joins the spawning. The spawning is finished by the youngest age groups of the gulf herring. During the spawning period the size and age of the herring diminish. The spawning in the Gulf of Riga is further characterised by following conditions/parameters:

- salinity of water at the south-eastern coast of 1.76‰–6.49‰,
- water depth range of 0.5–7.5 m,
- grounds with stony bottom covered by seaweeds (red, brown and green algae),
- usually the density of eggs are 10,000–300,000 per m^2,
- 1.0–2.5 millions eggs per 1m^2 forming 1–1.5 cm thick carpets (Kornilovs 1994).

In the Asko archipelago (**Sub-division 29**) spawning dominates during May and June (Aneer 1989). The preferred temperatures range from 4 to 15°C. Eggs are deposited on algae (typically *Chorda filum, Pilayella littoralis* and *Ceramium* sp.), on available phanerogams, on blue mussels and even on sand and gravel from the water surface down to 20 m depths. Egg mortality has been estimated to be high and even higher in the presence of filamentous algae (Aneer 1989). Egg density was low averaging 10,000 eggs per m^2 or 200 g/m^2. Spawning beds were restricted to shallow waters along the shores but could cover long distances (km). Only 10% of the estimated suitable shallow waters were occupied.

Nearly all herring in the **Northern Baltic Sea (Sub-divisions 29, 30, 31 and 32)** are spring spawners. The spawning period is long. In early spring the spawning starts in the end of April, but usually in the first half of May. The main spawning months are May and June. In the northernmost Baltic Sea, in the Bothnian Bay (Sub-division 31), spawning begins one month later than in the southern Finland.

In the Northern Baltic Sea the common length of herring is 15–18 cm. Fast-growing and old herring spawn first, slow-growing and young herring later. Spawning takes place in shallow water along the whole coast. Usual spawning depth is 1–5 m. Spawning places are often in sounds or in underwater slopes with hard bottom covered by vegetation. Spawning begins in early spring in shallow water, even in the depth of 20 cm, and moves gradually deeper when water gets warmer. In summer spawning may take place even in the depth of 20 m. At the beginning of spawning period the temperature of the water is about 5°C and at the end 15°C.

2.3 Stock Separation

The herring stocks in the Kattegat and the Skagerrak have traditionally been separated by the average counts in number of vertebrae in herring samples (Rosenberg & Palmen 1982; Gröger & Gröhsler 1995, 1996). North Sea autumn spawners have a mean number of 56.5 vertebra while the Western Baltic spring spawners are represented by a lower mean number, 55.8 vertebrae. For 1996 a new method was employed using otolith micro-structure for separating Western Baltic spring spawners from North Sea autumn spawners (Mosegaard & Popp-Madsen 1996).

Results from comparative vertebrae counts (mean range 55.0–55.15) and tagging experiments suggest that the spring spawners in the Hano Bight (Sub-division 25) belong to a separate stock unit (Otterlind 1976; Aro 1989). The coastal spring spawning herrings, open see and autumn herrings in Sub-division 25 and 26 are separated using the differences in morphological structure of their otoliths.

Vertebrae counts from herring along the Swedish east coast in the 1960s (mean range 55.15–55.35) deviate only marginally and can not be used for stock separation.

The open sea herring and the gulf herring in Sub-division 28 may be separated using differences in morphological structure of their otoliths.

Vertebrae counts in Sub-divisions 30 and 31 are generally higher than in the central Baltic but also more variable (mean range 55.10–55.60).

3 MATERIAL AND METHODS

3.1 Review of Sample Processing Techniques

The sampling and storing of otoliths by each country is described in Report by Correspondence of the Baltic Herring Age Reading Study Group (Anon 1997/J:5). 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.

All laboratories involved examine the otoliths under a stereo (binocular) microscope in reflected light against a black 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. Some readers found it uncomfortable to examine otoliths which were put in the plastic trays as it did not allow to move the otolith during the age determination that was sometimes very essential to get the best image. Still it was considered that this technique is mainly a matter of personal preference and it does not influences the precision of an experienced reader get used to work with this method.

3.2 Otolith Samples Used in the Otolith Exchanges

The Study Group had completed two otolith exchanges. The first otolith exchange was carried out in 1997 and it included 7 otolith samples of Baltic herring collected during the first half of the year in 1996. The number of otoliths in the samples and the Sub-division is as follows:

Estonia	- 102 otoliths from Sd 32;
Finland	- 50 otoliths from Sd 29,
	- 50 otoliths from Sd 30,
Finland	- 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 second otolith exchange started in September 1997 and was carried out till the Meeting of the Study Group and was completed during the Meeting. 8 samples were prepared for the second otolith exchange and they included otoliths of herring caught during the hydroacoustic surveys in October 1996 or were taken from commercial catches of the same time period by countries which do not perform hydroacoustic surveys. The number of otoliths in the samples and the Sub-division is as follows:

Estonia	- 100 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;
Lithuania	- 100 otoliths from Sd 26;
Poland	- 84 otoliths from Sd 25,
	- 100 otoliths from Sd 26;
Russia	- 100 otoliths from Sd 26;
Sweden	- 75 otoliths from Sd 25,
	- 75 otoliths from Sd 27.

The otolith samples circulated between the countries. Readers from 7 countries participated in the first otolith exchange. Latvia was represented by two readers and Estonia, Finland, Germany, Poland, Russia and Sweden by one reader. In the second otolith exchange the readers of the first exchange were joined by one reader from Denmark and one reader from Lithuania. Some samples were treated by two readers from Estonia.

3.3 Reference Collections

It was decided by the Study Group that it would be essential to prepare reference collections of Baltic herring otoliths. The reference collections should be prepared by the laboratories involved on the base of the otolith samples used during the first and the second otolith exchanges. Only those otoliths should be used for which all readers agreed or only one reader disagreed. It would be desirable to make photos of the otoliths from reference collections and distribute between participating laboratories. The reference collections could be used in training purposes and in the next Meetings to check the consistency of age determination.

3.4 Theoretical Background of the Analysis of Age Reading Results

In order to compare the particular readings of the 8 readers in the first herring otolith circulation program and of the 10 readers of the second otolith exchange program, based on the theory given in Gröger (1996a,b) per each reader an individual calibration model was fitted. The basic idea behind this is to relate the personal readings to a common standard. This common standard can be the readings of one specific reader, an average, the median, the mode or any other measure of that standard. The most ideal case would be the true age meaning that this standard can be considered as an approximation of the underlying real age which is usually not known (exception: mark and release experiments). Therefore it would be helpful to choose a standard which fulfills some basic requirements. One basic requirement is to be mostly unbiased (systematic component of variation), the other is to be mostly free of random uncertainty (random component of variation). Hence, it is not suitable to base that standard on the readings of only one or two single readers but on a larger group of readers in order to balance out individual uncertainty. The arithmetic mean has the problem to react relatively sensitive towards outliers. Some data experiments based on mark and release experiments have shown that the median and the mode (mode=highest agreement=most frequently read age of a single otolith) seem to be quite good approximations of the true age whereby the mode is superior of the median. Hence for the current herring age reading program the mode was choosen as standard.

Figure 1 Ideal and biased situations.

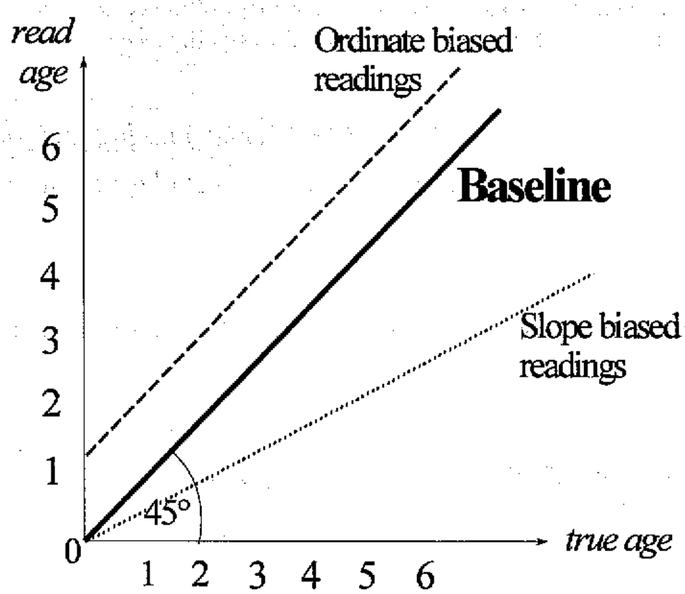


Figure 1 comprises two situations where the readings are deviating from the baseline which represents the unbiased situation. The standard here is called true age (considering the standard as an approximation of the true age). Obviously the baseline goes through the origin (i.e. intercept=0) and forms an angle of 45° with either the x- or the y-axis (i.e. slope=1). Compared to the baseline one line is horizontally (parallely) shifted (i.e. intercept >0, slope=1) and the other biased line shows a different slope (i.e. intercept=0, slope<1). All kind of combinations between these two situations are thinkable. Formally deviating readings are represented by:

$$read = a + b \, x \, true + u$$

where a is the intercept and b the slope which can be estimated by simple regression techniques. The u are the residuals containing the deviation between model and data. Therefore, any statistical test must check as well the significance of the estimated reader's slope from 1 as the estimated reader's intercept from 0. In order to do that two important statistical hypotheses (two-sided) can be stated. The first hypothesis whether there is a parallel bias of the readings (a<>0) and the second hypothesis whether there is a significant slope bias in the readings (b<>1) can be expressed as follows:

$$H_0 : a = 0 \quad vs \quad H_1 : a \neq 0 .$$

$$H_0 : b = 1 \quad vs \quad H_1 : b \neq 1 .$$

The two corresponding test statistics are:

$$t = \frac{\hat{a}}{s(\hat{a})}$$

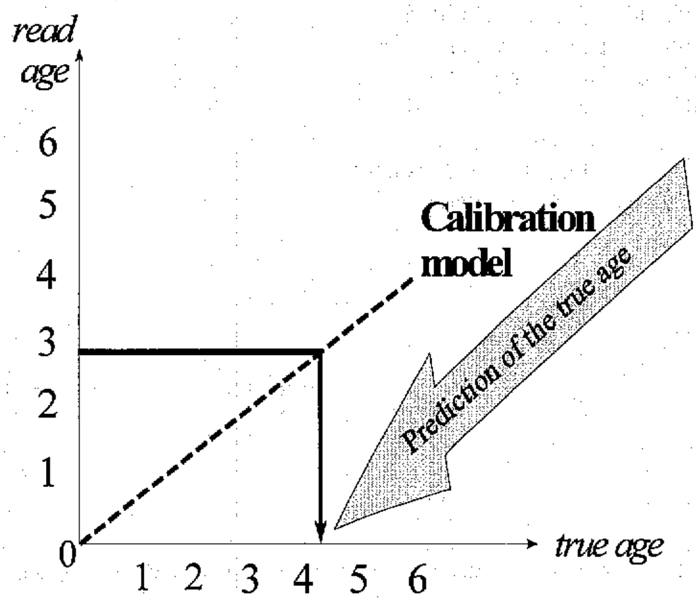
$$t = \frac{\hat{b} - 1}{s(\hat{b})}$$

where $s(\hat{a})$ and $s(\hat{b})$ mean the estimated variances of the corresponding regression coefficients. Both test statistics t are t(n-2) distributed. When controlling the level of significance at α the decision rule for both statistics is:

$$\text{if } F \leq F(2,n-2;1-\alpha) \ \underline{\text{no bias}} \text{ is indicated } (H_0)$$
$$\text{if } F > F(2,n-2;1-\alpha) \ \underline{\text{bias}} \text{ is indicated } (H_1).$$

Also simultaneous tests are available. For further details see Gröger (1996a,b).

Figure 2 Inverse prediction.



In principle, this method can help to find crucial otoliths or readings or correct the readings at all. The latter means that per each reader the correspondig significant regression model can be taken to calibrate (or correct) the reader's actual readings towards the given standard. This means that any reading of a reader who is participating in an age reading standardiziation program together with other readers can be calibrated to the same standard, i.e. relative to each other the readers will read in the same manner. In other words, the readings of one reader will be translated to the same age as that of the other readers. Fig. 2 comprises this way of calibration visually. The method is also called inverse prediction. Mathematically this is:

$$\hat{true}_{new} = \frac{read_{new} - \hat{a}}{\hat{b}}, \quad b \neq 0.$$

where $true_{new}$ is the inversely predicted true age. For further details (for instance, the construction of confidence limits see Gröger (1996a,b)).

Additionally Wilcoxon signed rank test, as it was recommended by the Workshop on Sampling Strategies for Age and maturity (Anon. 1994), was accomplished and percentage agreement of individual readers was calculated.

3.5 Identification of True and False Winter Rings in Otolith Microstructure of Baltic Herring

During the comparative age determination of otoliths on the video screen performed during the Meeting sometimes it was difficult to achieve agreement on the determination of the first winter ring. In such cases only other methods different from common examination under binocular microscope can be useful. The members of the Study Group were introduced with the analysis of otolith microstructure and how this method can be used for the identification of winter and false rings.

The mineral (aragonite crystals) and protein incorporation (otoline) of the otolith is dependent on seasonal and diurnal rhythmics variations in food and temperature, because it influences the biochemical processes of the fish.

If the fish starves for a period of time and lose weight, the biochemical processes will not stop, and there would be a small growth of otolith. These influences create a variation of the mineral to otoline composition of the otolith and will produce the optical appearance of the daily increments and the winter rings. In an old fish, which has stopped growing, the growth of the otolith will still occur, but it will slow down and the transparency will increase.

The incorporation of otoline varies between 0.5%–10%, and in periods with optimal growth conditions the otolith formation will be seen as white areas (opaque zones).

Sometimes it can be difficult to determine the age of the herring correctly, because false rings occur. These false rings (a translucent phase) possibly arise when the fish is in a stress condition, it may occur when it migrates from one area to another, during starvation or if the temperature increases to unusually high levels. Sometimes it also can be difficult to see if the first hyaline zone is a winter ring or just the false ring, and therefore should not be counted as a winter ring.

To determine the true and false rings one has to use the microstructure of the otolith and for identification of true and false winter rings a number of criteria relating to fish not more than 2 years old is suggested. Often the first winter rings are the most problematic.

Criteria for true winter rings:

- no daily increments in the translucent zone,
- decreasing daily increments before the zone,
- the zone will shimmer in a thin otolith preparation, when the focus is changed in the microscope,
- a pronounced check formation after the translucent zone,
- the daily increments in the rostrum will clearly decrease before each winter ring,
- a true winter ring is often distinct all the way around.

Criteria for false winter rings:

- daily increments in the translucent zone,
- wide daily increments just before the translucent zone,
- a special check mark may sometimes be found just before the zone,
- the translucent ring is blurred.

The preparation of otolith for the examination of microstructure

For the identification process it is necessary to prepare the otolith so that the microstructure can be seen. The otolith is put on a numbered glass slide with the sulcus side up. The glass slide is placed at the heating plate (150°C). Thermoplastic cement is melted directly on the glass slide. Some part of the cement is melted over the sample number to make it permanent. The otolith is placed with forceps in the melted cement and pressed down to the glass slide. After mounting of the otolith and cooling the otolith is polished with polish paper of 30 µm grain size until the nucleus gets clear and some microstructure can be seen in a dissection microscope (4,0x magnification and oculars at 10x). Next the otolith is polished with polish paper of 3 µm grain size and checked regularly in the light microscope until the daily increments are seen distinctly. Finally the otolith could be polished with aluminium oxide paste 0,3 µm, to take away grinding marks.

Determination of spawning type and false winter rings takes place in a microscope using 20x and 40x objectives with the light path of 2x and oculars of 16x.

Materials used for the preparation of otolith:

Heating plate 150°C.

Polish paper 30 µm carborondum grain. 3M734 P1200.

Polish paper 3 µm aluminium oxide grain. 3M263.

Aluminium oxide paste 0,3 µm based on distilled water. Buehler No. 40-6352-006.

Dissection microscope Leica MZ6, ocular 10x, objective 4x.

Microscope Leica DMLB, light path 2x, 20x and 40x objectives, ocular 16x.

Glass slides, 76x26 mm/3x1 inch, frosted in one end.

Thermoplastic cement. Buehler No. 40-8100.

Cloth.

Forceps.

4 RESULTS OF THE FIRST OTOLITH EXCHANGE

4.1 General Results of the First Otolith Exchange

8 readers from Estonia, Finland, Germany, Latvia, Poland, Russia and Sweden were participating in the first otolith exchange program. The complete data set contains 819x8=6552 readings of Sub-divisions 24 to 32 and is consisting of national samples from Estonia, Finnland, Germany, Latvia, Poland, Russia and Sweden. The whole statistical analysis was carried out on the basis of SAS v6.12.

In order to identify problematic otoliths per each otolith age ranges the coefficients of variation (CV) were calculated. Those otoliths with a percentage equal or higher than 20% of variation (CV >=20%) are given in the output for furthergoing discussions and analyses (for instance, additional interpersonal comparisions) and can be looked in the Appendix.

Furthermore, an analysis of variance (ANOVA) was carried out in order to detect principle sample and sub-division effects. The results are given in the Table 4.1.

Including all readers a principle sample as well as sub-division effect (beside other and interaction effects) seems to be inherent which makes it necessary to consider and check both effects during the furthergoing analysis of calibration modelling on a reader's level (see the marginal significance levels Pr > F under the "Type III SS" for unbalanced designs).

Three tests of contrasts for unbalanced designs but with slightly different constraints and properties (Scheffe test, Bonferroni-Dunn test, Ryan-Einot-Gabriel-Welsch multiple range test) were carried out to identify global groupings of readers, i.e. readers which read in a non-significant manner on a global level (Table 4.2).

On a 5% significance level all the three tests indicate one larger group consisting of readers 2, 3 and 6 which is internally homogenous but is reading significantly different in contrast to all other readers. The Scheffe test indicates a second group of readers consisting of readers 1 and 7 which is obvioulsy internally more homogenous in comparison to the readings of all other readers but more heterogenous than the first group since this second group is not detected by the two other tests. The remaining readers are reading more separated i.e. their reading results are more significantly different on a 5% confidence level.

In principle, the calibration results indicate a significant sub-division effect for all readers on a 5% significance level. But only for readers 5 and 8 the inclusion of an indicator variable as compensation for the sub-division effect has increased the quality of the calibration model fit rather drastically from 60 to 74% and from 69 to 76%, respectively. These two readers are obviously mainly responsible for the sub-division effect in the more global glm approach in the beginning of this section (despite this a sample effect as in the global approach could not be detected on a readers level). In all other cases the much more complex model explained nearly the same amount of variation than the simpler one without sub-division compensation. Since only two parameters (intercept and slope) for the whole data set (in contrast either to 11 parameters when including one sub-division indicator variable or to 9x2=18 parameters when fitting the models by sub-division) have to be estimated without loss in quality it is better to take the simpler model and gain higher degrees of freedom. Hence, in all cases except of readers 5 and 8 the overall sub-division model was chosen. For readers 5 and 8 the modelling was done by sub-division.

With exception of the calibration model of reader 1 all models showed a significant deviation of the intercept from 0 and in each case the slope differed signicantly from 1 (Table 4.3). All decisions are based on a significance level of α=0.05.

In detail the models of readers 5 and 8 with a strong sub-division effect are per sub-division (Table 4.4).

In order to use these models for any calibration purpose these models have to be inverted i.e. solved with respect to standardized age. For the group of readers without sub-division effect these calibration models are shown in Table 4.5 and for the readers 5 and 8 with a strong sub-division effect these calibration models are shown in Table 4.6.

The overall sub-division models of the readers are shown in Figures 4.1–4.8.

4.1.1 Estonian 1st sample

Wilcoxon signed ranks test showed that in 60.7% of cases (n=28 for all the samples of the first exchange) a significant bias between the readers existed (Table 4.7). The agreement between readers varied between 17.3 and 85.3%, the mean 57.8% (Table 4.19). The age reading calibration model revealed that for Sub-division 32 (Estonian sample and Finnish subsample joined) the model of readers 2 and 6 had the closest coincidence with unbiased readings line. Readers 1 and 7 overestimated the age of the fishes and that increased with the age. Readers 3 and 4 underestimated the age beginning correspondingly with age 5 and 3, besides they both had some overestimation in the younger ages. Reader 5 had overestimated all the ages and reader 8 had strongly underestimated all the ages beginning with age 3.

4.1.2 Finnish 1st sample

The Finnish sample consisted of 4 subsamples from Sub-divisions 29, 30, 31 and 32 and the results were analysed separately. Wilcoxon signed ranks test showed that for Sub-division 29 in 39.3% of the cases a significant bias between the readers existed (Table 4.8). The agreement between readers varied between 8.2 and 80.0%, the mean 56.5% (Table 4.20). The age reading calibration model revealed that the model of reader 7 was the closest with unbiased readings line slightly overestimating the age. Readers 1 and 6 had small overestimation of the age increasing with the age of the fishes. Readers 2, 3, 4 and 8 underestimated the age. Reader 5 strongly overestimated the age and that decreased with the age.

For subsample in Sub-division 30 in 42.9% of the cases a significant bias between readers was observed (Table 4.9). The agreement between readers varied between 12.5 and 80.0%, the mean 54.6% (Table 4.21). The age reading calibration model showed that the model of reader 4 was the closest with unbiased readings line. Readers 1, 2 and 7 had small difference with unbiased line. Reader 6 overestimated the age, but readers 3 and 8 rather strongly underestimated the age and that increased with the age of the fishes. Reader 5 strongly overestimated the age in all age groups.

For subsample in Sub-division 31 in 71.4% of the cases significant bias between readers was stated (Table 4.10). The agreement between readers varied between 22.7 and 88.0%, the mean 60.9% (Table 4.22). The age reading calibration model showed that the model of reader 4 was the closest with unbiased readings line. Readers 1 and 6 slightly and reader 5 strongly overestimated the age. Readers 2 and 7 slightly and readers 3 and 8 strongly overestimated the age.

For subsample in Sub-division 32 in 71.4% of the cases significant bias between readers was observed (Table 4.11). The agreement between readers varied between 21.4 and 78.0%, the mean 53.9% (Table 4.23). The age reading calibration model for Sub-division 32 see chapter 4.1.2.

4.1.3 German 1st sample

Wilcoxon signed ranks test showed that in 78.3% of cases (highest value for all the samples of the first exchange) a significant bias between the readers existed (Table 4.12). The agreement between readers varied between 0 and 69.7%, the mean 34.2% (Table 4.24). The worst results of this sample are explained by the fact that most of the readers are not familiar with Western Baltic herring. The age reading calibration model showed that the models of all readers differed from unbiased readings line especially for readers 5 and 7.

4.1.4 Latvian 1st sample

Wilcoxon signed ranks test showed that in 64.3% of cases a significant bias between the readers existed (Table 4.13). The agreement between readers varied between 12.1 and 87.0%, the mean 58.2% (Table 4.25). The age reading calibration model showed that the model of reader 6 was the closest with unbiased readings line. Readers 1, 2 and 7 overestimated the age. Reders 4 and 5 underestimated the age of the older fishes, but reader 5 had some overestimation with the younger ages. Readers 3 and 8 strongly underestimated the age.

4.1.5 Polish 1st sample

The sample consisted from two subsamples from Sub-divisions 25 and 26. For Sub-division 25 in 50.0% of the cases significant bias existed (Table 4.14). The agreement between readers varied between 9.8 and 73.0%, the mean 52.4% (Table 4.26). The age reading calibration model for Sub-division 25 (subsamples from Polish and Swedish samples joined) showed that the model of reader 4 was the closest with unbiased readings line. Readers 1 and 2 slightly underestimated and reader 6 slightly overestimated the age. Readers 3, 7 and 8 slightly overestimated the age of the younger fishes and slightly underestimated the age of the older fishes. Reader 8 strongly overestimated the age in all age groups. Reader 5 strongly overestimated the age in all age groups.

For Sub-division 26 in 42.9% of the cases significant bias was observed (Table 4.15). The agreement between readers varied between 1.9 and 77.8%, the mean 51.5% (Table 4.27). The age reading calibration model for Sub-division 26 (Polish subsample and Russian sample joined) showed that the model of reader 6 slightly overestimated, readers 1 and 7 overestimated and reader 5 strongly overestimated the age. Readers 2, 3 and 4 slightly overestimated the age of younger fishes and slightly underestimated the age of older fishes. Reader 8 strongly underestimated the age of older fishes.

4.1.6 Russian 1st sample

Wilcoxon signed ranks test revealed that in 75% of the cases significant bias existed between readers (Table 4.16). The agreement between readers varied between 35.0 and 79.0%, the mean 60.9% (Table 4.28). The age calibration model for Sub-division 26 see Section 4.1.6.

4.1.7 Swedish 1st sample

The sample consisted of two subsamples from Sub-divisions 25 and 27. For Sub-division 25 in 28.6% of the cases (lowest value in the 1st exchange) a significant bias between readers was stated (Table 4.17). The agreement between readers varied between 14 and 88%, the mean 58.5% (Table 4.29). The age calibration model for Sub-division 25 see chapter 4.1.6.

For subsample from Sub-division 27 Wilcoxon signed ranks test showed in 50% of the cases a significant bias between readers (Table 4.18). The agreement between readers varied between 24.0 and 86.0%, the mean 64.7% (Table 4.30). The age calibration model showed that models of readers 4 and 6 were very close with unbiased readings line. Readers 1 and 2 slightly overestimated and reader 5 strongly overestimated the age. Reader 3 underestimated and reader 8 strongly underestimated the age. Reader 7 overestimated the age of younger fishes and underestimated the age of older fishes.

5 RESULTS OF THE SECOND OTOLITH EXCHANGE

5.1 General Results of the Second Otolith Exchange

10 readers from Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden were participating in the second otolith exchange program. But in this case 4340 readings of only national samples from Germany, Poland and Sweden are included with Sub-divisions 24, 25, 26 and 27. These samples were treated by all laboratories before the Meeting. The age reading of other 5 samples was completed during the Meeting and therefore only Wilcoxon signed test for them is accomplished and agrreement between readers is calculated. The numbering of the readers is the same as in the first exchange program but is extended due to two additional readers from Lithuania and Denmark. As before the whole statistical analysis was carried out on the basis of SAS v6.12.

In order to identify problematic otoliths per each otolith age ranges the coefficents of variation (CV) were calculated. Those otoliths with a percentage equal or higher than 20% of variation (CV >=20%) are given in the output for furthergoing discussions and analyses (for instance, additional interpersonal comparisions) and can be looked in the Appendix.

Furthermore, an analysis of variance (ANOVA) was carried out in order to detect principle sample and sub-division effects. The results are given in Table 5.1.

As before this test includes all readers, national samples and sub-divisions. It can be seen that in contrast to the first exchange program the sample effect disappeared and that the sub-division effect is much weaker than before (see the marginal significance levels Pr > F under the "Type III SS" for unbalanced designs). But since a sub-division effect is still inherent it is necessary to observe and check this effect during furthergoing analyses on a more detailled reader's level.

As before the same three tests of contrasts for unbalanced designs (Scheffe test, Bonferroni-Dunn test, Ryan-Einot-Gabriel-Welsch multiple range test) were carried out to identify global groupings of the 10 readers, i.e. those readers which read in a more homogenous manner on a global level (Table 5.2).

On a 5% significance level all the three tests constructed at least two larger groups, the first consisting of readers 1, 2, 4 and 9 and the second consisting of readers 3, 6, 8 and 10. A third (weaker) group consisting of readers 5 and 10 could be inherent since detected by the Scheffe test. Reader 7 obviously has a more separate position. The two or perhaps three groups are considered to be internally homogenous whereby the first is significantly different to all other groups and reader 7. The second group is also separated to the first group and to reader 7 but is closer to the third due to the readings of reader 10. This kind of grouping indicate a much closer reading than in the first otolith exchange.

Also here the calibration results indicate a significant sub-division effect for all readers on a 5% significance level. But in contrast to the first reading exchange program in this case only for reader 9 the inclusion of a sub-division indicator variable has increased the quality of the calibration model drastically (shifting the fit from 70 to 81% in terms of explained variation). In all other cases the more complex model explained nearly the same amount of variation than the simpler one but with fewer parameters to be estimated. Hence, without loss in quality the simpler calibration model type with higher degrees of freedom was chosen. Only for reader 9 the calibration model fit was done by sub-division. From these results it seems that all readings in the second otolith exchange program were closer to each other than in the first exchange program.

With exception of the calibration model of readers 1 (as before), 2, 6 and 10 all calibration models showed a significant deviation of the intercept from 0. In most of the cases the slope differed signicantly from 1. Only for readers 6 and 7 the slope does not differ significantly from 1. This means, that reader 6 reads completely unbiased and that reader 7 only shows a horizontal shift in the readings. All decisions are based on a significance level of $\alpha=0.05$. In detail the models per reader without sub-division effect are given in Table 5.3 and the model of reader 9 by sub-division is given in Table 5.4.

In order to use these models for any calibration purpose these models have to be inverted i.e. solved with respect to standardized age. For the group of readers without sub-division effect these calibration models are given in Table 5.5 and for reader 9 in Table 5.6.

The overall sub-division models of the readers are shown in Figures 5.1–5.10.

5.2 Estonian 2nd Sample

Wilcoxon signed ranks test revealed that in 44.4% of the cases significant bias between readers existed (Table 5.7). The agreement between readers varied between 9.1 and 92.9%, the mean 65.6% (Table 5.20).

5.3 Finnish 2nd Sample

The Finnish sample consisted of 4 subsamples from Sub-divisions 29, 30, 31 and 32. For Sub-division 29 Wilcoxon signed ranks test showed that in 73.3% of the cases a significant bias between readers existed (Table 5.8). The agreement between readers varied between 2.2 and 86.0%, the mean 60.1% (Table 5.21).

For Sub-division 30 in 60.0% of the cases a significant bias between readers was observed (Table 5.9). The agreement between readers varied between 20.0 and 80.0%, the mean 55.9% (Table 5.22).

For Sub-division 31 in 44.4% of the cases a significant bias between readers was stated (Table 5.10). The agreement between readers varied between 10.0 and 92.0%, the mean 62.6% (Table 5.23).

For Sub-division 32 in 66.7% of the cases a significant bias between readers was observed (Table 5.11). The agreement between readers varied between 13.3 and 79.2%, the mean 48.7% (Table 5. 24).

5.4 German 2nd Sample

Wilcoxon signed ranks test revealed that in 71.1% of the cases a significant bias between readers was observed (Table 5.12). The agreement between readers varied between 10.0 and 71.0%, the mean 44.1% (Table 5.25).

5.5 Latvian 2nd Sample

Wilcoxon signed ranks test showed that in 65.5% of the cases significant bias between readers existed (Table 5.13). The agreement between readers varied between 26.0 and 79.2%, the mean 52.1% (Table 5.26).

5.6 Lithuanian Sample

Wilcoxon signed ranks test revealed that in 77.8% of the cases a significant bias between readers existed (Table 5.14). The agreement between readers varied between 22.0 and 69.8%, the mean 43.6% (Table 5.27).

5.7 Polish 2nd Sample

The Polish sample consisted from 2 subsamples from Sub-divisions 25 and 26. For Sub-division 25 in 81.8% of the cases a significant bias between readers was observed (Table 5.15). The agreement between readers varied between 10.7 and 84.0%, the mean 51.3% (Table 5.28).

For Sub-division 26 in 80.0% of the cases a significant bias between readers was stated (Table 5.16). The agreement between readers varied between 34.0 and 85.0%, the mean 64.4% (Table 5. 29).

5.8 Russian 2nd Sample

Wilcoxon signed ranks test showed that in 70.9% of the cases a significant bias between readers existed (Table 5.17). the agreement between readers varied between 26.8 and 72.7%, the mean 48.5% (Table 5.30).

5.9 Swedish 2nd Sample

The Swedish sample consisted of 2 subsamples from Sub-divisions 27 and 25. For Sub-division 27 in 71.1% of the cases a significant bias between readers was observed (Table 5.18). The agreement between-n readers varied between 6.7 and 82.7%, the mean 50.7% (Table 5.31).

For Sub-division 25 in 71.1% of the cases a significant bias between readers was stated (Table 5.19). The agreement between readers varied between 8.0 and 78.7%, the mean 47.1% (Table 5.32).

6 RESULTS OF COMPARATIVE AGE READING AT THE MEETING

6.1 General Results of Comparative Age Reading

12 readers from Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden were participating in the comparative reading at the Meeting. During this age reading standardisation program of 2400 readings of Sub-divisions 24, 25 and 28 was performed. The sample from Sub-division 28 consisted of 50 otoliths collected in spring 1997 and 50 otoliths collected in autumn 1997. The sample from Sub-division 25 consisted of 50 otoliths collected in autumn 1996 and sample from Sub-division 24 consisted of 50 otoliths collected in winter 1997. This time the total sample was not divided in national subsamples meaning that no sample effect could occur. The numbering of the readers is the same as in the first and second exchange program but is further extended due to two additional readers from

Estonia. As before the whole statistical analysis was carried out on the basis of SAS v6.12. Also in this section all statistical tests are based on a confidence level of 95% (i.e. $\alpha=0.05$).

In order to identify problematic otoliths per each otolith age ranges the coefficients of variation (CV) were calculated. Those otoliths with a percentage equal or higher than 20% of variation (CV >=20%) are kept in the output for any furthergoing discussion and particular analysis (for instance, additional interpersonal comparisons).

A first analysis of variance (ANOVA) was carried out in order to detect a principle sub-division effect. The results are given in Table 6.1.

As before this test includes all readers and sub-divisions. It can be seen that also in this comparative reading a global sub-division effect is still existent (see the marginal significance levels Pr > F under the "Type III SS" for unbalanced designs) and that it is still necessary to observe and check this effect during furthergoing analyses on a more detailed reader's level.

As before the same three tests of contrasts for unbalanced designs (Scheffé test, Bonferroni-Dunn test, Ryan-Einot-Gabriel-Welsch multiple range test) were carried out to identify global groupings of the 12 readers, i.e. those readers which read in a more homogenous manner on a global level. Their results which are confirming each other are given in Table 6.2 whereby means with the same letter mean that these are not significantly different.

Two to four homogenous groups were constructed by the three tests whereby in all three cases the first group is consisting of readers 7, 11 and 12 and is obviously mostly homogenous and distinct from all other groups and readers, respectively. A second slightly weaker grouping which is also constructed by all three methods is that of readers 1, 3, 4, 5, 8, 9 and 10. After the Scheffé test also readers 2 and 6 are belonging to this group (which in this case makes the grouping complete) but not in case of the two other tests. In all three tests this group is completely non-overlapping with the first one. But the Bonferroni-Dunn test as well as the Ryan-Einot-Gabriel-Welsch multiple range test construct a third non-distinct group consisting of readers 1, 2, 4, 5, 6, 9 and 10 which is heavily overlapping with the second grouping. In case of the latter test a fourth grouping is constructed which is relatively similar to the third one but excludes reader 6 and includes reader 5. This strongly overlapping construction of groups indicate a much closer reading than in the first and second otolith exchange programs leading obviously through some kind of standardisation to non-distinct reader groups.

This standardization effect could be further investigated since in the otolith collection of the second otolith exchange program and comparative reading at the Meeting a subsample of 25 identical otoliths were included which was unknown by the readers. These otoliths of numbers 51 to 75 are stemming from the Swedish sample of Sub-division 25. This subsample was taken as input for a second ANOVA as well as input for the three tests of contrast in order to compare the reading results from the second exchange program and comparative age reading during the Meeting and find any improvement. The grouping results are given in Table 6.3.

Whereby the Scheffé test detected only one homogenous group, the two other tests each formed two heavily overlapping groups in a similar way. This means that probably readers 3, 5, 6 and 10 read slightly different compared to reader 7 but in the same way as all other readers. Vice versa, the same is valid for reader 7. Obviously, it can be inferred from these results that the agreement between the participating readers could be increased drastically through practising comparative age readings.

In most cases the calibration results indicate a significant sub-division effect. But in contrast to the first and second otolith exchange program the inclusion of a sub-division indicator variable has not increased the quality of the calibration model at all. In all cases the simpler model explained approximately the same amount of variation than the more complex one but with fewer parameters to be estimated. Hence, without loss in quality in all cases the simpler calibration model type with higher degrees of freedom was selected.

The readings of readers 1, 4 and 10 were totally without any significant bias. The readings of readers 2 and 6 were intercept unbiased and slope unbiased, respectively. All other calibration models showed a significant deviation of the intercept from 0 and a slope differing significantly from 1. Obviously the amount of unbiasedness has drastically increased which is probably a positive effect of the three otolith exchange programs. In detail the models per reader are given in Table 6.4 (coefficients of determination are given in brackets).

The corresponding graphics can be found in the Figures 6.1–6.12. Also here only the overall models are presented in order to reduce the amount of output pages. To use these models for any calibration purpose they must be inverted i.e.

solved with respect to standardized age. For the group of readers without sub-division effect these calibration models are given in Table 6.5.

6.2 Sample from Sub-division 28

Wilcoxon signed ranks test showed that in 59.1% of the cases a significant bias between readers existed (Table 6.6). The agreement between readers varied between 30.0 and 78%, the mean 53.2% (Table 6.9). As compared with samples from Sub-division 28 in the first and second otolith exchanges the pairs of unbiased readings increased from respectively 25.0 and 27.3% to 33.3%, but if only those readers who participated in the exchange programs were considered the unbiased readings constituted 44.4%.

6.3 Sample from Sub-division 25

Wilcoxon signed ranks test revealed that in 43.9% of the cases a significant bias between readers existed (Table 6.7). The agreement between readers varied between 22.0 and 84.0%, the mean 49.3% (Table 6.10). In 39.4% of the cases no bias was determined, but for the readers who participated in the otolith exchange programme this value is 42.2%. In the first and second otolith exchanges the pairs of unbiased readings of Swedish subsample from Sub-division 25 were respectively 53.6 and 24.4% (the sample of the second otolith exchange which was also used in comparative age reading at the Meeting).

6.4 Sample from Sub-division 24

Wilcoxon signed ranks test revealed that in 66.7% of the cases a significant bias between readers existed (Table 6.8). The agreement between readers varied between 12.0 and 90.0% (Table 6.11). As compared with samples from Sub-division 24 in the first and second otolith exchanges the pairs of unbiased readings increased from respectively 17.9 and 17.8% to 27.3%, but if only those readers who participated in the exchange programs were considered the unbiased readings constituted 33.3%.

7 PROTOCOL FOR AGE DETERMINATION OF BALTIC HERRING OTOLITHS

7.1 Standardized Terminology

The Meeting agreed that the following terminology taken from the Report of ICES/NAFO Workshop on Greenland Halibut Age Determination (ICES CM 1997/G:1) could be adjusted and used for consistency among Baltic herring otolith age readers.

It is recommended that the following definitions be used when making reference to Baltic herring otoliths and interpretation of their ages:

Accuracy: The closeness of a measured or computed value (e.g. age) to its true value. Accuracy can be proven or estimated: estimates of accuracy are less valuable, but in some cases only an estimate is possible.

Age estimation, age determination: These terms are preferred when discussing the process of assigning ages to fish. The term ageing should not be used as it refers to time-related processes and the alteration of an organism's composition, structure, and function over time.

Age-group: The group of fish that has a given age (e.g. , the 5-year-old age-group). The term is not synonymous with year-class.

Annulus (pl. annuli): (Winter zone) A translucent growth zone that forms once a year representing a time of slower growth.

Annual growth zone: A growth zone that consists of one opaque zone (summer zone) and the annulus (winter zone).

Bias: A lack of precision that is not normally distributed around the mean; it is skewed to one side or the other. For age reading it may apply to one reader's interpretations which are predominantly more or less than those of another for all ages; or it may only apply to a portion of the age range.

Birth date: Based on the internationally accepted standard all Baltic herring are assumed to have a birth date of January 1.

Check: Translucent zone that forms within the opaque (summer) zone representing a slowing of growth. Such a zone is not usually as prominent as annuli and should not be included in the age estimate.

Cohort: A group of fish that were born during the same year (1 January–31 December).

Edge (marginal) growth: The amount and type of growth (opaque and translucent)on an otolith's margin or edge. The amount and type of growth on the edge must be related to the time of year the fish was caught and the internationally accepted and standard January 1st birthday. New opaque growth forming on the margin of the otolith is often referred to as plus growth or incremental growth.

Nucleus: The central area of the otolith formed during the larval stage.

Opaque zone: (summer zone) A growth zone that restricts the passage of light. In untreated otoliths under transmitted light, the opaque zone appears dark. Under reflected light it appears bright.

Precision: A process that measures the closeness of repeated independent age estimates. Precision relates to reproducibility and is not a measure of accuracy. The degree of agreement among readers is a measure of precision of the determinations and not the accuracy of the technique.

Reflected light: Light that shines onto the surface of an otolith from above, or from the side if the surface is not shadowed.

Sagitta (pl. sagittae): The largest of three otolith pairs found in Baltic herring. The sagitta is the otolith used most frequently in otolith studies.

Summer zone: Opaque growth that is normally deposited during the summer and autumn seasons when fish are growing relatively quickly.

Transition zone: A region of change in an otolith growth pattern between two similar or dissimilar regions. It is recognised as region of significant change in the form (e.g., width or clarity) of the annual growth zones. A transition zone is often defined as the region of change from juvenile to mature growth. The juvenile annual growth zones are relatively larger than those of later adult zones. In some instances otoliths may also show a change in width or clarity of the annual growth zones which may be related to significant changes of growth rate.

Translucent zone: (Hyaline zone, annulus, check) A growth zone that allows a better passage of light. In untreated otoliths under transmitted light, the translucent zone appears bright. Under reflected light it appears dark.

Transmitted light: Light that is passed through the otolith from below (e.g., sections).

Validation: The process of estimating the accuracy of an age estimating method, etc.

Winter zone: Translucent growth (annulus; not check) that is normally deposited during the late autumn and winter seasons when fishes are growing relatively slowly.

Year-class: The cohort of fish that were in a given year (1 January–31 December) (e.g., the 1990 year-class).

Zone: Region of similar structure or optical density (opaque or translucent). Synonymous with ring, band, and mark. The term zone is preferred.

7.2 Age Determination Criteria and the Main Reasons for Differences in Age Reading

Age determination

The age of Baltic herring is determined based on otoliths. Both otoliths should be taken. The otoliths are investigated using binocular microscope. The otoliths are put on a black background and examined under reflecting light. Opaque zones are then visible as white and hyaline zones dark. A 1 January birthdate is used. The date of capture must always be available. One year's growth consists of one opaque zone and one hyaline zone. Herring is aged by counting of hyaline winter rings, mainly in the rostrum. If a new hyaline zone appears in late autumn it is not counted as a winter zone till the 1 January of the next year. The timing of the new opaque zone formation in the current year should be taken into account.

False rings in the first growth zone

The size of the first growth zone is decreasing from west to north-east in the Baltic Sea because of the different time of the spawning period in the different parts of the Baltic Sea. Especially in the southern Baltic Sea some specimens have a false ring within the first growth zone. This metamorphic ring is close to the nucleus and does not have the shape of true winter rings, but is rounder.

Identification of the first winter zone

In some cases, especially in older herring, the first winter ring may be overgrown by the opaque material, and therefore the first winter ring may be visible only in the dorsal and ventral area of the otolith. In the cases when the second summer zone is very narrow in comparison with the first summer zone it could be an indication that the first winter ring is hardly visible and the reader should try to identify the possible first winter zone from the both sides of the otolith. The area of the capture of the fish also should be taken into account like is mentioned in the previous chapter.

Differences in various parts of the otolith

The first two winter rings are mostly not visible in the rostrum of older fish, but are visible in the other parts of the otolith. The third and next winter rings are usually visible in the whole otolith. In old fish the last winter rings can be distinguished only in rostrum.

Transparency of otoliths

Crystallised otoliths should be recorded and then discarded from the sample. Partly crystallised otoliths which are readable should be recorded and the age should be read. At present it is not clear if the phenomenon of crystallisation is a feature of particular year classes.

Splitted opaque zones

In old herring the opaque zones may be splitted into two parts and it is difficult to determine if they are separate growth zones or not. The structure of the questionable hyaline zone should be compared with the normal winter rings. If the splitted opaque zone is not the outermost one, the gradual diminishment of the growth zones could be taken into account. If the outermost opaque zone is splitted it is difficult to use the width of the previous growth zones to determine if the outermost zone should be regarded as two separate growth zones.

Interpretation of check zones

Checks tend to be discontinuous, weak or diffuse, and inconsistent with the general growth pattern of true winter zones. Therefore it is recommended to compare the pattern of the questionable zone with normal winter zones to decide whether the questionable zone is a true winter ring or not.

Formation of summer zones

The formation of summer zone depends on the area, hydrometeorological condition and age of fish. In western Baltic Sea the growth in young age groups may start already in March. Due to the climate the growth starts later in more northern areas. In the northern Baltic Sea the yearly growth in young age groups may start as late as in July. The formation of growth zone in adult fish depends on spawning time and feeding conditions. In the central and northern parts of the Baltic Sea the growth of otoliths in old age groups may start as late as in September-October. In central and northern Baltic sea in autumn it may be difficult to determine, if the outermost hyaline zone is formed in the current feeding season or in the previous year. For old fishes the presence of a hyaline zone on the edge of the otolith in late summer and early autumn should be considered as the winter zone of the previous year. To detect the beginning of summer zone formation regular monthly sampling should be performed. In some years due to feeding conditions very narrow or wide summer growth zones are formed and they can be used as markers for the age determination in next years.

7.3 Other Available Information for Age Determination

Usually the otolith readers are provided by information on length, weight and often also on sex and maturity of the aged fishes. It was considered by the Study Group that an experienced otolith reader is not much influenced by the information on the length of the fish. It would be desirable that otolith readers are provided with information on hydrometeorological and herring feeding conditions in the area of investigations. It can help the reader to estimate the formation of the summer zone in the current year. The peculiarities of formation of annual growth zones in the previous years should be recorded. It would be desirable that otolith reader is familiar with the structure and year class strength of Baltic herring stock he is working with. It can help the reader to avoid systematic errors due to specific formation of the growth zones.

8 SUMMARY

The Baltic Herring Age Reading Study Group has started to work in February 1997. Two otolith exchange programmes were performed by the Study Group. 8 readers from 7 countries participated in the first otolith exchange. 7 otolith samples collected during winter-spring period of 1996 comprising in total 819 otolith from Sub-divisions 24–32 were circulating among the national laboratories.. In the second otolith exchange 8 otolith samples comprising in total 1034 otolith were prepared and treated by 10 readers from all 9 states around the Baltic sea. The samples covered the same Sub-divisions as in the first otolith exchange but were collected during October 1996. The work of the Study Group was completed by a Meeting in Riga 23–27 February 1998. During the Meeting a lot of time was spent observing the otoliths from the first and the second exchanges on the video screen. It was highly appreciated by the Study group members as it allowed to co-ordinate the age reading criteria for Baltic herring. A comparative age reading was accomplished during the Meeting. 3 samples comprising 200 otoliths from Sub-divisions 24, 25 and 28 covering different seasons were prepared for the Meeting and treated by 12 readers from 9 countries. Although the results were influenced by the time limit for the reading of samples and by unfamiliar microscopes the analysis of results of comparative age reading revealed that the age determination of Baltic herring has become closer and it has confirmed the necessity and importance of regular otolith exchanges between readers and regular Meetings (see Recommendations). It was especially obvious for those readers who have differed significantly during the otolith exchanges (compare readers models for the first and second otolith exchanges and comparative age reading: Figures 4.1–4.8, 5.1–5.10, 6.1–6.1). Besides the work of the Study group has favoured the establishment of bi/multi lateral connections between readers from neighbouring countries working with the same populations of Baltic herring.

9 RECOMMENDATIONS

- The Baltic Herring Age Reading Study Group decided that the otolith exchanges between institutes should be conducted regularly. The samples for the next otolith exchange should be prepared till May 1998 and the exchange of the samples should be completed till November 1999. The results of this otolith exchange should be presented to the Baltic Fisheries Assessment Working Group in 2000. The exchange programme will be co-ordinated by Latvian Fisheries Research Institute.

- The Meetings with comparative age reading are very useful to improve the interpretation of otolith structure between readers and it is recommended to have such Meetings regularly once in three years.

- Reference collections of Baltic herring otoliths should be prepared on the base of samples used during the otolith exchanges as well as from the next exchanges. The photos of these otoliths should be prepared and distributed between the participating institutes.

- The Study Group recommends that the Baltic Fisheries Assessment Working Group uses age groups up to and including age 7 with a 8+ age group.

- A regular monthly sampling of Baltic herring otoliths is desirable from each Sub-division of the Baltic Sea.

- The otolith readers have to be provided with information on hydrometeorological and feeding conditions in the investigation area, on structure and year class strength of the Baltic herring stocks.

- It is recommended to provide special otolith microstructure studies that will be especially valuable for the determination of the first winter ring.

10 REFERENCES

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Table4.1. General Linear Models Procedure
Class Level Information

Class	Levels	Values
SAMPLE	7	ESTONIA FINNLAND GERMANY LATVIA POLAND RUSSIA SWEDEN
SUBDIV	9	24 25 26 27 28 29 30 31 32
AGESTAND	11	1 2 3 4 5 6 7 8 9 10 12
READER	8	1 2 3 4 5 6 7 8

Number of observations in data set = 6552

NOTE: Due to missing values, only 6455 observations can be used in this analysis.

Dependent Variable: AGE Age

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	175	17677.294774	101.013113	248.94	0.0001
Error	6279	2547.872693	0.405777		
Corrected Total	6454	20225.167467			

	R-Square	C.V.	Root MSE	AGE Mean
	0.874025	13.98026	0.6370061	4.5564679

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SAMPLE	6	1036.450771	172.741795	425.71	0.0001
SUBDIV	5	1173.447879	234.689576	578.37	0.0001
AGESTAND	10	13394.870395	1339.487040	3301.04	0.0001
READER	7	1174.635481	167.805069	413.54	0.0001
SUBDIV*READER	56	491.018805	8.768193	21.61	0.0001
SAMPLE*READER	21	158.334523	7.539739	18.58	0.0001
AGESTAND*READER	70	248.536920	3.550527	8.75	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SAMPLE	3	22.108079	7.369360	18.16	0.0001
SUBDIV	5	9.129750	1.825950	4.50	0.0004
AGESTAND	10	13243.142457	1324.314246	3263.65	0.0001
READER	7	73.609666	10.515667	25.91	0.0001
SUBDIV*READER	35	43.639190	1.246834	3.07	0.0001
SAMPLE*READER	21	151.383727	7.208749	17.77	0.0001
AGESTAND*READER	70	248.536920	3.550527	8.75	0.0001

Table 4.2. Ryan-Einot-Gabriel-Welsch Multiple Range Test for variable: AGE

Means with the same letter are not significantly different.

REGWQ Grouping	Mean	N	READER
A	5.54044	816	5
B	4.70416	818	7
C	4.60391	818	1

D	4.44403	813	3
D			
D	4.44074	810	2
D			
D	4.43468	819	6
E	4.31209	769	4
F	3.93813	792	8

Bonferroni (Dunn) T tests for variable: AGE

Means with the same letter are not significantly different.

Bon Grouping	Mean	N	READER
A	5.54044	816	5
B	4.70416	818	7
C	4.60391	818	1
D	4.44403	813	3
D			
D	4.44074	810	2
D			
D	4.43468	819	6
E	4.31209	769	4
F	3.93813	792	8

Scheffe's test for variable: AGE

Means with the same letter are not significantly different.

Scheffe Grouping	Mean	N	READER
A	5.54044	816	5
B	4.70416	818	7
B			
B	4.60391	818	1
C	4.44403	813	3
C			
C	4.44074	810	2
C			
C	4.43468	819	6
D	4.31209	769	4
E	3.93813	792	8

Table 4.3 Models of readers 1, 2, 3, 4, 6 and 7

Reader 1: read age = 1.042614 x standardized age (0.98)
Reader 2: read age = 0.127228 + 0.978148 x standardized age (0.91)
Reader 3: read age = 0.575781 + 0.876746 x standardized age (0.85)
Reader 4: read age = 0.138244 + 0.954981 x standardized age (0.92)
Reader 6: read age = -0.119034 + 1.031670 x standardized age (0.89)
Reader 7: read age = 0.507978 + 0.951878 x standardized age (0.81)
(coefficients of determination are given in brackets)

Table 4.4. The models of readers 5 and 8 with a strong subdivision effect (coefficients of determination are given in brackets):

```
Reader 5
SD 24: read age = 4.411855 + 0.540944 x standardized age (0.47)
SD 25: read age = 1.995739 + 0.957389 x standardized age (0.55)
SD 26: read age = 0.892089 + 1.072702 x standardized age (0.62)
SD 27: read age = 0.614207 + 1.028475 x standardized age (0.91)
SD 28: read age = 0.694018 + 0.898415 x standardized age (0.85)
SD 29: read age = 1.740444 + 0.848889 x standardized age (0.72)
SD 30: read age = 0.887725 + 1.095434 x standardized age (0.76)
SD 31: read age = 0.523622 + 1.086614 x standardized age (0.83)
SD 32: read age = 0.645892 + 0.954702 x standardized age (0.73)

Reader 8
SD 24: read age = 0.357093 + 0.895063 x standardized age (0.74)
SD 25: read age = 0.568908 + 0.856555 x standardized age (0.85)
SD 26: read age = 1.407609 + 0.598059 x standardized age (0.67)
SD 27: read age = 0.221678 + 0.909829 x standardized age (0.93)
SD 28: read age = 1.408403 + 0.500799 x standardized age (0.58)
SD 29: read age = 0.663818 + 0.806268 x standardized age (0.80)
SD 30: read age = 0.759186 + 0.765144 x standardized age (0.81)
SD 31: read age = 0.568717 + 0.656309 x standardized age (0.77)
SD 32: read age = 1.289563 + 0.461672 x standardized age (0.47)
```

Table 4.5 Calibration models of readers 1, 2, 3, 4, 6 and 7

```
Reader 1: standardized age =  read age / 1.042614
Reader 2: standardized age = (read age - 0.127228) / 0.978148
Reader 3: standardized age = (read age - 0.575781) / 0.876746
Reader 4: standardized age = (read age - 0.138244) / 0.954981
Reader 6: standardized age = (read age + 0.119034) / 1.031670
Reader 7: standardized age = (read age - 0.507978) / 0.951878
```

Table 4.6. Calibration models of readers 5 and 8 with a strong subdivision effect

```
Reader 5
SD 24: standardized age = (read age - 4.411855) / 0.540944
SD 25: standardized age = (read age - 1.995739) / 0.957389
SD 26: standardized age = (read age - 0.892089) / 1.072702
SD 27: standardized age = (read age - 0.614207) / 1.028475
SD 28: standardized age = (read age - 0.694018) / 0.898415
SD 29: standardized age = (read age - 1.740444) / 0.848889
SD 30: standardized age = (read age - 0.887725) / 1.095434
SD 31: standardized age = (read age - 0.523622) / 1.086614
SD 32: standardized age = (read age - 0.645892) / 0.954702

Reader 8
SD 24: standardized age = (read age - 0.357093) / 0.895063
SD 25: standardized age = (read age - 0.568908) / 0.856555
SD 26: standardized age = (read age - 1.407609) / 0.598059
SD 27: standardized age = (read age - 0.221678) / 0.909829
SD 28: standardized age = (read age - 1.408403) / 0.500799
SD 29: standardized age = (read age - 0.663818) / 0.806268
SD 30: standardized age = (read age - 0.759186) / 0.765144
SD 31: standardized age = (read age - 0.568717) / 0.656309
SD 32: standardized age = (read age - 1.289563) / 0.461672
```

Table 4.7 Inter-reader bias test (Wilcoxon test) of Estonian sample (Sd 32)

Reader	1	2	3	4	5	6	7	8
1		97(23)	143(31)	12(30)	355.5(39)	26(31)	45(15)	0(64)
2	-		224(31)	60(28)	333.5(43)	103(33)	85.5(21)	0(69)
3	*	-		90(31)	322.5(45)	93(30)	155(31)	0(74)
4	**	**	**		143.5(47)	233(31)	13(30)	19(61)
5	-	-	*	**		156(46)	345(41)	0(81)
6	**	**	**	-	**		13(29)	483(74)
7	-	-	-	**	-	**		0(75)
8	**	**	**	**	**	**	**	

Table 4.8 Inter-reader bias test (Wilcoxon test) of Finnish sample A (Sd 29)

Reader	1	2	3	4	5	6	7	8
1		35(18)	35(19)	40(18)	45.5(35)	20(10)	48.5(16)	8.5(21)
2	*		33.5(12)	20.5(10)	0(39)	16.5(14)	29(14)	39(18)
3	*	-		39(14)	15(41)	28(19)	369.5(42)	315(39)
4	*	-	-		0(38)	20.5(15)	28.5(13)	14(16)
5	**	**	**	**		44(33)	31(36)	0(45)
6	-	*	**	*	**		43.5(17)	0(21)
7	-	-	-	-	**	-		0(17)
8	**	*	-	*	**	**	**	

Table 4.9 Inter-reader bias test (Wilcoxon test) of Finnish sample C (Sd 30)

Reader	1	2	3	4	5	6	7	8
1		54(15)	45(20)	14(10)	0(39)	20(12)	30(13)	9(14)
2	-		66.5(20)	52.5(15)	0(40)	24(16)	73(20)	77(21)
3	*	-		66.5(19)	9(42)	50(24)	63(24)	48(16)
4	-	-	-		0(42)	0(11)	12(13)	9(10)
5	**	**	**	**		13.5(39)	0(37)	10(42)
6	-	*	**	**	**		78(18)	8(15)
7	-	-	*	*	**	-		14(18)
8	**	-	-	-	**	**	**	

Table 4.10 Inter-reader bias test (Wilcoxon test) of Finnish sample C (Sd 31)

Reader	1	2	3	4	5	6	7	8
1		7.5(5)	0(21)	0(10)	24(30)	9(6)	68(17)	7.5(19)
2	-		9.5(21)	6(11)	10.5(27)	3(5)	26(12)	0(17)
3	**	**		6.5(14)	0(39)	0(18)	12(25)	13.5(9)
4	**	*	**		0(35)	0(8)	17(16)	6(14)
5	**	**	**	**		11.5(29)	22(27)	0(34)
6	-	-	**	**	**		37(13)	8.5(19)
7	-	-	**	**	**	-		10.5(24)
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 cell: T value (number of differences)

Table 4.11 Inter-reader bias test (Wilcoxon test) of Finnish sample D (Sd 32)

Reader	1	2	3	4	5	6	7	8
1		0(12)	0(27)	0(18)	23(26)	5(11)	25.5(17)	68(31)
2	**		31.5(20)	28(13)	12(32)	45(15)	35(15)	0(22)
3	**	**		40(19)	0(36)	0(19)	9(19)	0(13)
4	**	-	*		11(35)	6.5(12)	34(17)	0(18)
5	**	**	**	**		22(31)	13(32)	0(33)
6	*	-	**	**	**		68(16)	0(23)
7	*	-	**	*	**	-		0(24)
8	**	**	**	**	**	**	**	

Table 4.12 Inter-reader bias test (Wilcoxon test) of German sample D (Sd 24)

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	**	-	**	-	**	**	**	

Table 4.13 Inter-reader bias test (Wilcoxon test) of Latvian sample (Sd 28)

Reader	1	2	3	4	5	6	7	8
1		6.5(13)	192(38)	34.5(29)	320(34)	55(24)	100(27)	23(61)
2	**		197(33)	87.5(28)	236.5(38)	90(21)	71.5(31)	26(58)
3	**	-		256(33)	273(46)	225(34)	294(53)	37(65)
4	**	**	-		124(39)	63(22)	102(45)	13(71)
5	-	-	**	**		276(42)	343(41)	55.5(70)
6	**	-	-	*	*		101(37)	26(58)
7	*	**	**	**	-	**		40.5(66)
8	**	**	**	**	**	**	**	

Table 4.14 Inter-reader bias test (Wilcoxon test) of Polish sample (Sd 25)

Reader	1	2	3	4	5	6	7	8
1		66.5(22)	28(32)	69.5(19)	0(54)	13(19)	78(24)	61.5(21)
2	-		35.5(25)	24(12)	0(55)	32(17)	53(14)	85.5(19)
3	**	**		40.5(30)	0(49)	121.5(27)	75(27)	67.5(28)
4	-	-	**		0(56)	16(19)	70(21)	54(18)
5	**	**	**	**		0(50)	0(56)	0(55)
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 cell: T value (number of differences)

Table 4.15 Inter-reader bias test (Wilcoxon test) of Polish sample (Sd 26)

Reader	1	2	3	4	5	6	7	8
1		14(13)	80.5(21)	24(14)	5(46)	85(18)	51(17)	19(21)
2	*		57.5(24)	32.5(12)	0(47)	23(14)	32.5(13)	19.5(14)
3	-	**		60(22)	0(45)	256.5(27)	80.5(23)	58(31)
4	-	-	*		5(50)	20(12)	46.5(15)	21(15)
5	**	**	**	**		4.5(47)	0(50)	0(49)
6	-	-	-	-	**		58.5(17)	34.5(20)
7	-	-	-	-	**	-		6(14)
8	**	*	**	*	**	**	**	

Table 4.16 Inter-reader bias test (Wilcoxon test) of Russian sample (Sd 26)

Reader	1	2	3	4	5	6	7	8
1		9.5(32)	171.5(36)	60.5(35)	289.5(44)	54(28)	122(30)	48(48)
2	**		36(27)	90.5(21)	0(57)	18(21)	14.5(44)	70.5(38)
3	*	**		120.5(32)	70(44)	184(28)	192.5(46)	61.5(52)
4	**	-	**		18.5(51)	57.5(22)	13(41)	35(34)
5	*	**	**	**		32(43)	420(41)	39.5(65)
6	**	**	-	*	**		33.5(33)	59(44)
7	*	**	**	**	-	**		46(56)
8	**	**	**	**	**	**	**	

Table 4.17 Inter-reader bias test (Wilcoxon test) of Swedish sample (Sd 25)

Reader	1	2	3	4	5	6	7	8
1		8(7)	21(9)	0(6)	0(43)	18(9)	46(20)	22(12)
2	-		42.5(13)	10(10)	0(42)	26.5(10)	38.5(17)	16.5(12)
3	-	-		36.5(14)	12.5(41)	45.5(14)	36(17)	16.5(13)
4	*	-	-		28(40)	4.5(10)	123(23)	24(16)
5	**	**	**	**		13(40)	27(38)	0(43)
6	-	-	-	*	**		66(20)	41.5(15)
7	*	-	-	-	**	-		30.5(22)
8	-	-	*	*	**	-	**	

Table 4.18 Inter-reader bias test (Wilcoxon test) of Swedish sample (Sd 27)

Reader	1	2	3	4	5	6	7	8
1		42(13)	6(15)	11(11)	12(26)	11.5(12)	7.5(15)	0(14)
2	-		5.5(14)	10(10)	28(30)	13.5(11)	12(12)	15(16)
3	**	**		3.5(9)	0(37)	6(9)	36(13)	38(13)
4	-	-	*		15.5(34)	12(7)	26(13)	4(11)
5	**	**	**	**		33(36)	17(38)	13(36)
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 cell: T value (number of differences)

Table 4.19 Estonian 1st sample, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	77.5	69.0	70.6	60.8	68.6	85.3	29.6	65.9
2		-	69.0	70.6	56.9	67.6	79.4	29.6	64.4
3			-	69.0	55.0	70.0	68.0	24.5	60.6
4				-	53.9	69.6	70.6	36.7	63.0
5					-	54.9	59.8	17.3	51.2
6						-	71.6	36.7	62.7
7							-	27.6	66.0
8								-	28.9

Table 4.20 Finnish 1st sample, SD 29, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	64.0	62.0	64.0	30.0	80.0	68.0	57.1	60.7
2		-	76.0	80.0	22.0	70.0	72.0	63.3	63.9
3			-	72.0	18.0	62.0	66.0	61.2	59.6
4				-	24.0	70.0	74.0	67.3	64.5
5					-	34.0	28.0	8.2	23.5
6						-	66.0	57.1	62.7
7							-	65.3	62.8
8								-	54.2

Table 4.21 Finnish 1st sample, SD 30, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	69.4	60.0	80.0	22.0	76.0	74.0	70.8	64.6
2		-	59.2	69.4	18.4	67.3	59.2	57.4	57.2
3			-	62.0	16.0	52.0	52.0	66.7	52.6
4				-	16.0	78.0	74.0	79.2	65.5
5					-	22.0	26.0	12.5	19.0
6						-	64.0	68.8	58.8
7							-	62.5	59.7
8								-	59.7

Table 4.22 Finnish 1st sample, SD31, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	87.5	58.0	80.0	40.0	88.0	66.0	56.8	68.0
2		-	56.3	77.1	43.8	87.5	75.0	60.5	69.7
3			-	72.0	26.0	64.0	50.0	79.5	58.0
4				-	30.0	84.0	68.0	68.2	68.5
5					-	42.0	46.0	22.7	35.8
6						-	74.0	56.8	70.9
7							-	45.5	60.6
8								-	55.7

Table 4.23 Finnish 1st sample, SD 32, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	74.5	44.9	64.0	48.0	78.0	64.0	33.3	58.1
2		-	56.5	72.3	31.9	68.1	68.1	45.0	59.5
3			-	61.2	26.5	61.2	61.2	69.0	54.4
4				-	30.0	76.0	66.0	57.1	60.9
5					-	38.0	36.0	21.4	33.1
6						-	68.0	45.2	62.1
7							-	42.9	58.0
8								-	44.8

Table 4.24. German 1st sample, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	52.5	69.7	50.0	8.2	36.0	43.4	49.5	44.2
2		-	53.5	68.0	4.1	44.4	25.3	53.5	43.0
3			-	72.0	1.0	36.0	32.0	54.0	45.5
4				-	0.0	44.0	6.0	58.0	42.6
5					-	2.0	8.1	2.0	3.6
6						-	22.0	45.0	32.8
7							-	16.0	21.8
8								-	39.7

Table 4.25 Latvian 1st sample, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	87.0	62.0	71.0	65.0	76.0	73.0	37.8	67.4
2		-	67.0	72.0	62.0	79.0	69.0	38.8	67.8
3			-	67.0	54.0	66.0	47.0	33.7	56.7
4				-	61.0	78.0	55.0	43.9	64.0
5					-	58.0	59.0	12.1	53.0
6						-	63.0	40.8	65.8
7							-	32.0	56.9
8								-	34.2

Table 4.26 Polish 1st sample, SD 25, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	65.1	48.4	69.8	14.3	69.8	61.9	65.6	56.4
2		-	59.7	81.0	12.7	73.0	79.4	68.9	62.8
3			-	51.6	19.4	56.5	56.5	54.1	49.5
4				-	11.1	69.8	66.7	70.5	60.1
5					-	20.6	11.1	9.8	14.1
6						-	66.7	67.2	60.5
7							-	67.2	58.5
8								-	57.6

Table 4.27 Polish 1st sample, SD 26, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	75.0	59.6	74.1	13.0	66.7	68.5	57.4	59.2
2		-	53.8	76.9	9.6	73.1	75.0	73.1	62.4
3			-	57.7	13.5	48.1	53.8	40.4	46.7
4				-	7.4	77.8	72.2	71.2	62.5
5					-	13.0	7.4	1.9	9.4
6						-	68.5	61.5	58.4
7							-	73.1	59.8
8								-	53.5

Table 4.28 Russian 1st sample, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	68.0	64.0	65.0	56.0	72.0	70.0	52.0	63.9
2		-	73.0	79.0	43.0	79.0	56.0	62.0	65.7
3			-	68.0	53.0	72.0	54.0	48.0	61.7
4				-	49.0	78.0	59.0	66.0	66.3
5					-	57.0	59.0	35.0	50.3
6						-	67.0	56.0	68.7
7							-	44.0	58.4
8								-	51.9

Table 4.29 Swedish 1st sample, SD 25, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	86.0	72.0	88.0	14.0	82.0	60.0	76.0	68.3
2		-	74.0	80.0	16.0	80.0	66.0	76.0	68.3
3			-	72.0	20.0	72.0	66.0	74.0	64.3
4				-	20.0	78.0	54.0	68.0	65.7
5					-	20.0	24.0	14.0	18.3
6						-	60.0	70.0	66.0
7							-	56.0	55.1
8								-	62.0

Table 4.30 Swedish 1st sample, SD 27, percentage agreement of individual readers

Reader	1	2	3	4	5	6	7	8	Mean
1	-	74.0	70.0	78.0	48.0	76.0	70.0	72.0	69.7
2		-	72.0	80.0	40.0	78.0	76.0	68.0	69.7
3			-	82.0	26.0	82.0	74.0	74.0	68.6
4				-	32.0	86.0	74.0	78.0	72.9
5					-	28.0	24.0	28.0	32.3
6						-	80.0	76.0	72.3
7							-	64.0	66.0
8								-	65.7

Table [illegible].1. General Linear Models Procedure
Class Level Information

Class	Levels	Values
SAMPLE	3	GERMANY POLAND SWEDEN
SUBDIV	4	24 25 26 27
AGESTAND	9	0 1 2 3 4 5 6 7 9
READER	10	1 2 3 4 5 6 7 8 9 10

Number of observations in data set = 4340

NOTE: Due to missing values, only 4330 observations can be used in this analysis.

Dependent Variable: AGE Age

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	129	13749.493625	106.585222	290.32	0.0001
Error	4200	1541.971733	0.367136		
Corrected Total	4329	15291.465358			

R-Square	C.V.	Root MSE	AGE Mean
0.899161	16.68441	0.6059176	3.6316397

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SAMPLE	2	522.332773	261.166386	711.36	0.0001
SUBDIV	2	1074.090975	537.045488	1462.80	0.0001
AGESTAND	8	11292.821028	1411.602629	3844.90	0.0001
READER	9	427.551081	47.505676	129.40	0.0001
SUBDIV*READER	27	165.532288	6.130825	16.70	0.0001
SAMPLE*READER	9	87.987861	9.776429	26.63	0.0001
AGESTAND*READER	72	179.177619	2.488578	6.78	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SAMPLE	1	0.302039	0.302039	0.82	0.3644
SUBDIV	2	3.047818	1.523909	4.15	0.0158
AGESTAND	8	11284.622828	1410.577853	3842.11	0.0001
READER	9	134.343635	14.927071	40.66	0.0001
SUBDIV*READER	18	8.972053	0.498447	1.36	0.1419
SAMPLE*READER	9	74.410042	8.267782	22.52	0.0001
AGESTAND*READER	72	179.177619	2.488578	6.79	0.0001

Table 5.2. Ryan-Einot-Gabriel-Welsch Multiple Range Test for variable: AGE

Means with the same letter are not significantly different.

REGWQ Grouping	Mean	N	READER
A	4.42166	434	7
B	3.76498	434	4
B			
B	3.74885	434	9
B			
B	3.70670	433	2
B			
B	3.70507	434	1
C	3.49539	434	6
C			
C	3.44393	428	8
C			
C	3.43187	433	3
C			
C	3.37963	432	10
D	3.21429	434	5

Bonferroni (Dunn) T tests for variable: AGE

Means with the same letter are not significantly different.

Bon Grouping	Mean	N	READER
A	4.42166	434	7
B	3.76498	434	4
B			
B	3.74885	434	9
B			
B	3.70670	433	2
B			
B	3.70507	434	1
C	3.49539	434	6
C			
C	3.44393	428	8
C			
C	3.43187	433	3
C			
C	3.37963	432	10
D	3.21429	434	5

Scheffe's test for variable: AGE

Means with the same letter are not significantly different.

Scheffe Grouping		Mean	N	READER
	A	4.42166	434	7
	B	3.76498	434	4
	B			
	B	3.74885	434	9
	B			
	B	3.70670	433	2
	B			
	B	3.70507	434	1
	C	3.49539	434	6
	C			
	C	3.44393	428	8
	C			
	C	3.43187	433	3
	C			
D	C	3.37963	432	10
D				
D		3.21429	434	5

Table 5.3. Models of readers 1, 2, 3, 4, 5, 6, 7, 8 and 10

Reader 1: read age = 1.056707 x standardized age (0.98)
Reader 2: read age = 1.059508 x standardized age (0.98)
Reader 3: read age = 0.440421 + 0.854418 x standardized age (0.86)
Reader 4: read age = 0.128615 + 1.039645 x standardized age (0.91)
Reader 5: read age = 0.367420 + 0.813926 x standardized age (0.89)
Reader 6: read age = 0.997187 x standardized age (0.98)
Reader 7: read age = 0.901144 + 1.006524 x standardized age (0.82)
Reader 8: read age = 0.349145 + 0.892565 x standardized age (0.84)
Reader 10: read age = 0.963922 x standardized age (0.98)

Table 5.4. Model of reader 9

Reader 9
SD 24: read age = 1.392311 + 0.852292 x standardized age (0.77)
SD 25: read age = 1.569846 + 0.614394 x standardized age (0.55)
SD 26: read age = 0.318840 + 0.719842 x standardized age (0.87)
SD 27: read age = 1.186352 + 0.877297 x standardized age (0.88)

Table 5.5. Calibration models of readers 1, 2, 3, 4, 5, 6, 7, 8 and 10

Reader 1: standardized age = read age / 1.056707
Reader 2: standardized age = read age / 1.059508
Reader 3: standardized age = (read age - 0.440421) / 0.854418
Reader 4: standardized age = (read age - 0.128615) / 1.039645
Reader 5: standardized age = (read age - 0.367420) / 0.813926
Reader 6: standardized age = read age / 0.997187
Reader 7: standardized age = (read age - 0.854418) / 1.006524
Reader 8: standardized age = (read age - 1.039645) / 0.892565
Reader 10: standardized age = read age / 0.963922

Table 5.6. Calibration model of reader 9

Reader 9
SD 24: standardized age = (read age - 1.392311) / 0.852292
SD 25: standardized age = (read age - 1.569846) / 0.614394
SD 26: standardized age = (read age - 0.318840) / 0.719842
SD 27: standardized age = (read age - 1.186352) / 0.877297

Table 5.7 Inter-reader bias test (Wilcoxon test) of the second Estonian sample (Sd 32)

	1	2	3	4	5	6	7	8	9	10
1		16.5(11)	125(28)	45(17)	14(18)	4(9)	225.5(46)	126.5(25)	210.5(85)	48(16)
2	-		130(25)	52.5(14)	14(14)	8(7)	35(36)	95(19)	0(81)	30(11)
3	-	-		88(21)	45(17)	144(75)	19.5(41)	88(21)	0(84)	103.5(22)
4	-	-	-		7.5(14)	26(12)	84(43)	175.5(26)	0(83)	42(13)
5	**	*	-	**		13(12)	0(44)	55(21)	0(90)	6.5(12)
6	*	-	-	-	*		38(40)	90(20)	0(85)	13.5(8)
7	**	**	**	**	**	**		55.5(38)	54(53)	36(37)
8	-	-	-	-	*	-	**		0(77)	132(23)
9	**	**	**	**	**	**	**	**		0(81)
10	-	-	-	-	**	-	**	-	**	

Table 5.8 Inter-reader bias test (Wilcoxon test) of the second Finnish sample (Sd 29)

	1	2	3	4	5	6	7	8	9	10
1		0(9)	7.5(16)	7(7)	5(12)	3.5(8)	33(26)	5.5(18)	147(39)	20(9)
2	**		10(9)	0(11)	18(9)	0(13)	0(26)	5(15)	58.5(41)	3(7)
3	**	-		0(17)	36(10)	7(19)	0(30)	3.5(12)	42(44)	0(9)
4	-	**	**		0(12)	7(7)	9(20)	0(17)	176.5(40)	9(7)
5	**	-	-	**		5(15)	0(27)	0(11)	37.5(38)	0(8)
6	*	**	**	-	**		41(22)	4.5(19)	154(30)	3(6)
7	**	**	**	**	**	**		0(30)	144.5(29)	7.5(18)
8	**	**	**	**	**	**	**		0(45)	0(12)
9	**	**	**	**	**	-	-	**		87(36)
10	-	-	**	-	**	-	**	**	**	

Table 5.9 Inter-reader bias test (Wilcoxon test) of the second Finnish sample (Sd 30)

	1	2	3	4	5	6	7	8	9	10
1		24(12)	7.5(16)	5(12)	5(13)	0(11)	34.5(27)	0(19)	60(34)	66.5(16)
2	-		5.5(11)	6.5(16)	4(9)	6.5(17)	10.5(25)	0(14)	35(37)	63(17)
3	**	*		0(20)	25(10)	0(21)	0(30)	15(14)	16.5(40)	30(17)
4	**	**	**		0(20)	18(9)	96(27)	7.5(23)	175(36)	34(18)
5	**	*	-	**		0(18)	0(28)	22(15)	0(38)	30(17)
6	**	**	**	-	**		89(25)	0(22)	192(35)	31(18)
7	**	**	**	*	**	*		0(31)	196.5(29)	38(29)
8	**	**	*	**	*	**	**		13.5(40)	27(20)
9	**	**	**	*	**	*	-	**		112(37)
10	-	-	*	*	*	*	**	**	**	

Table 5.10 Inter-reader bias test (Wilcoxon test) of the second Finnish sample (Sd 31)

	1	2	3	4	5	6	7	8	9	10
1		0(4)	0(14)	15(10)	2.5(5)	2.5(4)	0(36)	2.5(5)	0(31)	3(5)
2	-		15(14)	9(10)	10.5(6)	3.5(7)	0(38)	5(5)	0(33)	0(7)
3	**	*		0(15)	22.5(15)	0(16)	0(45)	12(12)	0(42)	0(15)
4	-	-	**		10(10)	15(9)	80(39)	3.5(7)	64(34)	10.5(7)
5	-	-	*	-		3.5(7)	19(39)	5(5)	0(32)	3.5(7)
6	-	-	**	-	-		18.5(36)	3(6)	0(28)	18(8)
7	**	**	**	**	**	**		0(32)	94.5(20)	17.5(34)
8	-	-	*	-	-	-	**		0(30)	3.5(7)
9	**	**	**	**	**	**	-	**		15(30)
10	-	*	**	-	-	-	**	-	**	

- : 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 5.11 Inter-reader bias test (Wilcoxon test) of the second Finnish sample (Sd 32)

	1	2	3	4	5	6	7	8	9	10
1		0(20)	0(26)	24(13)	0(21)	21(12)	100(20)	38.5(36)	195.5(29)	0(25)
2	**		22.5(14)	7.5(17)	34(12)	0(25)	22(26)	34(27)	75(33)	37.5(15)
3	**	-		9.5(23)	45(16)	0(32)	0(28)	26.5(21)	42(34)	36(12)
4	-	**	**		0(18)	23.5(17)	70(21)	31.5(31)	154(28)	22(24)
5	**	-	-	**		25(29)	10.5(25)	36(26)	79(31)	11(10)
6	-	**	**	*	**		127.5(24)	35.5(38)	256(33)	25.5(30)
7	-	**	**	-	**	-		42.5(39)	292.5(34)	11(27)
8	**	**	**	**	**	**	**		12.5(38)	41.5(23)
9	-	**	**	**	**	-	-	**		69.5(32)
10	**	-	-	**	-	**	**	**	**	

Table 5.12 Inter-reader bias test (Wilcoxon test) of the second German sample (Sd 24)

	1	2	3	4	5	6	7	8	9	10
1		153(38)	318.5(55)	66(42)	212(39)	307(37)	37(79)	114(48)	54(71)	217.5(31)
2	**		527(51)	140(33)	103.5(44)	159(40)	194(66)	387(51)	356(74)	251.5(41)
3	**	-		433(45)	256(65)	192(52)	172(76)	331(37)	276(61)	314(53)
4	**	*	-		88.5(56)	78(47)	227(73)	538(47)	473(64)	51.5(38)
5	*	**	**	**		194.5(35)	47(90)	22.5(57)	30.5(84)	234.5(41)
6	-	**	**	**	*		121(86)	144(56)	205(84)	168(29)
7	**	**	**	**	**	**		318(77)	501.5(66)	108(80)
8	**	**	-	-	**	**	**		396(60)	155.5(48)
9	**	**	**	**	**	**	**	**		187(77)
10	-	*	**	**	*	-	**	**	-	

Table 5.13 Inter-reader bias test (Wilcoxon test) of the second Latvian sample (Sd 28)

	1	2	3	4	5	6	7	8	9	10	11
1		147(24)	137.5(66)	80(44)	78(61)	152.5(67)	245(38)	154(55)	673.5(57)	82(45)	84(30)
2	-		132.5(63)	42(35)	109(55)	156(61)	178.5(33)	144(48)	827.5(63)	87.5(41)	150(34)
3	**	**		64(34)	150(26)	137.5(27)	100(67)	170.5(32)	375(66)	62.5(31)	163(74)
4	**	**	**		48(27)	149(35)	33(44)	99(26)	630(61)	92.5(20)	60(53)
5	**	**	-	**		169.5(27)	37(56)	153(28)	376.5(66)	18(23)_	82.5(74)
6	**	**	-	**	-		21.5(58)	327(38)	546.5(69)	72.5(30)	76.5(68)
7	-	-	**	**	**	**		74(52)	750(66)	39(48)	70.5(21)
8	**	**	-	-	-	-	**		469(63)	85.5(25)	90(57)
9	-	-	**	*	**	**	*	**		840.5(63)	584(63)
10	**	**	**	-	**	**	**	*	-		39(51)
11	**	*	**	**	**	**	-	**	**	**	

Table 5.14 Inter-reader bias test (Wilcoxon test) of second Lithuanian sample (Sd 26)

	1	2	3	4	5	6	7	8	9	10
1		165(40)	274.5(64)	205.5(51)	252(76)	335(55)	365(50)	204(63)	843.5(59)	145(29)
2	**		97.5(65)	98.5(54)	69(76)	196.5(64)	790.5(58)	139.5(68)	142.5(43)	142.5(43)
3	**	**		253.5(40)	351(51)	308.5(43)	190.5(73)	248(34)	347.5(66)	204(54)
4	**	**	*		253(56)	336(37)	201.5(64)	195(40)	489(66)	195(43)
5	**	**	**	**		214(53)	101(78)	268.5(44)	219(71)	111.5(61)
6	**	**	*	-	**		193(62)	174.5(37)	677.5(71)	117.5(37)
7	**	-	**	**	**	**		100(68)	581.5(59)	366(54)
8	**	**	-	**	**	**	**		291.5(68)	82(49)
9	-	-	**	**	**	**	*	**		712.5(59)
10	-	**	**	**	**	**	**	**	-	

- : 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. 15 Inter-reader bias test (Wilcoxon test) of the second Polish sample (Sd 25)

	1	2	3	4	5	6	7	8	9	10	11
1		97(24)	155.5(48)	86.5(20)	19.5(44)	139.5(30)	49.5(40)	82.5(30)	74.5(50)	96.5(33)	0(48)
2	-		32(42)	96(22)	17(44)	56(30)	90(41)	9.5(26)	48(50)	14(31)	47(50)
3	**	**		123(46)	84(22)	75(31)	0(61)	117.5(27)	81(36)	72(25)	0(73)
4	-	-	**		34(44)	89(29)	82.5(38)	21(26)	60.5(49)	131.5(37)	20.5(45)
5	**	**	-	**		24(29)	24(67)	25(25)	122(35)	48(28)	0(74)
6	-	**	**	**	**		98(56)	52.5(18)	69.5(43)	84(22)	58.5(66)
7	**	**	**	**	**	**		0(49)	54(65)	0(56)	50(24)
8	**	**	-	**	**	-	**		35(35)	45.5(13)	0(61)
9	**	**	**	**	**	**	**	**		51.5(39)	62(75)
10	**	**	*	**	**	-	**	-	**		0(69)
11	**	**	**	**	**	**	**	**	**	**	

Table 5.16Inter-reader bias test (Wilcoxon test) of the second Polish sample (Sd 26)

	1	2	3	4	5	6	7	8	9	10	11
1		40(20)	82.5(41)	42(21)	14(39)	64(28)	68(37)	12(31)	0(45)	12.5(33)	0(37)
2	*		64(30)	85(18)	8.5(22)	80.5(21)	79(45)	50(28)	0(36)	24(27)	0(46)
3	**	**		36(29)	80(20)	57.5(27)	0(58)	95(19)	39(31)	85(18)	0(61)
4	**	-	**		9.5(28)	30(15)	56(43)	14(21)	0(41)	10(24)	0(47)
5	**	**	-	**		9.5(23)	0(61)	49(18)	52(29)	120(25)	0(61)
6	**	-	**	-	**		64.5(51)	37.5(21)	0(35)	28.5(21)	21(53)
7	**	**	**	**	**	**		20.5(55)	0(66)	49.5(58)	63(19)
8	**	**	-	**	-	**	**		28(31)	107(21)	0(55)
9	**	**	**	**	**	**	**	**		25.5(25)	0(66)
10	**	**	-	**	-	**	**	-	**		0(60)
11	**	**	**	**	**	**	-	**	**	**	

Table 5.17 Inter-reader bias test (Wilcoxon test) of the second Russian sample (Sd 26)

	1	2	3	4	5	6	7	8	9	10	11
1		122.5(21)	35(48)	60(36)	122(46)	198(33)	218(40)	193.5(38)	30(39)	52.5(45)	173(36)
2	-		97(47)	126(37)	85(38)	197(29)	180(42)	198(33)	8.5(33)	74(43)	120(37)
3	**	**		87(35)	323(41)	31(42)	42(71)	205(50)	476.5(54)	318.5(40)	21.5(69)
4	**	**	**		280.5(41)	48(27)	81.5(59)	269.5(33)	332(58)	308.5(42)	55.5(57)
5	**	**	-	-		117.5(40)	66(68)	331.5(49)	326(51)	388.5(39)	58(61)
6	-	-	**	**	**		160(40)	207.5(33)	37.5(38)	107.5(42)	134.5(39)
7	*	**	**	**	**	**		106.5(48)	76(71)	120.5(67)	189(27)
8	*	-	**	-	**	-	**		98(52)	329(49)	110.5(47)
9	**	**	*	**	**	**	**	**		337(51)	18(67)
10	**	**	-	-	-	**	**	**	**		64.5(67)
11	*	**	**	**	**	**	-	**	**	**	

- : 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 5.18 Inter-reader bias test (Wilcoxon test) of the second Swedish sample (Sd 27)

	1	2	3	4	5	6	7	8	9	10
1		35.5(15)	13(29)	19(19)	0(31)	21(22)	23.5(50)	0(27)	294.5(56)	66.5(32)
2	-		24(25)	54.5(19)	12.5(32)	38.5(20)	0(54)	10(26)	168(56)	106(32)
3	**	**		20(19)	27(19)	17.5(13)	29(70)	57(20)	65(68)	123(23)
4	**	-	**		0(25)	38(14)	30.5(65)	7(20)	178.5(62)	58.5(23)
5	**	**	**	**		9.5(22)	0(70)	57(17)	0(70)	125(27)
6	**	*	-	-	**		0(67)	28(20)	132(66)	96.5(25)
7	**	**	**	**	**	**		0(66)	57(22)	62.5(64)
8	**	**	-	**	-	**	**		0(65)	171(28)
9	**	**	**	**	**	**	*	**		132.5(62)
10	**	**	-	*	-	-	**	-	**	

Table 5.19 Inter-reader bias test (Wilcoxon test) of the second Swedish sample (Sd 25)

	1	2	3	4	5	6	7	8	9	10
1		87.5(25)	32(37)	249(30)	42(38)	117.5(40)	16(37)	105(39)	97.5(43)	0(37)
2	*		37.5(30)	60(24)	28(30)	132(33)	0(47)	112(35)	50(52)	0(25)
3	**	**		26(30)	90.5(21)	105(25)	0(62)	198(28)	0(65)	66.5(16)
4	-	**	**		26(38)	66(36)	39(41)	87.5(39)	342(58)	0(33)
5	**	**	-	**		100(27)	19.5(60)	183(29)	0(69)	105(22)
6	**	**	-	**	*		26.5(63)	259.5(36)	50(61)	59.5(21)
7	**	**	**	**	**	**		17.5(53)	279(35)	0(63)
8	**	**	-	**	-	-	**		46(62)	167(26)
9	**	**	**	**	**	**	-	**		27(67)
10	**	**	-	**	-	-	**	-	**	

- : 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 5.20 Estonian 2nd sample, percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		88.8	71.7	82.8	81.8	90.9	53.5	74.2	14.1	83.5	71.3
2			74.5	85.7	85.9	92.9	63.3	80.4	17.3	88.7	75.3
3				79.0	82.8	75.8	59.0	78.4	15.2	77.6	68.2
4					85.9	87.9	57.0	73.2	16.2	86.7	72.7
5						87.9	55.6	78.4	9.1	87.6	72.8
6							59.6	79.4	14.1	91.8	75.6
7								60.8	46.5	62.2	57.5
8									20.6	76.3	69.1
9										16.5	18.8
10											74.5

Table 5. 21 Finnish second sample (Sd 29), percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		82.0	68.0	86.0	76.0	84.0	48.0	61.7	22.0	79.1	67.4
2			82.0	78.0	82.0	74.0	48.0	68.1	18.0	83.7	68.4
3				66.0	80.0	62.0	40.0	73.9	12.0	79.1	62.6
4					76.0	86.0	60.0	63.0	20.0	83.7	68.7
5						70.0	46.0	76.1	24.0	81.4	67.9
6							56.0	58.7	40.0	86.0	68.5
7								34.8	42.0	58.1	48.1
8									2.2	72.1	56.7
9										16.3	21.8
10											71.1

Table 5.22 Finnish second sample (Sd 30), percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		76.0	68.0	76.0	74.0	78.0	46.0	62.0	32.0	68.0	64.4
2			78.0	68.0	82.0	66.0	50.0	72.0	26.0	66.0	64.9
3				60.0	80.0	58.0	40.0	72.0	20.0	66.0	60.2
4					60.0	82.0	46.0	54.0	28.0	64.0	59.8
5						64.0	44.0	70.0	24.0	66.0	62.7
6							50.0	56.0	30.0	64.0	60.9
7								38.0	42.0	42.0	44.2
8									20.0	60.0	56.0
9										26.0	27.6
10											58.0

Table 5.23 Finnish second sample (Sd 31), percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		92.0	72.0	80.0	90.0	92.0	28.0	88.6	38.0	89.6	74.5
2			72.0	80.0	88.0	86.0	24.0	88.6	34.0	85.4	72.2
3				70.0	70.0	68.0	10.0	72.7	16.0	68.8	57.7
4					80.0	82.0	22.0	84.1	32.0	85.4	68.4
5						86.0	22.0	88.6	36.0	85.4	71.8
6							28.0	86.4	44.0	83.3	72.9
7								27.3	60.0	29.2	27.8
8									31.8	83.3	72.4
9										37.5	36.6
10											72.0

Table 5.24 Finnish second sample (Sd 32), percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		60.0	48.0	74.0	58.0	76.0	60.0	20.0	42.0	47.9	54.0
2			72.0	66.0	76.0	50.0	48.0	40.0	34.0	68.8	57.2
3				54.0	68.0	36.0	44.0	53.3	32.0	75.0	53.6
4					64.0	66.0	58.0	31.1	44.0	50.0	56.3
5						42.0	50.0	42.2	38.0	79.2	57.5
6							52.0	15.6	34.0	37.5	45.5
7								13.3	32.0	43.8	44.6
8									15.6	47.7	31.0
9										33.3	33.9
10											53.7

Table 5.25 German second sample (Sd 24), percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		62.0	45.0	58.0	61.0	63.0	21.0	52.0	29.0	69.0	51.1
2			49.0	67.0	56.0	60.0	34.0	49.0	26.0	59.0	51.3
3				55.0	35.0	48.0	24.0	63.0	39.0	47.0	46.9
4					44.0	53.0	27.0	53.0	36.0	62.0	50.6
5						65.0	10.0	43.0	16.0	59.0	43.2
6							14.0	44.0	16.0	71.0	48.2
7								23.0	34.0	20.0	23.0
8									40.0	52.0	46.6
9										23.0	28.8
10											51.3

Table 5.26 Latvian second sample, percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	11	Mean
1		76.0	34.0	56.0	39.0	32.3	62.0	41.5	43.0	53.1	70.0	50.7
2			37.0	65.0	45.0	38.4	67.0	48.9	37.0	57.3	66.0	53.8
3				66.0	74.0	72.7	33.0	66.0	34.0	67.7	26.0	51.0
4					73.0	64.6	56.0	72.3	39.0	79.2	47.0	61.8
5						72.7	44.0	70.2	34.0	76.0	26.0	55.4
6							41.4	59.6	30.3	68.8	31.3	51.2
7								44.7	34.0	50.0	79.0	51.1
8									33.0	73.1	39.4	54.9
9										34.4	37.0	35.6
10											46.9	60.7
11												46.9

Table 5.27 Lithuanian 2nd sample, percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		60.0	36.0	49.0	24.0	45.0	50.0	35.7	41.0	69.8	45.6
2			35.0	46.0	24.0	36.0	42.0	30.6	42.0	55.2	41.2
3				60.0	49.0	57.0	27.0	65.3	34.0	43.8	45.2
4					44.0	63.0	36.0	59.2	34.0	55.2	49.6
5						47.0	22.0	55.1	29.0	36.5	36.7
6							38.0	62.2	29.0	61.5	48.7
7								30.6	41.0	43.8	36.7
8									30.6	49.0	46.5
9										38.5	35.5
10											50.4

Table 5.28 Polish second sample (Sd 25), percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	11	Mean
1		71.4	42.9	76.2	47.6	64.3	52.4	60.7	40.5	60.7	42.9	56.0
2			50.0	73.8	47.6	64.3	51.2	67.9	40.5	63.1	40.5	57.0
3				45.2	73.8	63.7	27.4	66.7	57.1	70.2	13.1	51.0
4					47.6	65.5	54.8	67.9	41.7	56.0	45.2	57.4
5						65.5	20.2	69.1	58.3	66.7	11.9	50.8
6							33.3	77.8	48.8	73.8	21.4	57.8
7								39.5	22.6	33.3	71.4	40.6
8									58.3	84.0	27.4	61.9
9										53.6	10.7	43.2
10											17.9	57.9
11												30.2

Table 5.29 Polish second sample (Sd 26), percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	11	Mean
1		79.8	59.0	79.0	61.0	72.0	63.0	68.0	55.0	66.7	63.0	66.7
2			69.7	81.8	77.8	78.8	54.5	71.1	63.6	72.7	53.5	70.3
3				71.0	80.0	73.0	42.0	80.4	69.0	81.8	39.0	66.5
4					72.0	85.0	57.0	78.4	59.0	75.8	53.0	71.2
5						77.0	39.0	81.4	71.0	74.7	39.0	67.3
6							49.0	78.4	65.0	78.8	47.0	70.4
7								43.3	34.0	41.4	81.0	50.4
8									68.0	78.4	43.3	69.1
9										74.7	34.0	59.3
10											39.4	68.4
11												49.2

Table 5.30 Russian second sample, percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	11	Mean
1		72.7	38.5	53.8	41.0	57.7	48.7	49.3	50.0	42.3	53.8	50.8
2			40.5	53.2	51.9	62.3	46.2	56.0	57.7	45.6	52.6	53.9
3				64.3	58.2	46.2	27.6	46.2	44.3	59.2	28.9	45.4
4					59.0	65.4	39.2	64.5	40.2	57.1	41.2	53.8
5						48.7	29.9	45.4	47.4	60.2	37.1	47.9
6							48.7	56.0	51.3	46.2	50.0	53.3
7								48.4	26.8	30.9	72.2	41.9
8									44.1	47.3	49.5	50.7
9										47.4	30.9	44.0
10											30.9	46.7
11												44.7

Table 5.31 Second Swedish sample (Sd 27), percentage agreement of I dividual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		80.0	60.8	78.7	58.7	70.7	33.3	64.0	25.3	57.3	58.8
2			66.2	78.7	57.3	73.3	28.0	65.3	25.3	57.3	59.0
3				74.3	78.7	82.7	6.7	73.3	17.3	69.3	58.8
4					66.7	81.3	13.3	73.3	17.3	69.3	61.4
5						70.7	6.7	77.3	6.7	64.0	54.1
6							10.7	73.3	12.0	66.7	60.2
7								12.0	70.7	14.7	21.8
8									13.3	62.7	57.2
9										17.3	22.8
10											53.2

Table 5.32 Second Swedish sample (Sd 25), percentage agreement of I dividual readers

	1	2	3	4	5	6	7	8	9	10	Mean
1		66.7	50.7	60.0	49.3	53.3	49.3	46.7	42.7	50.7	52.2
2			60.0	68.0	60.0	56.0	37.3	53.3	30.7	66.7	55.4
3				60.0	72.0	66.7	17.3	62.7	13.3	78.7	53.5
4					49.3	52.0	45.3	46.7	22.7	56.0	51.1
5						64.0	20.0	61.3	8.0	70.7	50.5
6							16.0	52.0	18.7	72.0	50.1
7								29.3	53.3	16.0	31.5
8									17.3	65.3	48.3
9										10.7	24.2
10											54.1

Table 6.1. General Linear Models Procedure
Class Level Information

Class	Levels	Values
SUBDIV	3	24 25 28
AGESTAND	11	0 1 2 3 4 5 6 7 8 9 10
READER	12	1 2 3 4 5 6 7 8 9 10 11 12

Number of observations in data set = 2400

NOTE: Due to missing values, only 2392 observations can be used in this analysis.

General Linear Models Procedure

Dependent Variable: AGE   Age

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	155	7629.7781168	49.2243749	117.22	0.0001
Error	2236	938.9572511	0.4199272		
Corrected Total	2391	8568.7353679			

R-Square	C.V.	Root MSE	AGE Mean
0.890421	14.47436	0.6480179	4.4770067

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SUBDIV	2	861.7342928	430.8671464	1026.05	0.0001
AGESTAND	10	6448.2365458	644.8236546	1535.56	0.0001
READER	11	152.9030604	13.9002782	33.10	0.0001
SUBDIV*READER	22	65.4619548	2.9755434	7.09	0.0001
AGESTAND*READER	110	101.4422630	0.9222024	2.20	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SUBDIV	2	32.2646936	16.1323468	38.42	0.0001
AGESTAND	10	6439.4634985	643.9463498	1533.47	0.0001
READER	11	49.6968321	4.5178938	10.76	0.0001
SUBDIV*READER	22	45.7763714	2.0807442	4.96	0.0001
AGESTAND*READER	110	101.4422630	0.9222024	2.20	0.0001

Table 6.2. Ryan-Einot-Gabriel-Welsch Multiple Range Test for variable: AGE

REGWQ Grouping	Mean	N	READER
A	4.93500	200	11
A			
A	4.89500	200	7
A			
A	4.84500	200	12
B	4.48744	199	8
B			

```
                 B           4.42714     199   3
                 B
       C         B           4.38500     200   5
       C         B
       C         B           4.36500     200   10
       C         B
       C         B           4.35000     200   1
       C         B
       C         B           4.30000     200   4
       C         B
       C         B           4.30000     200   9
       C
       C                     4.22165     194   2
       C
       C                     4.20500     200   6
```

Bonferroni (Dunn) T tests for variable: AGE

```
Bon Grouping              Mean         N  READER

                 A              4.93500    200   11
                 A
                 A              4.89500    200   7
                 A
                 A              4.84500    200   12

                 B              4.48744    199   8
                 B
       C         B              4.42714    199   3
       C         B
       C         B    D         4.38500    200   5
       C         B    D
       C         B    D         4.36500    200   10
       C         B    D
       C         B    D         4.35000    200   1
       C         B    D
       C         B    D         4.30000    200   4
       C         B    D
       C         B    D         4.30000    200   9
       C              D
       C              D         4.22165    194   2
                      D
                      D         4.20500    200   6
```

Scheffe's test for variable: AGE

```
Scheffe Grouping          Mean        N  READER

                 A       4.93500    200   11
                 A
                 A       4.89500    200   7
                 A
                 A       4.84500    200   12

                 B       4.48744    199   8
                 B
                 B       4.42714    199   3
                 B
                 B       4.38500    200   5
                 B
                 B       4.36500    200   10
                 B
```

Grouping	Mean	N	READER
B	4.35000	200	1
B			
B	4.30000	200	4
B			
B	4.30000	200	9
B			
B	4.22165	194	2
B			
B	4.20500	200	6

Table 6.3. Ryan-Einot-Gabriel-Welsch Multiple Range Test for variable: AGE

REGWQ Grouping		Mean	N	READER
	A	5.0800	50	7
	A			
B	A	4.7200	50	9
B	A			
B	A	4.6400	50	1
B	A			
B	A	4.6200	50	4
B	A			
B	A	4.4600	50	8
B	A			
B	A	4.3750	48	2
B				
B		4.2400	50	5
B				
B		4.1429	49	3
B				
B		4.1000	50	10
B				
B		4.0800	50	6

Bonferroni (Dunn) T tests for variable: AGE

Bon Grouping		Mean	N	READER
	A	5.0800	50	7
	A			
B	A	4.7200	50	9
B	A			
B	A	4.6400	50	1
B	A			
B	A	4.6200	50	4
B	A			
B	A	4.4600	50	8
B	A			
B	A	4.3750	48	2
B				
B		4.2400	50	5
B				
B		4.1429	49	3
B				
B		4.1000	50	10
B				
B		4.0800	50	6

Scheffe's test for variable: AGE

Scheffe Grouping   Mean   N   READER

```
A            5.0800     50   7
A
A            4.7200     50   9
A
A            4.6400     50   1
A
A            4.6200     50   4
A
A            4.4600     50   8
A
A            4.3750     48   2
A
A            4.2400     50   5
A
A            4.1429     49   3
A
A            4.1000     50   10
A
A            4.0800     50   6
```

Table 6.4

```
Reader  1: read age = 0.998242 x standardized age (0.98)
Reader  2: read age = 0.957476 x standardized age (0.98)
Reader  3: read age = 0.412486 + 0.914091 x standardized age (0.85)
Reader  4: read age = 0.979341 x standardized age (0.98)
Reader  5: read age = 0.333348 + 0.922928 standardized age (0.91)
Reader  6: read age =-0.307628 + 1.027934 standardized age (0.89)
Reader  7: read age = 0.860893 + 0.918931 standardized age (0.84)
Reader  8: read age = 1.144050 + 0.764752 x standardized age (0.81)
Reader  9: read age = 0.736651 + 0.811697 x standardized age (0.80)
Reader 11: read age = 1.001758 x standardized age (0.98)
Reader 11: read age = 0.857471 + 0.928822 x standardized age (0.82)
Reader 12: read age = 0.843081 + 0.911599 x standardized age (0.84)
```

Table 6.5

```
Reader  1: standardized age = read age / 0.998242
Reader  2: standardized age = read age / 0.957476
Reader  3: standardized age = (read age - 0.412486) / 0.914091
Reader  4: standardized age = read age / 0.979341
Reader  5: standardized age = (read age - 0.333348) / 0.922928
Reader  6: standardized age = (read age + 0.307628) / 1.027934
Reader  7: standardized age = (read age - 0.860893) / 0.918931
Reader  8: standardized age = (read age - 1.144050) / 0.764752
Reader  9: standardized age = (read age - 0.736651) / 0.811697
Reader 10: standardized age = read age / 1.001758
Reader 11: standardized age = (read age -0.857471 ) / 0.928822
Reader 12: standardized age = (read age -0.843081 ) / 0.911599
```

Table 6.6. Inter-reader bias test (Wilcoxon test) of comparative age reading sample from Sd 28

	1	2	3	4	5	6	7	8	9	10	11	12
1		165(30)	410(44)	133(33)	310(36)	114(32)	201(50)	483.5(53)	484.5(49)	241(32)	137(55)	301(52)
2	-		267.5(39)	182(31)	235(38)	137.5(27)	193(60)	359.5(53)	570.5(48)	165.5(31)	161(60)	210.5(53)
3	-	-		109.5(37)	474.5(45)	165(38)	396(57)	444.5(48)	450.5(51)	385.5(42)	355.5(62)	412.5(52)
4	**	-	**		200(43)	310(35)	95(54)	154(51)	605.5(53)	162.5(37)	69(62)	120(56)
5	-	*	-	**		165(39)	193(47)	246(43)	217.5(36)	358.5(37)	157.5(54)	180(44)
6	**	-	**	-	**		199(70)	446(59)	377.5(42)	157.5(37)	192.5(70)	202(63)
7	**	**	**	**	**	**		545.5(56)	170.5(50)	257(49)	34(18)	77(22)
8	*	**	-	**	**	**	*		301(51)	562.5(54)	425(55)	401(46)
9	-	-	*	-	-	-	**	**		431.5(47)	108(53)	205(51)
10	-	-	-	**	-	**	**	-	-		260.5(59)	345.5(54)
11	**	**	**	**	**	**	*	**	**	**		108.5(32)
12	**	**	**	**	**	**	-	-	**	**	**	

Table 6.7. Inter-reader bias test (Wilcoxon test) of comparative age reading sample from Sd 25

	1	2	3	4	5	6	7	8	9	10	11	12
1		79(18)	54(18)	36.5(17)	88(25)	135(32)	33(26)	60(30)	85(20)	101(22)	52.5(25)	28.5(24)
2	-		122(25)	45(17)	69(22)	133(30)	36(23)	66(28)	88(20)	109.5(23)	63(23)	40(24)
3	-	-		75(26)	92.5(30)	110(24)	38(30)	43.5(34)	72(22)	139.5(24)	57(28)	41.5(31)
4	-	-	*		106.5(21)	98(34)	70(24)	146.5(32)	112.5(24)	57.5(24)	92.5(23)	80(24)
5	*	-	**	-		70.5(33)	70(23)	101(27)	125.5(26)	28.5(21)	110(24)	77(23)
6	*	*	-	**	**		0(35)	32(39)	75(29)	90(24)	0(31)	0(36)
7	**	**	**	*	*	**		112.5(21)	84(30)	24(29)	4.5(8)	13.5(8)
8	**	**	**	*	*	**	-		93(32)	12.5(29)	84(21)	81.5(19)
9	-	-	-	-	-	**	**	**		60(20)	104(28)	60(26)
10	-	-	-	**	**	-	**	**	-		36(27)	26(29)
11	**	*	**	-	-	**	**	-	*	**		27(12)
12	**	**	**	*	-	**	-	-	**	**	-	

Table 6.8. Inter-reader bias test (Wilcoxon test) of comparative age reading sample from Sd 24

	1	2	3	4	5	6	7	8	9	10	11	12
1		7(16)	31.5(20)	22(10)	30(16)	11(12)	25(33)	55(24)	105(21)	66.5(19)	21(31)	28(35)
2	**		0(28)	8(18)	73.5(21)	0(20)	0(40)	105(20)	34.5(24)	20(23)	12.5(39)	0(41)
3	**	**		17(16)	0(20)	51(16)	56(30)	0(26)	22.5(16)	47.5(18)	19.5(25)	40.5(29)
4	-	**	**		34(18)	19.5(13)	24(31)	38(23)	77(17)	59.5(17)	20(29)	11.5(30)
5	-	-	**	*		36(22)	0(39)	42.5(17)	13(14)	40(21)	14.5(39)	0(41)
6	*	**	-	-	**		74.5(31)	52.5(28)	110(24)	32.5(13)	63(30)	67.5(32)
7	**	**	**	**	**	**		0(44)	0(32)	48(31)	52.5(15)	6(5)
8	**	-	**	**	-	**	**		21(22)	34(24)	0(39)	0(42)
9	-	**	*	-	*	-	**	**		115(23)	13(33)	15.5(35)
10	-	**	-	-	**	-	**	**	-		31.5(28)	37.5(31)
11	**	**	**	**	**	**	-	**	**	**		72.5(17)
12	**	**	**	**	**	**	-	**	**	**		

- : 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 6.9. Comparative age reading sample from Sd 28, percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	11	12	Mean
1		68.8	56.0	67.0	64.0	68.0	50.0	46.5	51.0	68.0	45.0	48.0	57.5
2			59.4	67.7	60.4	71.9	37.5	44.2	50.0	67.7	37.5	44.8	55.4
3				63.0	55.0	62.0	43.0	51.5	49.0	58.0	38.0	48.0	53.0
4					57.0	65.0	46.0	49.0	47.0	63.0	38.0	44.0	55.2
5						61.0	53.0	56.6	64.0	63.0	46.0	56.0	57.8
6							30.0	40.4	58.0	63.0	30.0	37.0	53.3
7								43.4	50.0	51.0	82.0	78.0	51.3
8									48.5	45.5	44.4	53.5	47.6
9										53.0	47.0	49.0	51.5
10											41.0	46.0	56.3
11												68.0	47.0
12													52.0

Table 6.10. Comparative age reading sample from Sd 25, percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	11	12	Mean
1		62.5	63.3	66.0	50.0	36.0	48.0	40.0	60.0	56.0	50.0	52.0	53.1
2			47.9	66.0	54.2	37.5	52.1	41.7	58.3	52.1	52.1	50.0	52.2
3				46.9	38.8	51.0	38.8	30.6	55.1	51.0	42.9	36.7	45.7
4					58.0	32.0	52.0	36.0	52.0	52.0	54.0	52.0	51.5
5						34.0	54.0	46.0	48.0	58.0	52.0	54.0	49.7
6							30.0	22.0	42.0	52.0	38.0	28.0	36.6
7								58.0	40.0	42.0	84.0	84.0	53.0
8									36.0	42.0	58.0	62.0	42.9
9										60.0	44.0	48.0	49.4
10											46.0	42.0	50.3
11												76.0	54.3
12													53.2

Table 6.11. Comparative age reading sample from Sd 24, percentage agreement of individual readers

	1	2	3	4	5	6	7	8	9	10	11	12	Mean
1		68.0	60.0	80.0	68.0	76.0	34.0	52.0	58.0	62.0	38.0	30.0	56.9
2			44.0	64.0	58.0	60.0	20.0	60.0	52.0	54.0	22.0	18.0	47.3
3				68.0	60.0	68.0	40.0	48.0	68.0	64.0	50.0	42.0	55.6
4					64.0	74.0	38.0	54.0	66.0	66.0	42.0	40.0	59.6
5						56.0	22.0	66.0	72.0	58.0	22.0	18.0	51.3
6							38.0	44.0	52.0	74.0	40.0	36.0	56.2
7								12.0	36.0	38.0	70.0	90.0	39.8
8									56.0	52.0	22.0	16.0	43.8
9										54.0	34.0	30.0	52.5
10											44.0	38.0	54.9
11												66.0	40.9
12													38.5

Figure 4.1

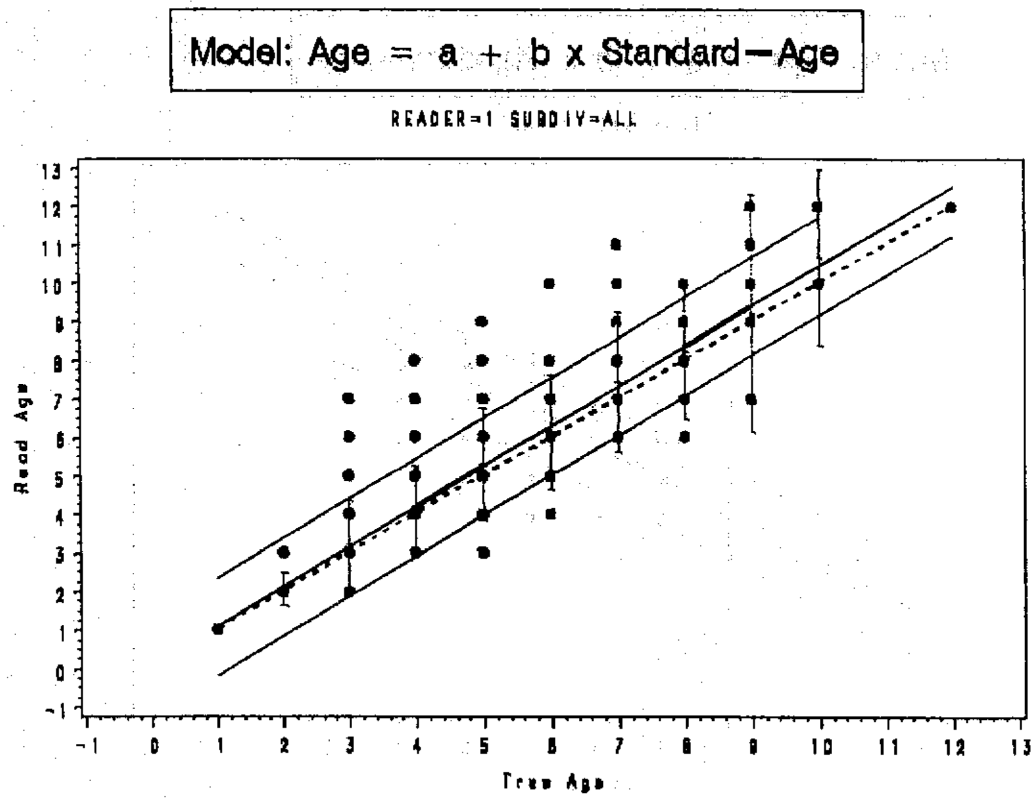
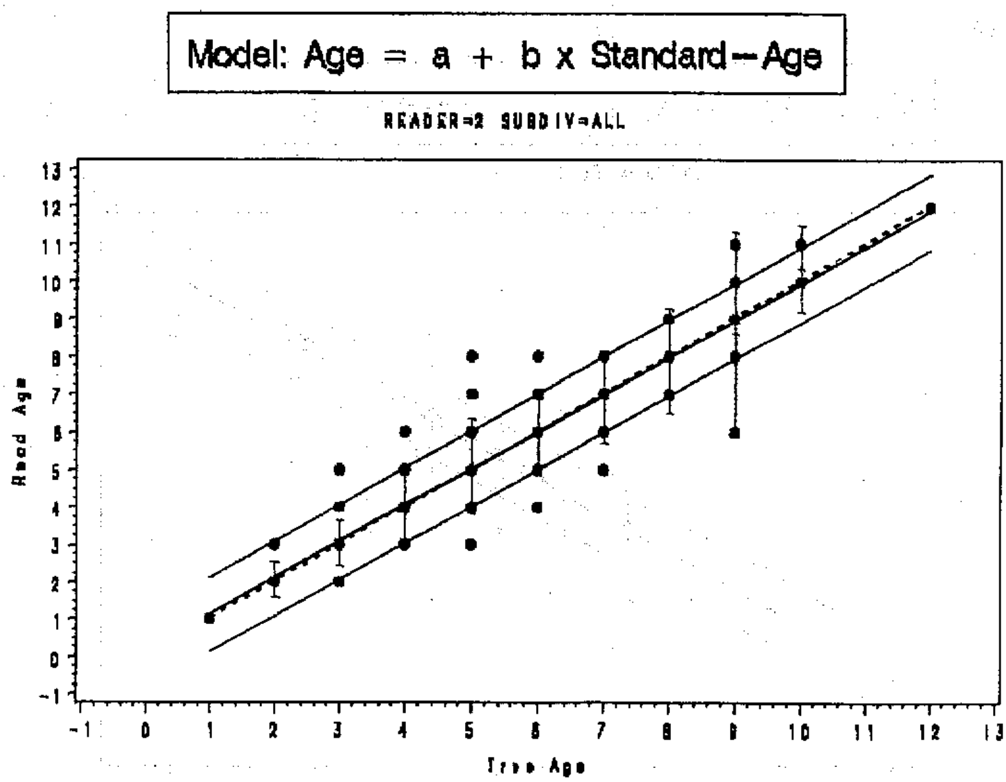


Figure 4.2



* in all figures: solid line-reader's model; dotted line- unbiased readings line

Figure 4.3

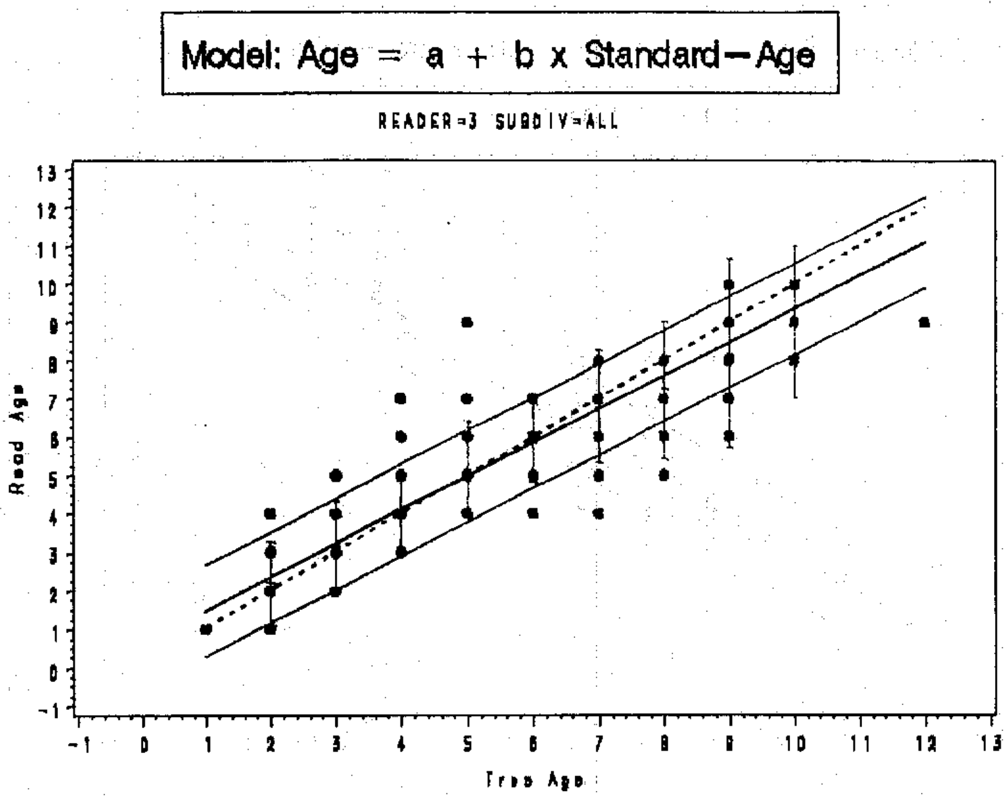
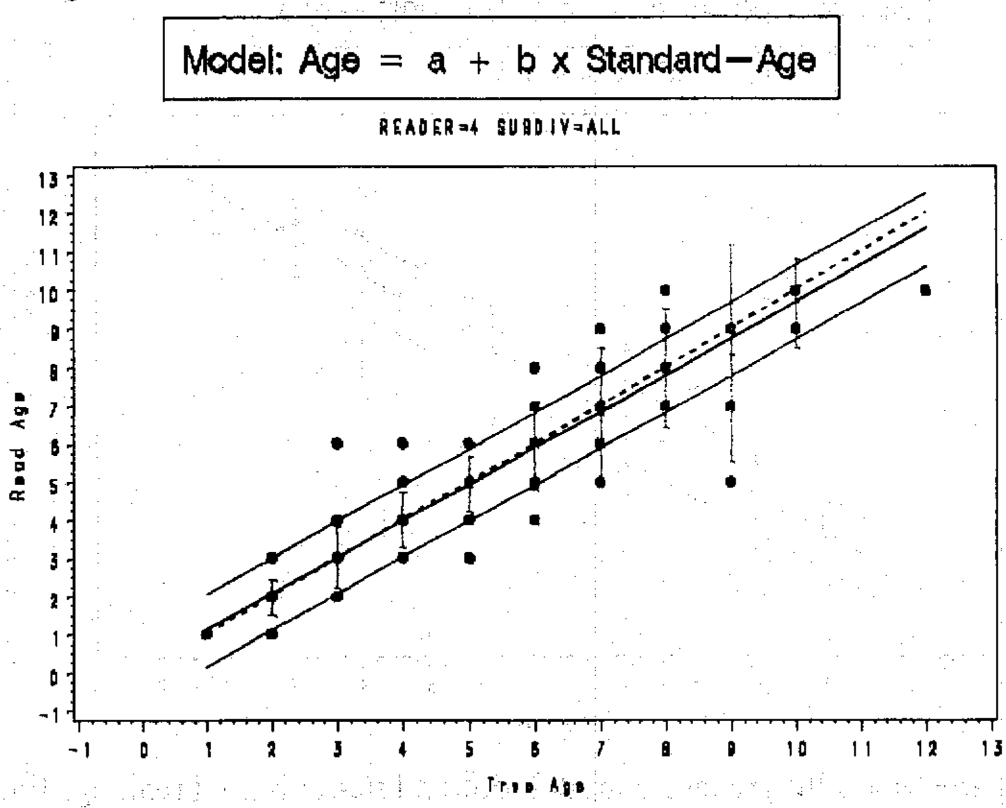


Figure 4.4



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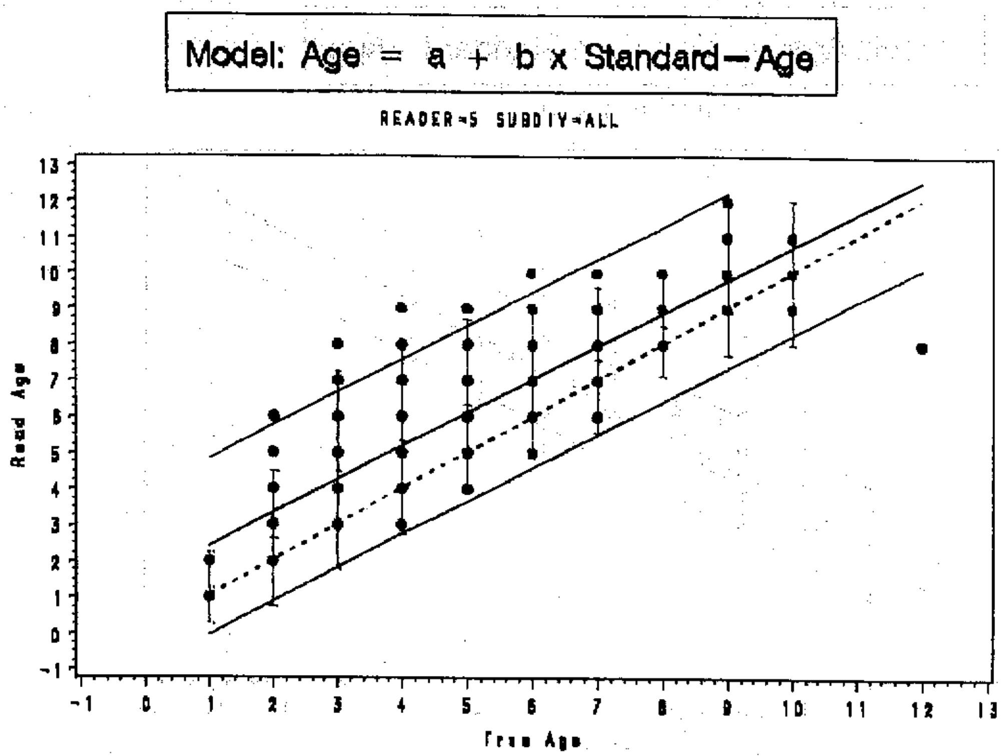

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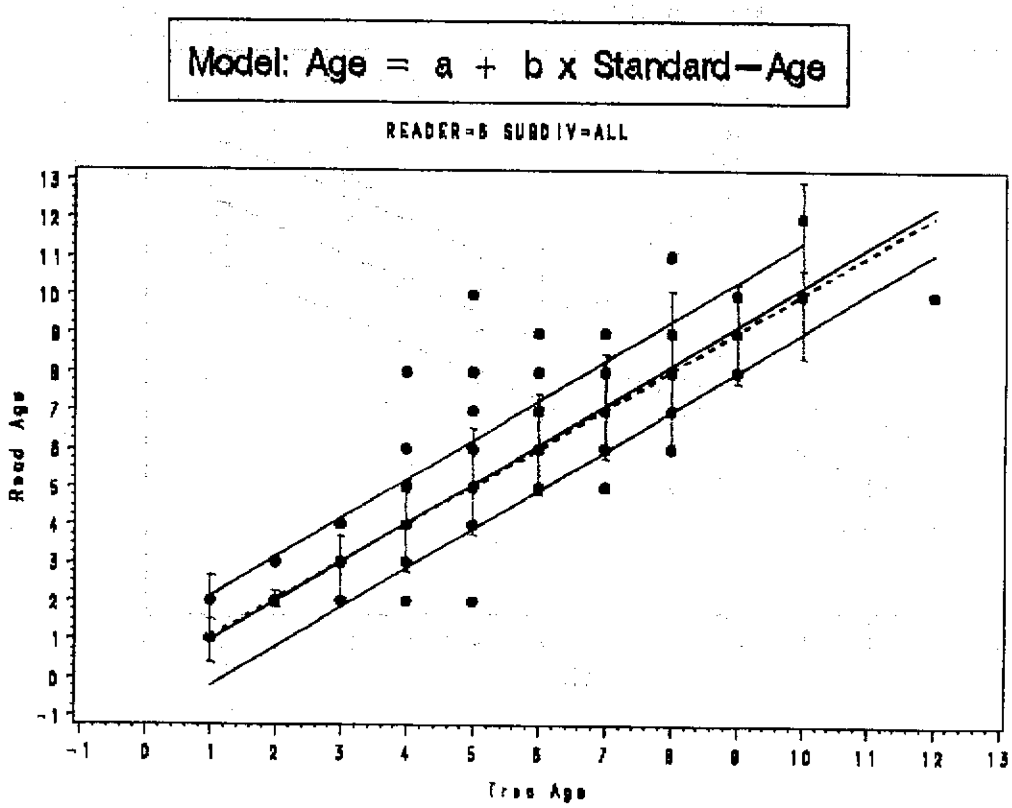

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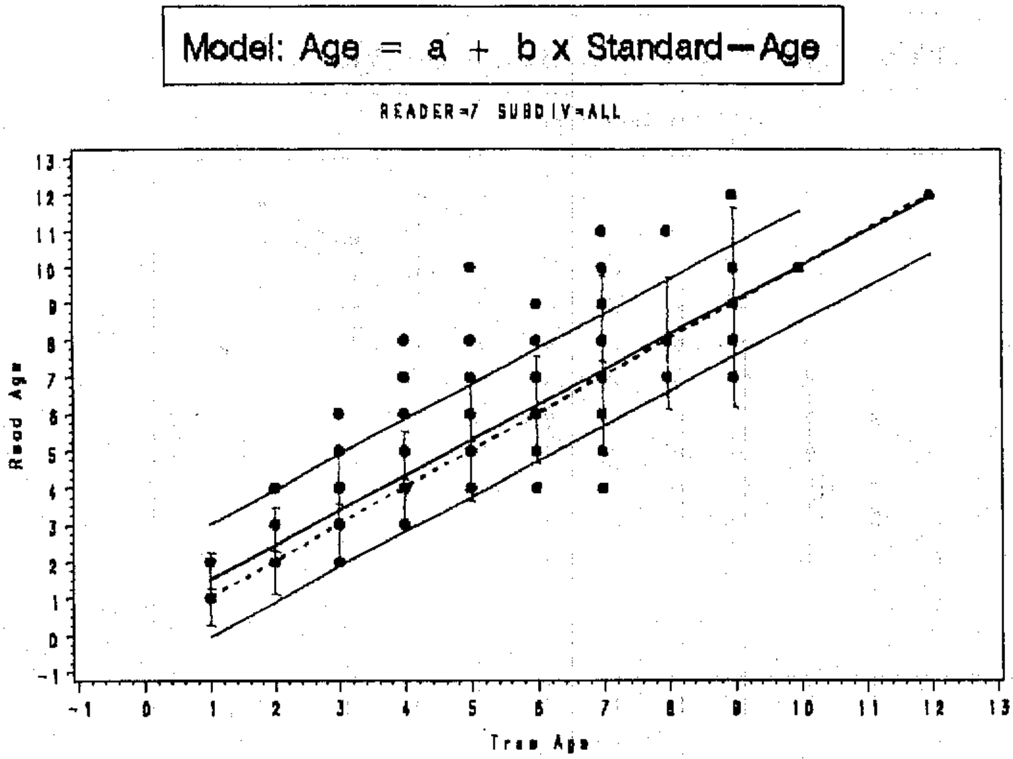

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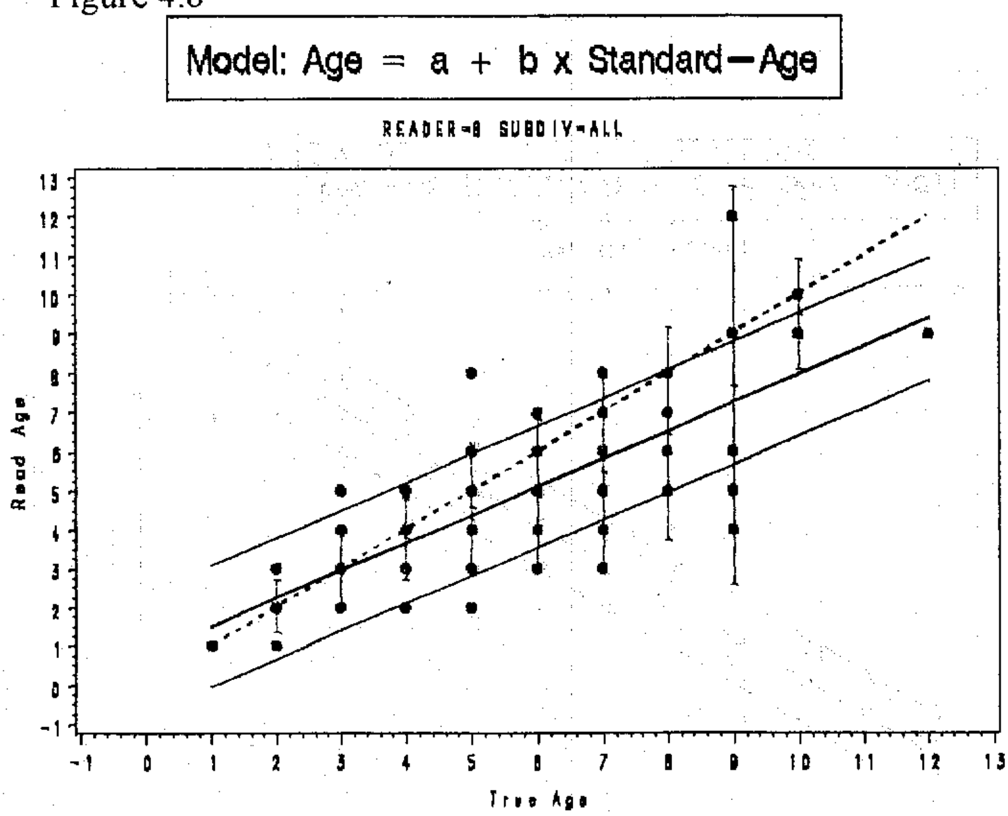
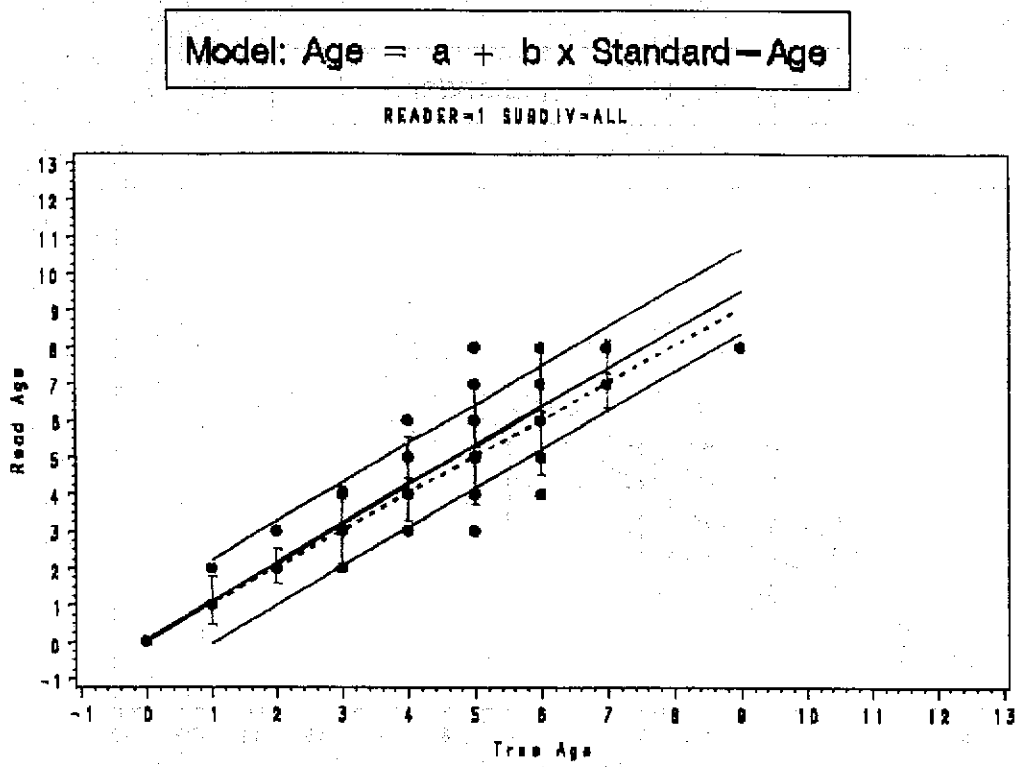


Figure 5.1



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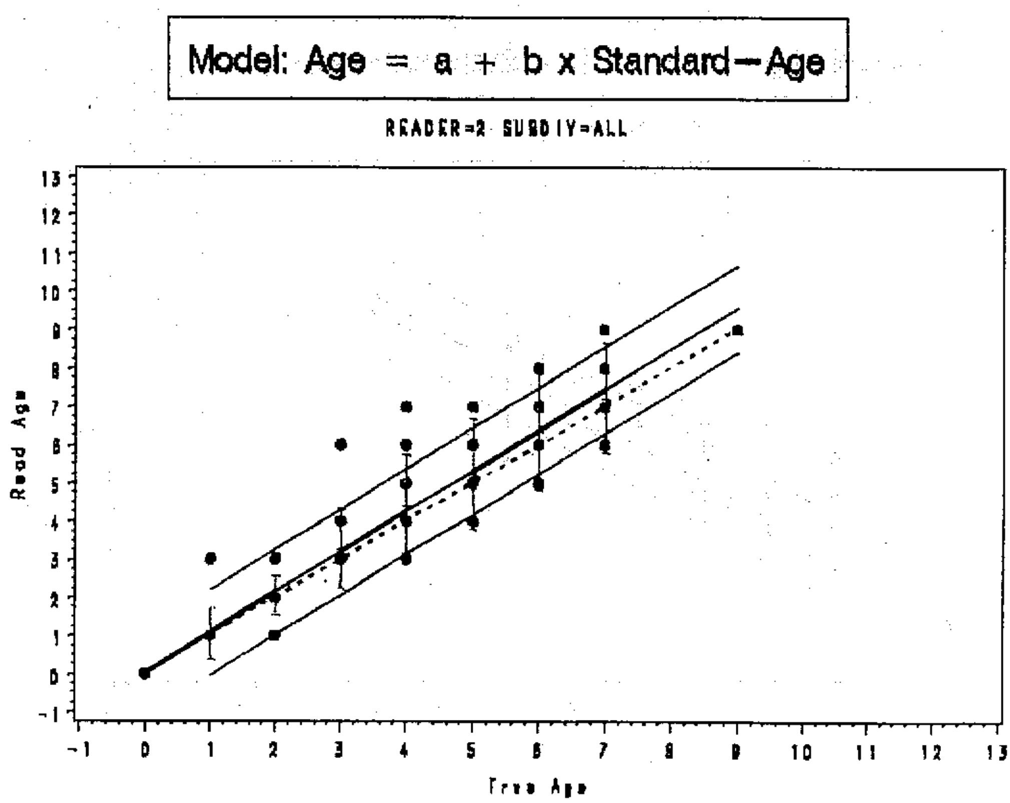

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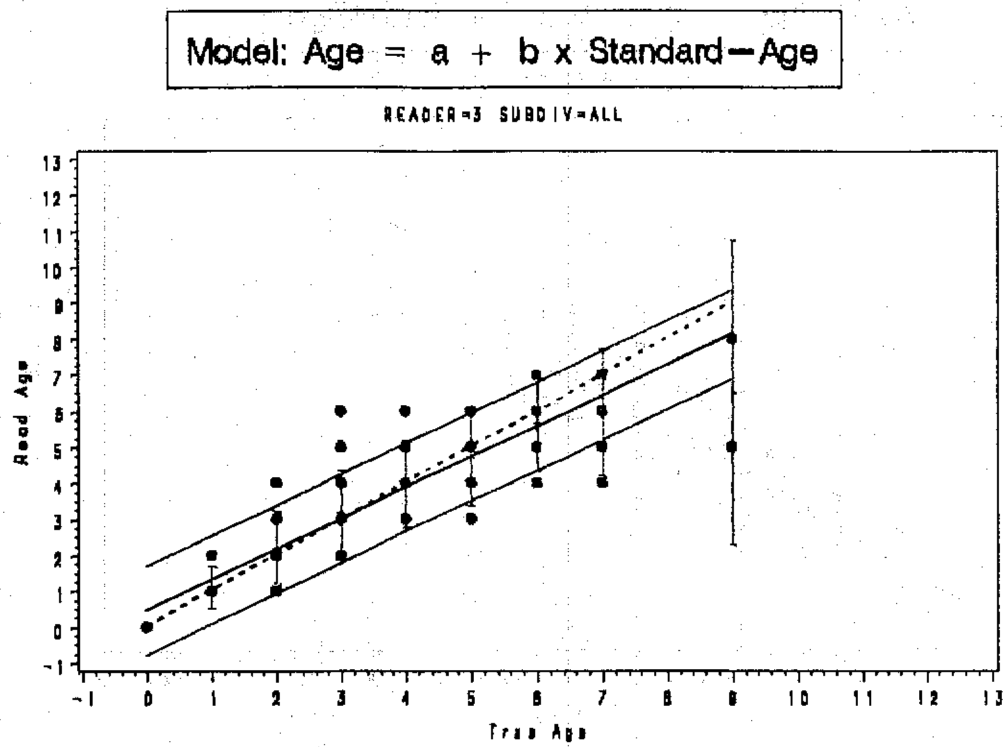

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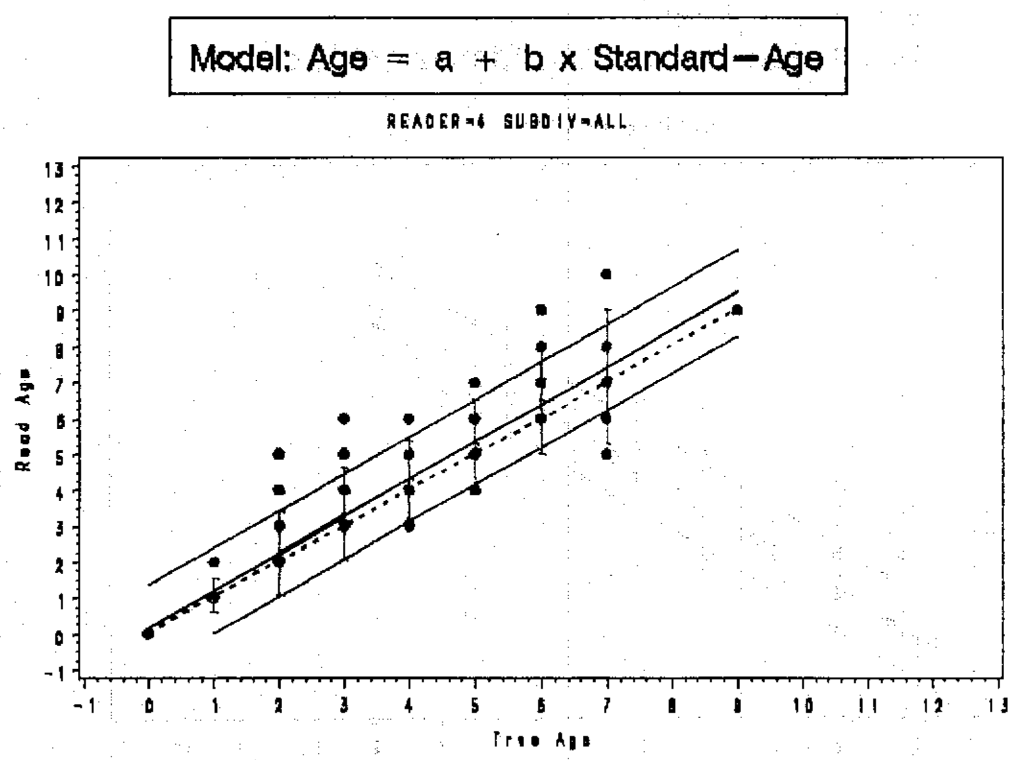
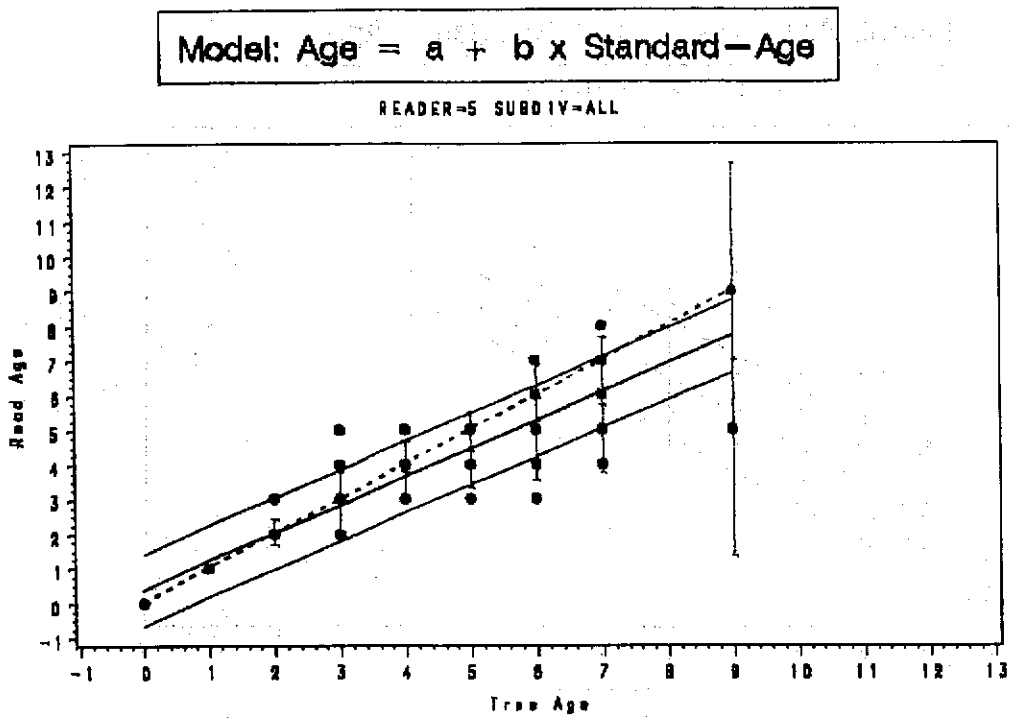


Figure 5.5



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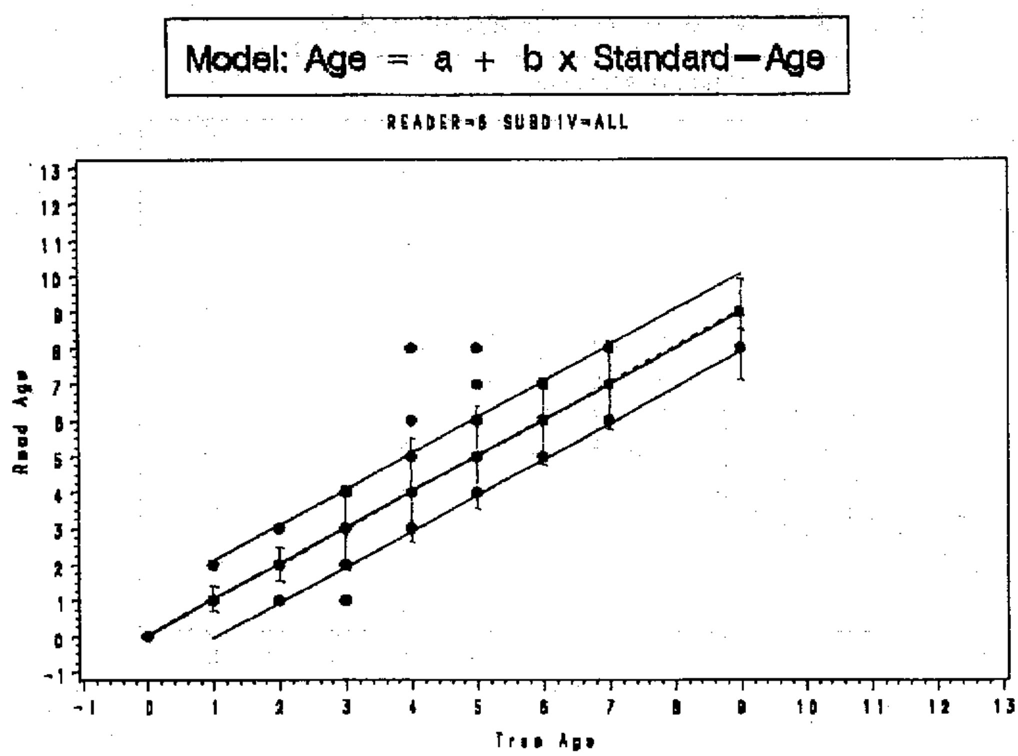

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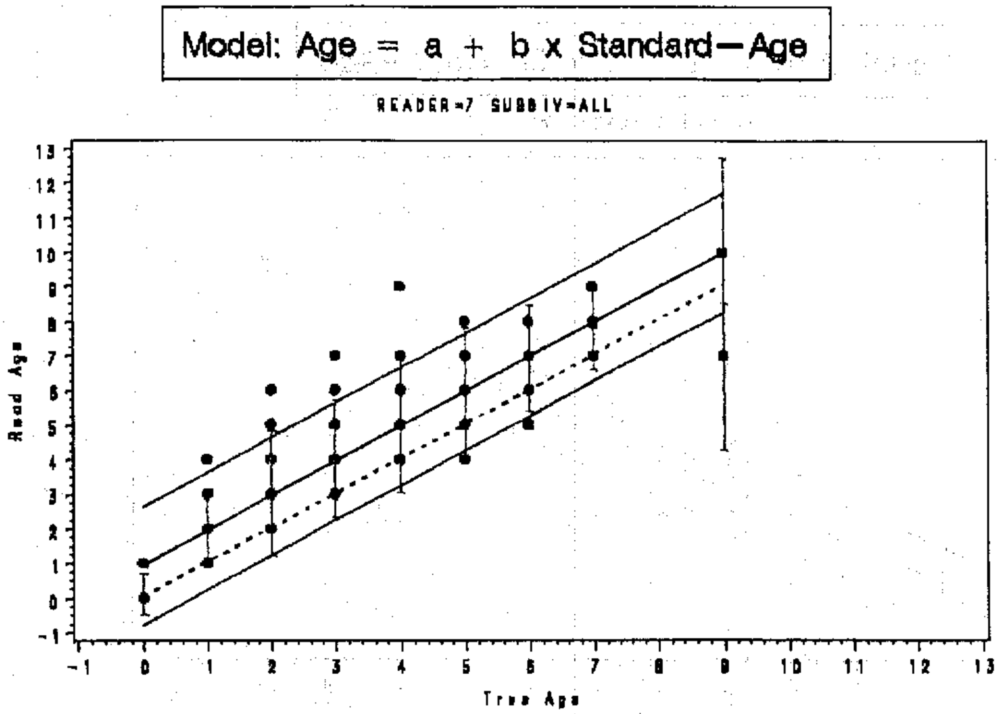

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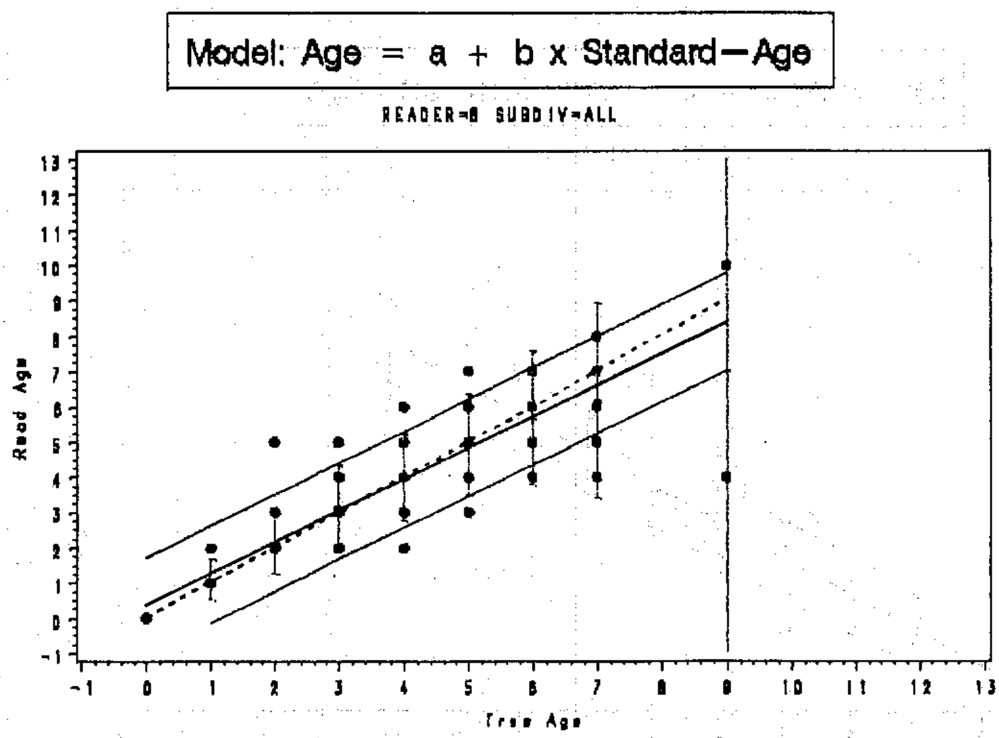

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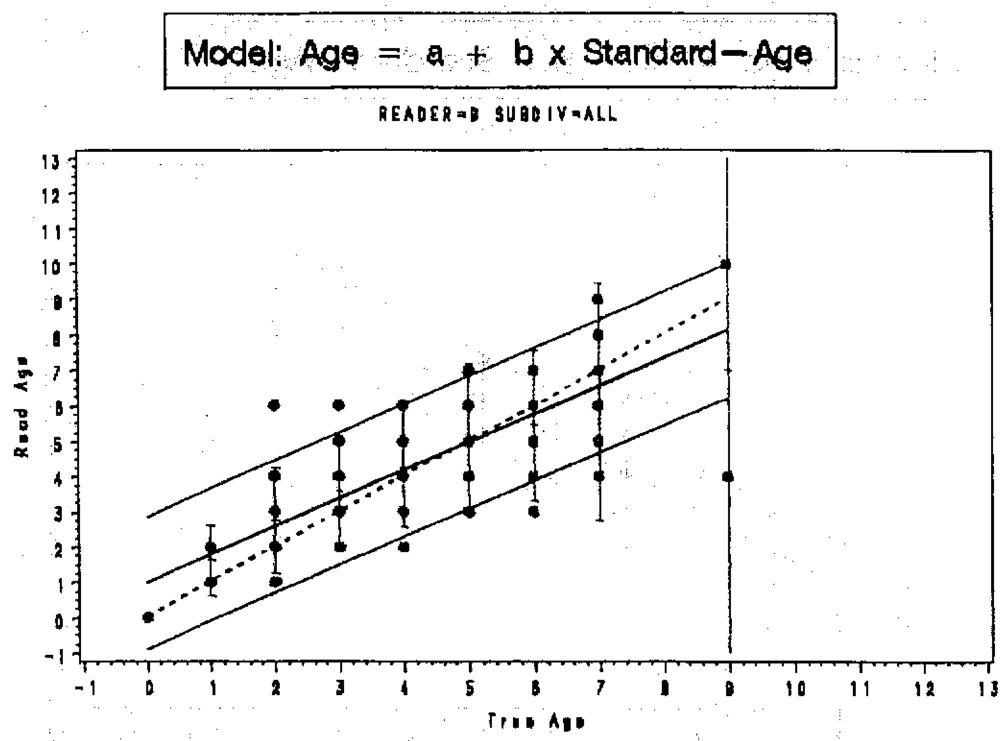

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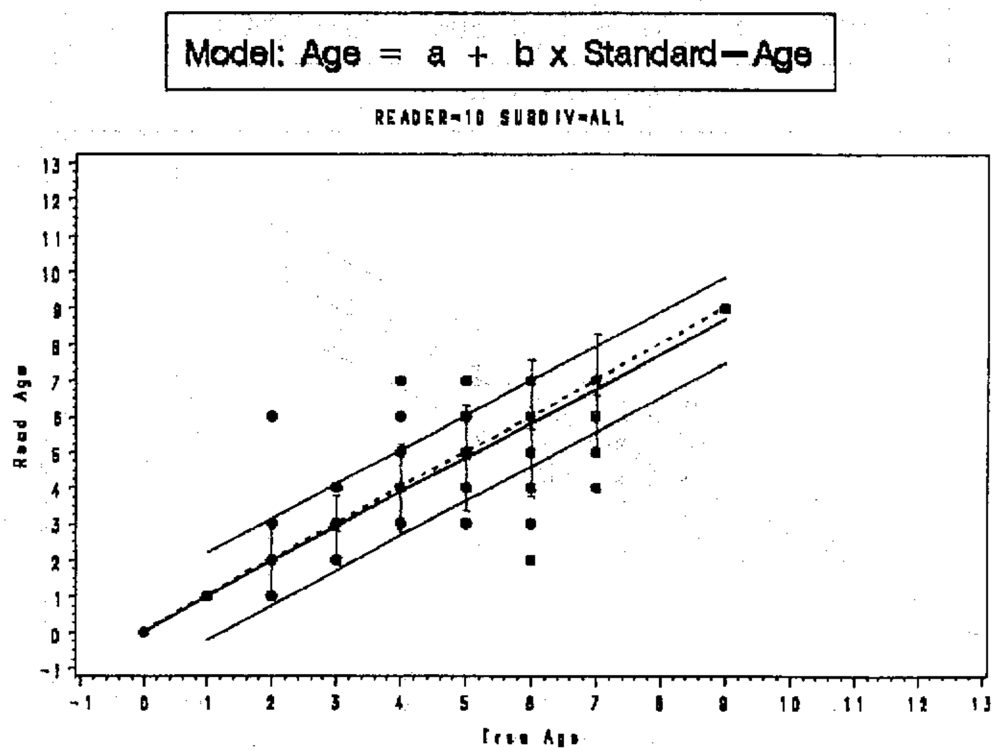
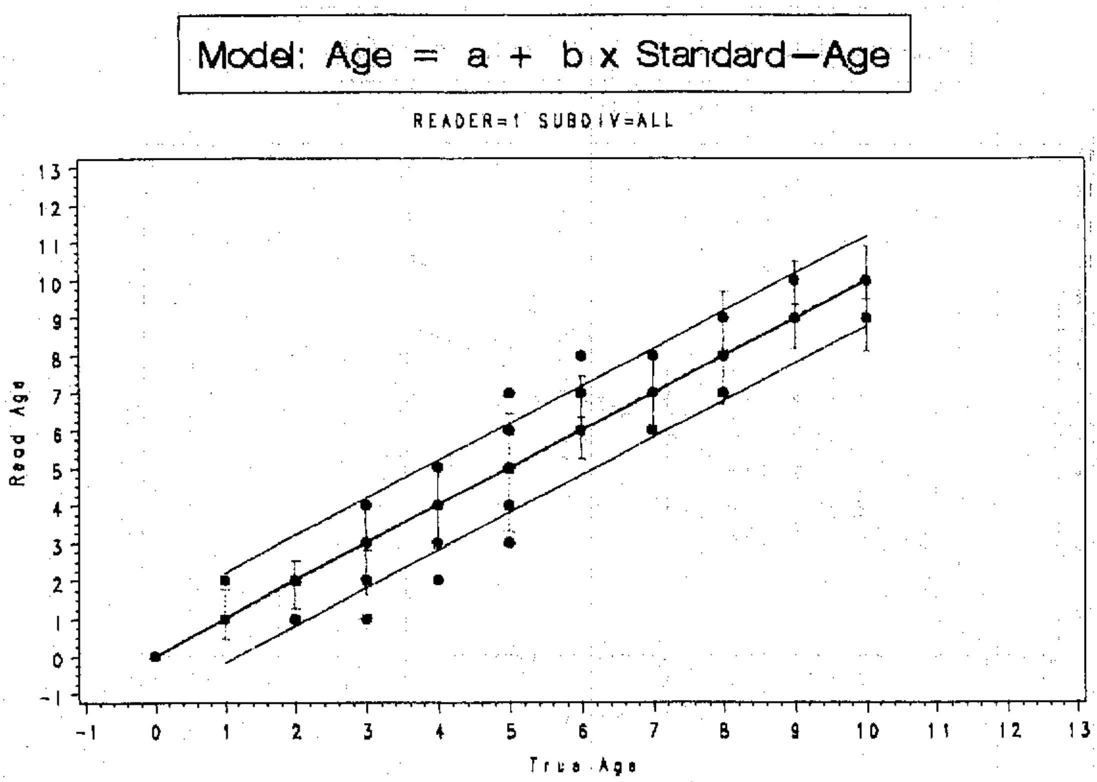


Figure 6.1



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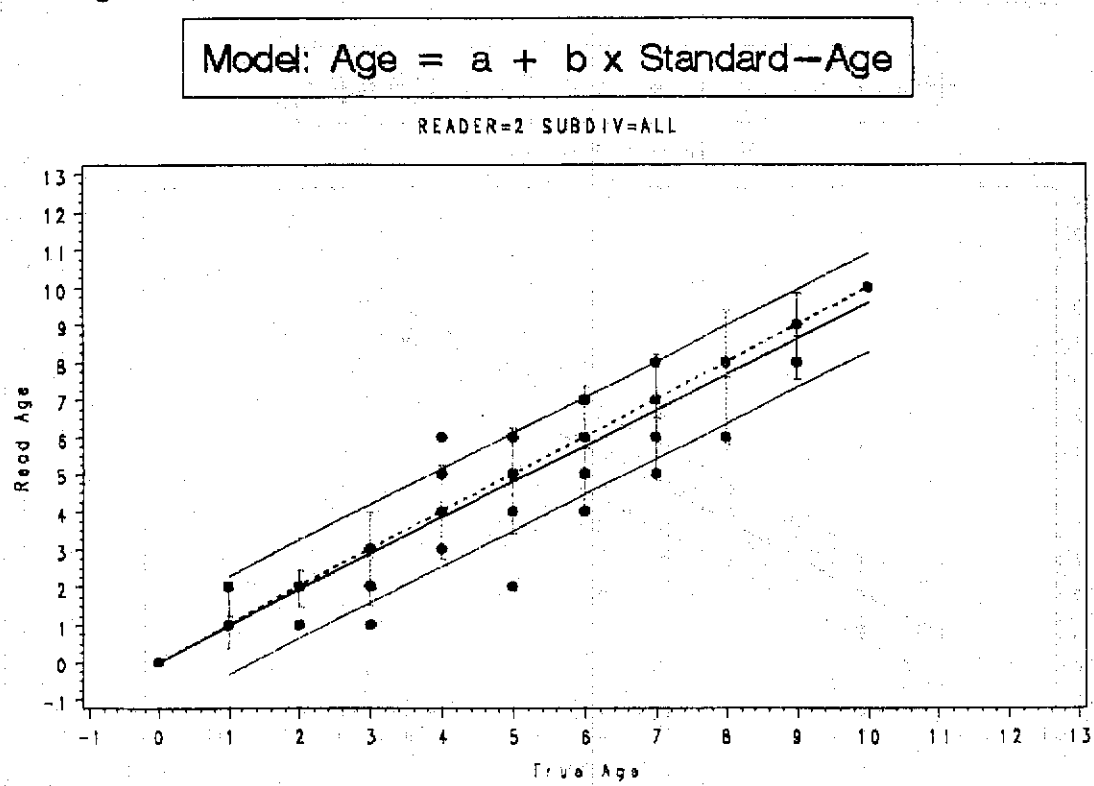

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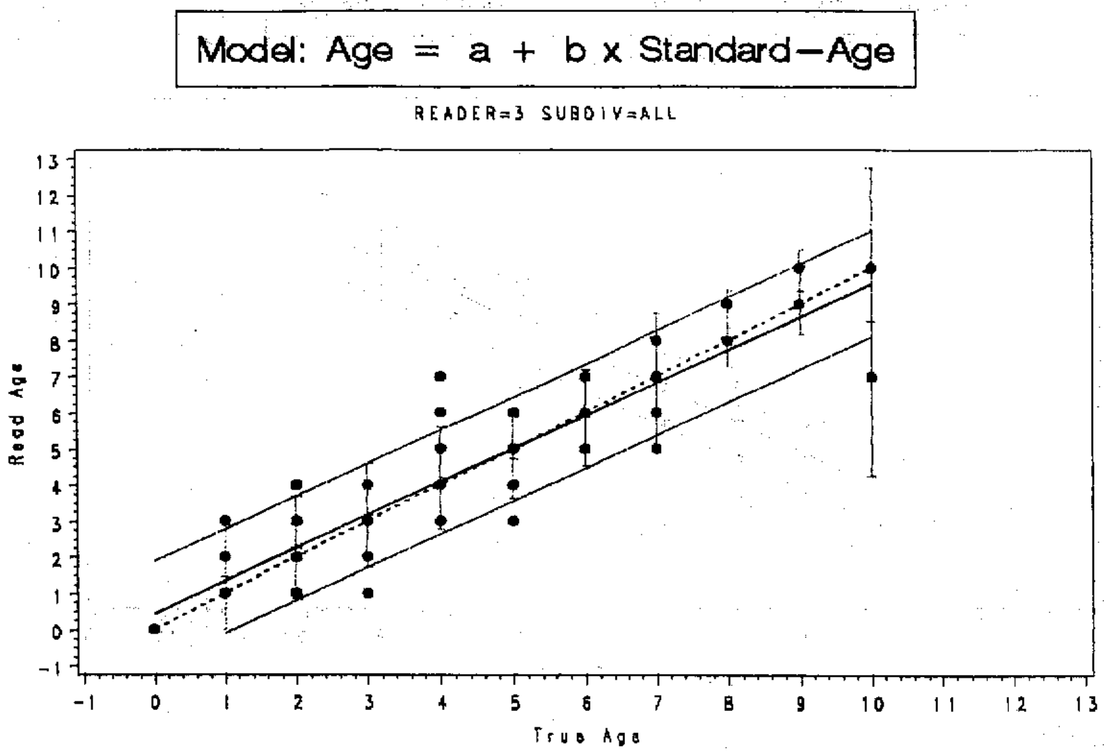

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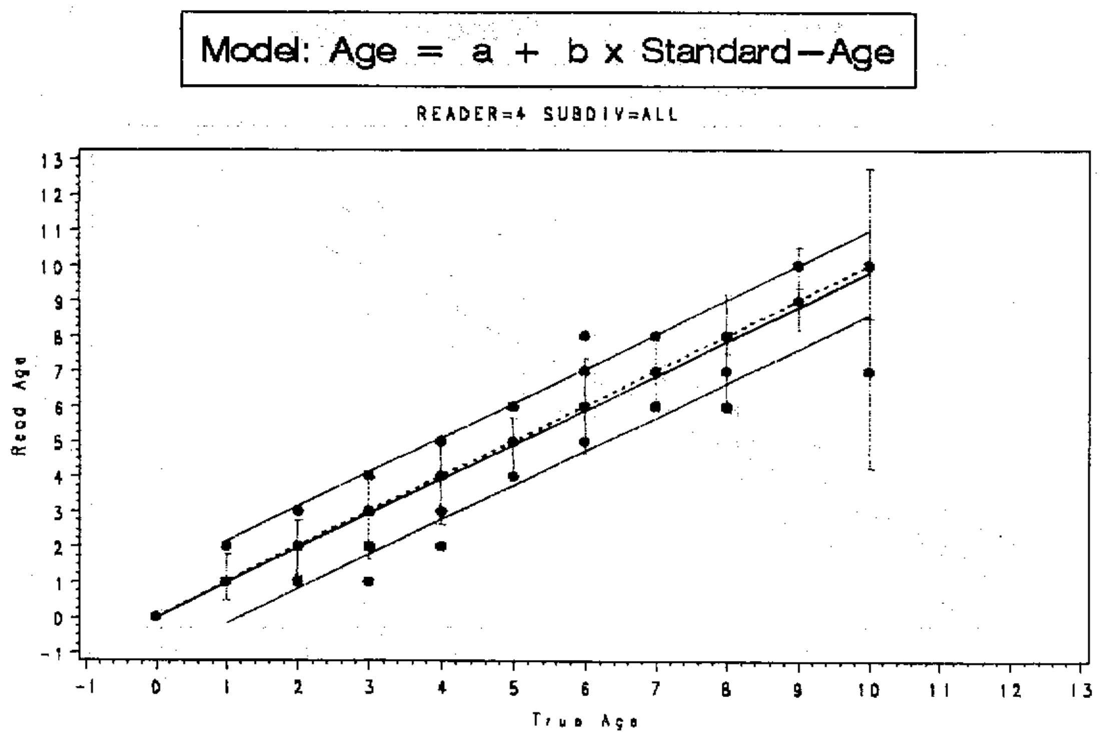

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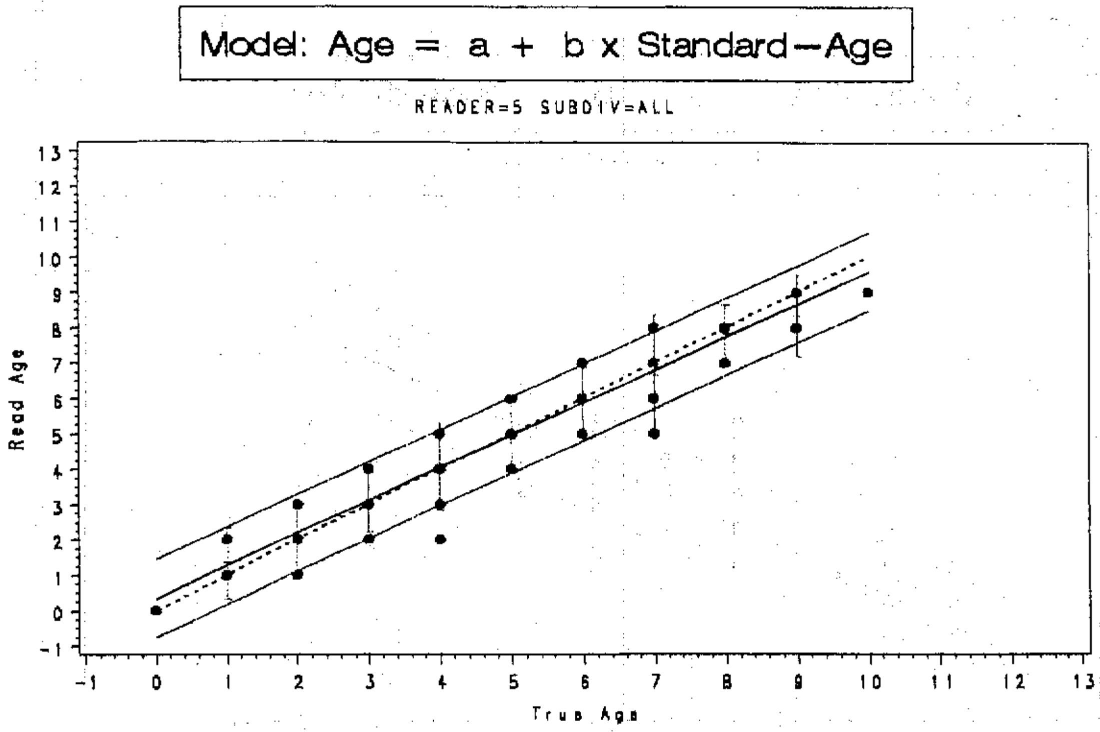

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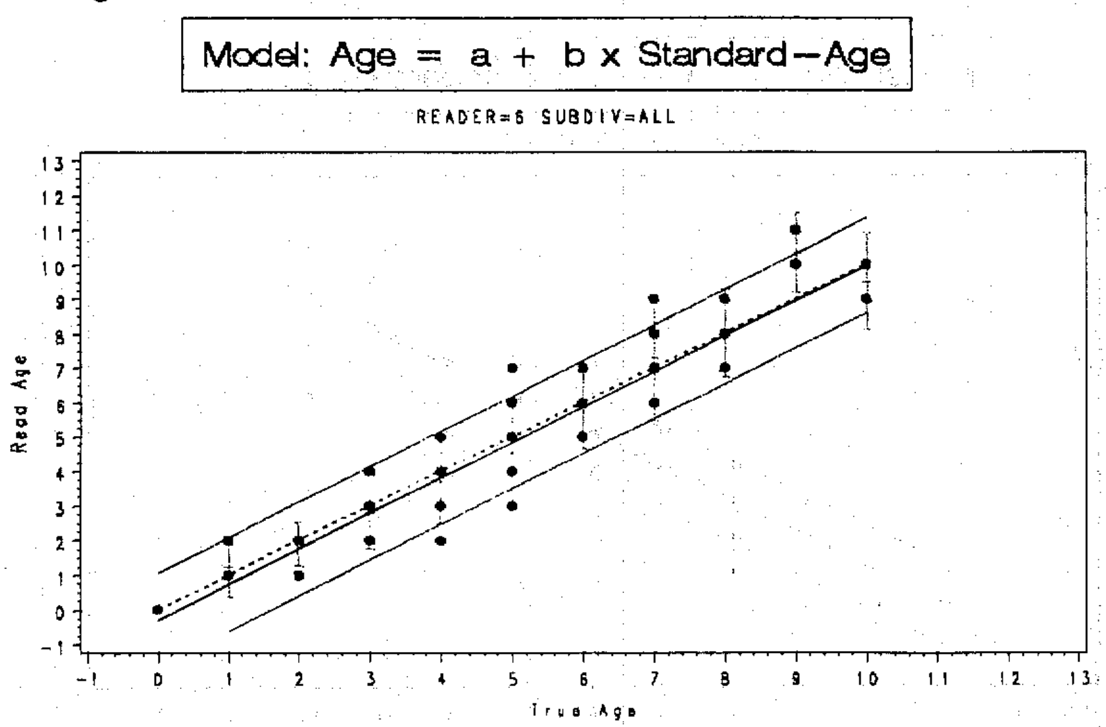

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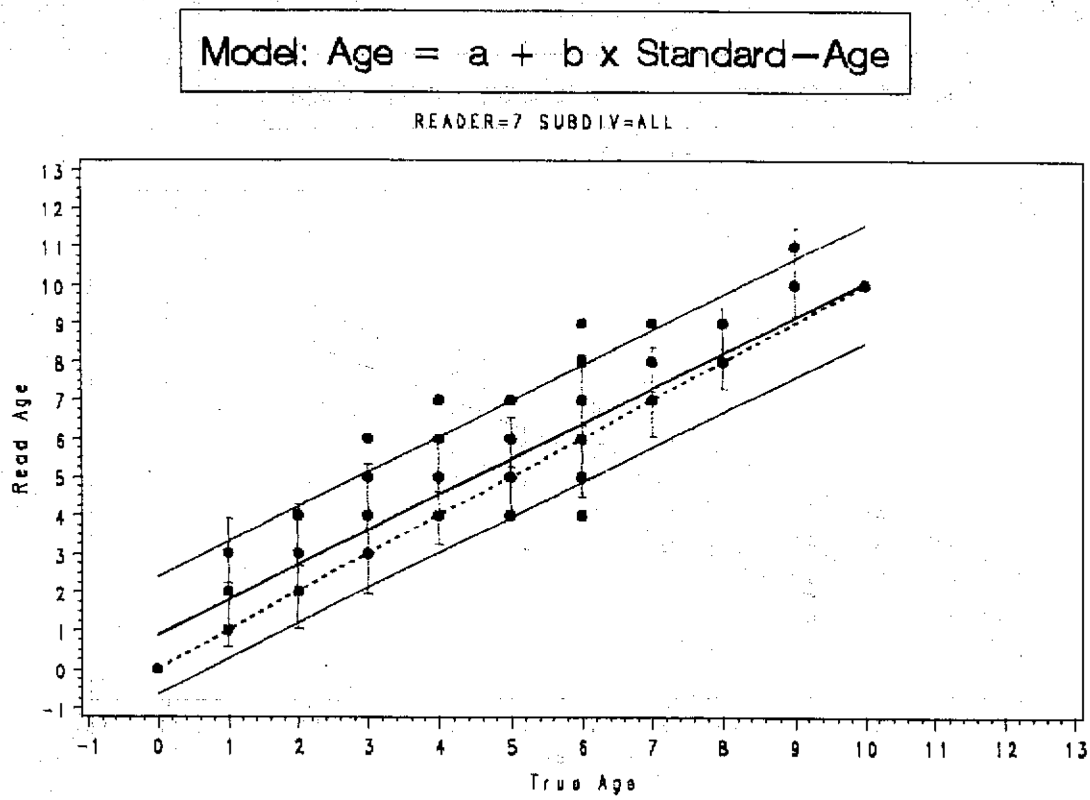

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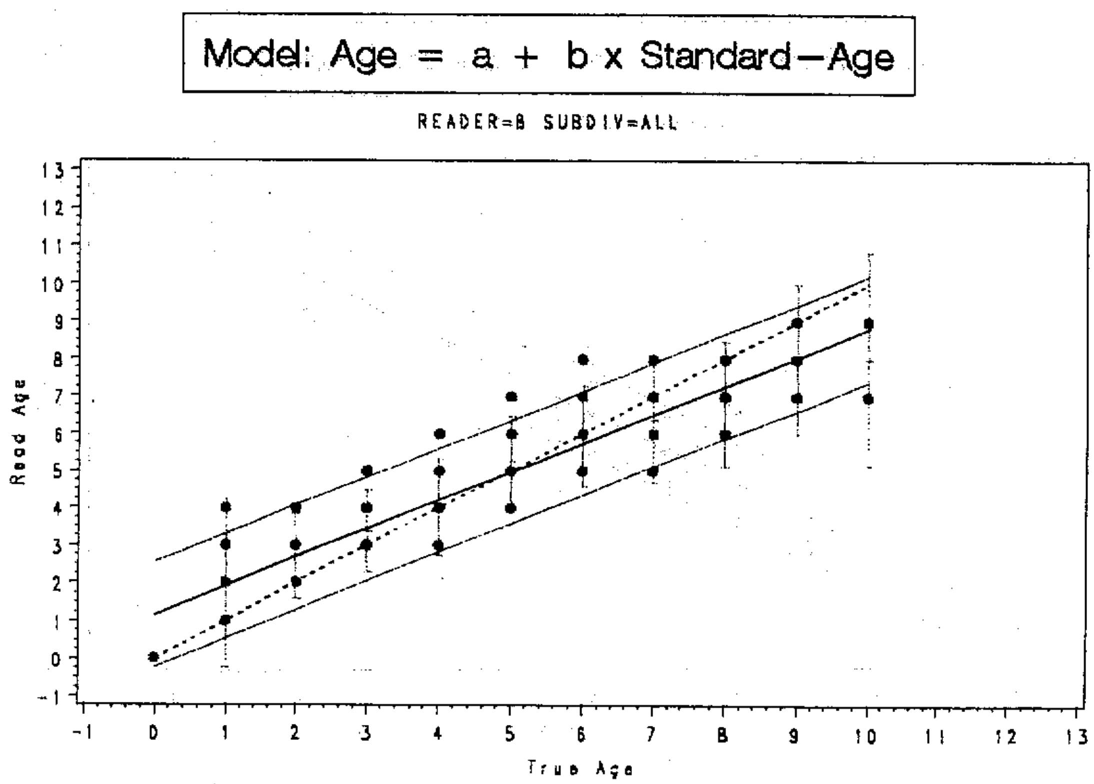

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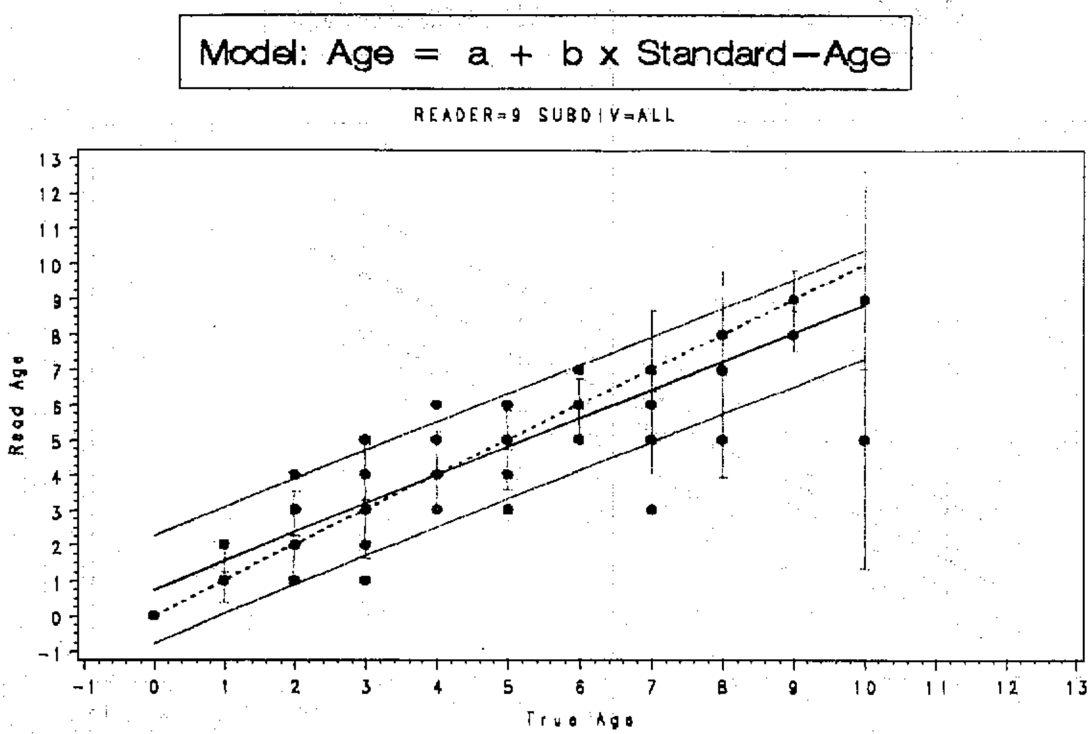

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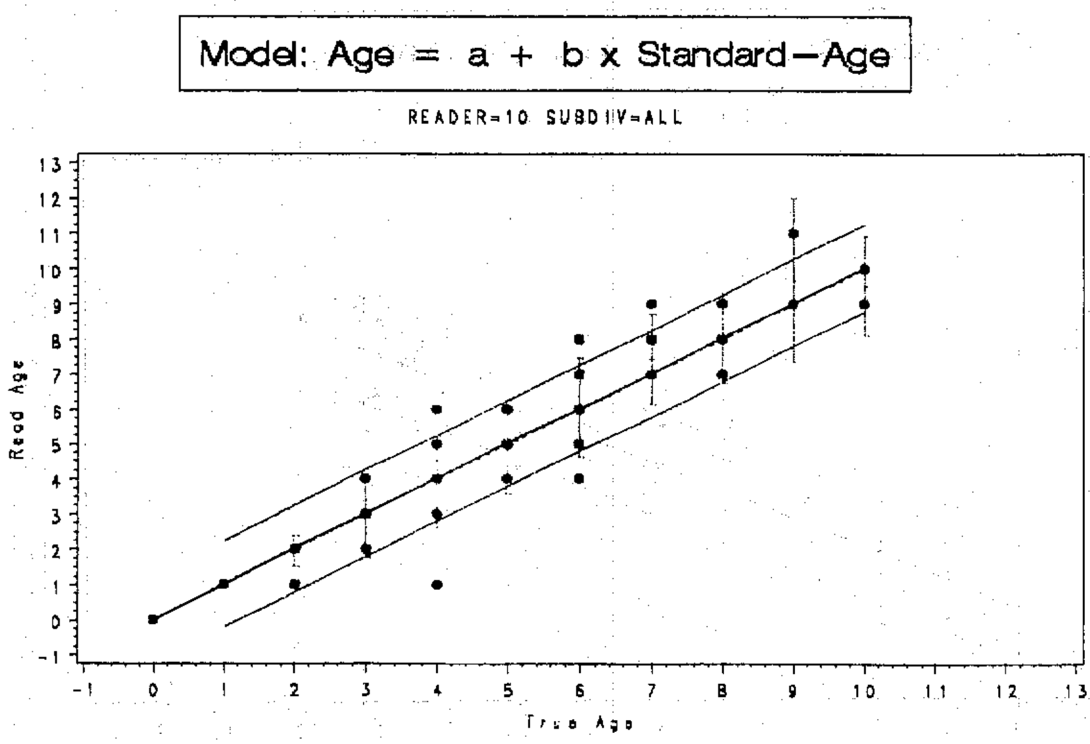

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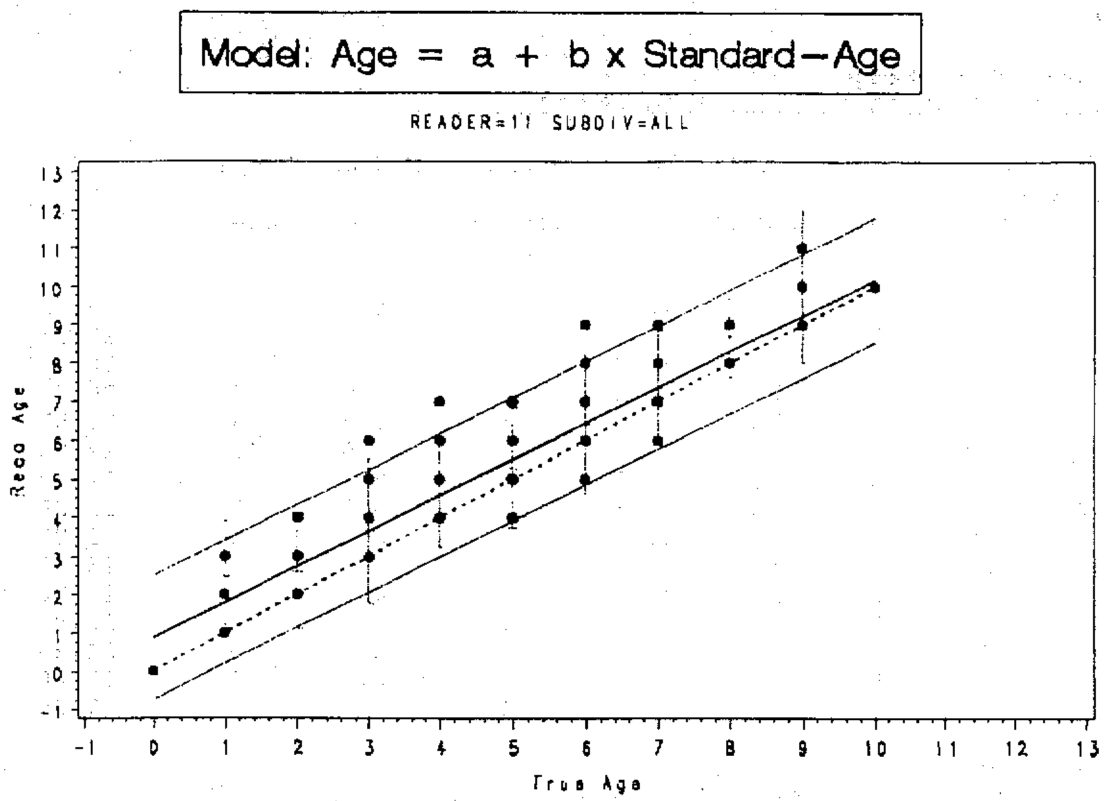
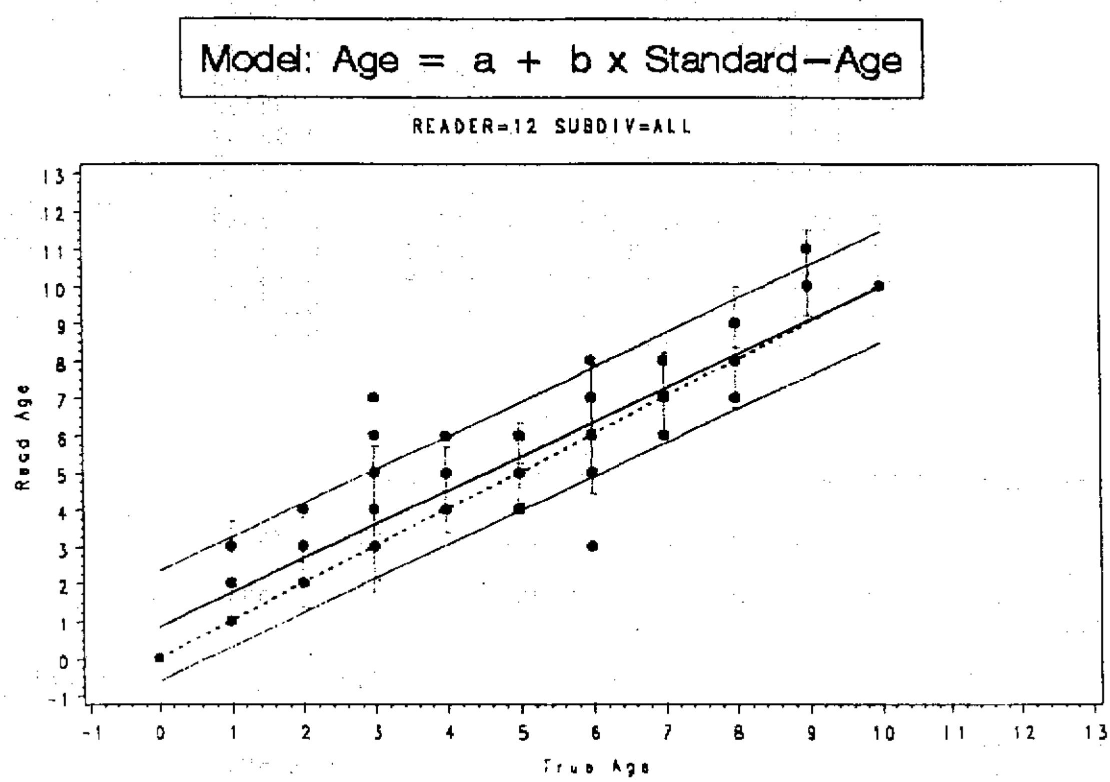


Figure 6.12



Appendix

First otolith exchange

National Sample=ESTONIA Subdivision=32 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
73	30	8	0	4.13	4	4.0	4	20.23
66	30	8	0	5.75	6	6.0	6	20.26
13	30	8	0	6.38	6	6.0	6	20.43
31	30	8	0	2.25	2	2.0	2	20.57
40	30	8	0	4.50	5	4.5	4	20.57
36	30	8	0	3.38	3	3.0	3	22.05
25	30	8	0	5.75	6	6.0	6	22.29
39	30	8	0	2.88	3	3.0	3	22.29
101	30	8	0	2.88	3	3.0	3	22.29
28	30	8	0	6.00	6	6.5	7	23.57
56	30	8	0	4.50	5	4.0	4	23.76
58	30	8	0	6.25	6	6.5	6	23.81
18	30	8	0	5.38	5	5.0	5	24.23
60	30	8	0	8.13	8	8.5	9	25.00
1	30	6	2	4.00	4	4.0	4	27.39

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
73	2	-0.27653	-1.39172	0.83667	0.07147
66	4	-2.25893	6.20499	0.61431	0.00033
13	4	-0.41217	0.57955	0.87719	0.18021
31	1	1.44016	0.00000	0.56631	0.00010
40	3	0.00000	0.00000	0.93039	0.52431
36	2	1.95103	3.20499	0.60064	0.00023
25	4	-1.56038	3.02760	0.80956	0.03757
39	2	0.06784	0.74102	0.80956	0.03757
101	2	0.06784	0.74102	0.80956	0.03757
28	4	-1.61624	2.47143	0.77050	0.01462
56	3	0.46771	-0.83125	0.86037	0.12363
58	5	-1.60418	3.62456	0.82252	0.05119
18	4	-0.41217	0.57955	0.87719	0.18021
60	7	-1.04228	2.37828	0.89943	0.28985
1	3	-1.36931	2.50000	0.81394	0.07189

N = 15

National Sample=ESTONIA Subdivision=32 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
99	40	8	0	5.63	6	5.5	6	36.73

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)

99	7	1.31849	3.02799	0.86933	0.15132

N = 1

National Sample=FINNLAND Subdivision=29 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
17	30	8	0	5.13	5	5.0	4	21.97
20	30	8	0	5.13	5	5.0	4	21.97

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
17	3	0.48783	-0.98869	0.88326	0.20578
20	3	0.48783	-0.98869	0.88326	0.20578

N = 2

National Sample=FINNLAND Subdivision=30 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
29	30	8	0	4.13	4	4.0	4	20.23
17	30	8	0	2.25	2	2.0	2	20.57
21	30	8	0	2.25	2	2.0	2	20.57
36	30	8	0	2.25	2	2.0	2	20.57
46	30	8	0	2.25	2	2.0	2	20.57
19	30	8	0	5.50	6	5.0	5	21.73
37	30	8	0	5.25	5	5.0	5	22.19
33	30	8	0	4.00	4	4.0	4	23.15
18	30	7	1	6.43	6	6.0	5	25.17
1	30	8	0	3.88	4	4.0	4	25.57
50	30	8	0	3.13	3	3.0	3	26.70
30	30	8	0	3.63	4	3.0	3	29.26

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
29	2	-0.27653	-1.39172	0.83667	0.07147
17	1	1.44016	0.00000	0.56631	0.00010
21	1	1.44016	0.00000	0.56631	0.00010
36	1	1.44016	0.00000	0.56631	0.00010
46	1	1.44016	0.00000	0.56631	0.00010
19	4	1.33866	2.57600	0.84667	0.09025
37	3	0.81322	-0.49640	0.80476	0.03348
33	3	1.44016	3.50000	0.75583	0.01023
18	4	0.67409	-1.15101	0.86009	0.15615
1	3	1.48606	2.97309	0.77335	0.01567
50	2	-0.27653	-1.39172	0.83667	0.07147
30	3	1.96044	3.93651	0.67515	0.00143

N = 12

National Sample=FINNLAND Subdivision=30 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
42	40	8	0	3.38	3	3.0	3	31.43

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
42	3	2.82843	8.00000	0.41685	0.00000

N = 1

National Sample=FINNLAND Subdivision=31 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
3	30	7	1	1.86	2	2.0	2	20.35
26	30	8	0	2.25	2	2.0	2	20.57
34	30	8	0	2.25	2	2.0	2	20.57
37	30	8	0	2.25	2	2.0	2	20.57
21	30	8	0	2.50	3	2.5	2	21.38
14	30	8	0	6.00	6	6.5	7	21.82
5	30	8	0	2.88	3	3.0	3	22.29
6	30	8	0	2.88	3	3.0	3	22.29
47	30	7	1	5.57	6	5.0	5	22.84
17	30	8	0	4.00	4	4.0	4	23.15
25	30	8	0	2.00	2	2.0	2	26.73
41	30	7	1	2.00	2	2.0	2	28.87

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
3	1	-2.64575	7.00000	0.45694	0.00001
26	1	1.44016	0.00000	0.56631	0.00010
34	1	1.44016	0.00000	0.56631	0.00010
37	1	1.44016	0.00000	0.56631	0.00010
21	1	0.00000	-2.80000	0.66679	0.00116
14	3	-1.01835	-0.70000	0.74907	0.00867
5	2	0.06784	0.74102	0.80956	0.03757
6	2	0.06784	0.74102	0.80956	0.03757
47	4	1.13725	1.94740	0.89017	0.28647
17	3	1.44016	3.50000	0.75583	0.01023
25	2	0.00000	3.50000	0.72949	0.00538
41	2	0.00000	3.00000	0.78332	0.02758

N = 12

National Sample=FINNLAND Subdivision=31 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
29	40	8	0	3.00	3	3.0	3	30.86
16	40	8	0	3.75	4	4.0	4	31.07
27	40	8	0	2.38	2	2.0	2	31.33
8	40	8	0	2.25	2	2.0	2	31.43
13	40	8	0	2.25	2	2.0	2	31.43
4	40	8	0	1.63	2	2.0	2	31.85
15	40	8	0	1.63	2	2.0	2	31.85
30	40	8	0	1.63	2	2.0	2	31.85
31	40	8	0	2.75	3	2.5	2	37.64

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
29	3	1.44016	3.50000	0.75583	0.01023
16	4	0.63250	1.73740	0.89123	0.24416
27	2	1.95103	3.20499	0.60064	0.00023
8	2	-0.40406	-0.22857	0.82754	0.05764
13	2	2.82843	8.00000	0.41685	0.00000
4	1	-0.64406	-2.24000	0.64291	0.00065
15	1	-0.64406	-2.24000	0.64291	0.00065
30	1	-0.64406	-2.24000	0.64291	0.00065
31	3	1.67456	3.13600	0.74431	0.00772

N = 9

National Sample=FINNLAND Subdivision=32 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
30	30	8	0	4.13	4	4.0	4	20.23
25	30	8	0	3.63	4	3.5	3	20.52
33	30	8	0	2.25	2	2.0	2	20.57
10	30	8	0	3.88	4	4.0	3	21.54
9	30	8	0	4.00	4	4.0	4	23.15
15	30	6	2	4.50	5	4.5	4	23.31
5	30	7	1	2.86	3	3.0	3	24.15
38	30	8	0	4.38	4	5.0	5	24.24
31	30	8	0	4.25	4	4.0	4	24.36
2	30	8	0	3.00	3	3.0	3	25.20

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
30	2	-0.27653	-1.39172	0.83667	0.07147
25	2	0.82377	-0.15151	0.79825	0.02963
33	1	1.44016	0.00000	0.56631	0.00010
10	2	0.27653	-1.39172	0.83667	0.07147
9	3	1.44016	3.50000	0.75583	0.01023
15	3	0.00000	-0.24793	0.95964	0.82523

5	2	0.17390	0.33600	0.84092	0.10334
38	3	-1.96044	3.93651	0.67515	0.00143
31	3	0.38644	-0.44800	0.91773	0.41662
2	2	0.00000	-0.70000	0.84946	0.09627

N = 10

National Sample=FINNLAND Subdivision=32 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
36	40	8	0	5.25	5	5.0	5	33.38

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
36	5	-0.71656	0.26652	0.87020	0.15430

N = 1

National Sample=GERMANY Subdivision=24 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
74	30	7	1	5.00	5	5.0	5	20.00
72	30	7	1	5.57	6	5.0	5	20.35
19	30	8	0	3.63	4	3.5	3	20.52
95	30	7	1	6.71	7	6.0	6	20.56
73	30	7	1	5.14	5	5.0	5	20.79
85	30	7	1	5.14	5	5.0	5	20.79
97	30	7	1	6.29	6	6.0	5	21.96
60	30	7	1	4.43	4	4.0	4	22.04
21	30	8	0	3.38	3	3.0	3	22.05
62	30	7	1	4.29	4	4.0	4	22.19
67	30	7	1	5.57	6	5.0	5	22.84
77	30	7	1	5.29	5	5.0	5	23.72
49	30	7	1	2.86	3	3.0	3	24.15
14	30	8	0	4.25	4	4.0	4	24.36
34	30	8	0	4.25	4	4.0	4	24.36
75	30	7	1	4.00	4	4.0	4	25.00
91	30	7	1	6.43	6	6.0	5	25.17
65	30	7	1	4.43	4	4.0	4	25.60
22	30	8	0	3.50	4	3.5	3	26.45
52	30	7	1	4.71	5	4.0	4	26.59
13	30	8	0	3.13	3	3.0	3	26.70
26	30	8	0	4.00	4	4.0	3	26.73
40	30	8	0	6.13	6	6.5	4	26.81
7	30	8	0	3.38	3	3.0	3	27.14
1	30	8	0	3.25	3	3.0	3	27.27
17	30	8	0	3.25	3	3.0	3	27.27
20	30	8	0	3.25	3	3.0	3	27.27
10	30	8	0	3.75	4	4.0	4	27.60

61	30	7	1	3.86	4	4.0	3	27.72
76	30	7	1	4.57	5	4.0	4	27.83
98	30	7	1	7.43	7	8.0	5	27.87
70	30	7	1	5.71	6	6.0	5	28.06
56	30	7	1	4.43	4	4.0	4	28.73
18	30	8	0	3.88	4	3.5	3	29.06
27	30	8	0	3.63	4	3.0	3	29.26
31	30	8	0	3.63	4	3.0	3	29.26
43	30	8	0	3.63	4	3.0	3	29.26
66	30	7	1	3.71	4	3.0	3	29.96

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
74	3	1.40000	3.00000	0.78907	0.03160
72	3	2.15580	4.58025	0.61372	0.00041
19	2	0.82377	-0.15151	0.79825	0.02863
95	4	0.70645	-0.32550	0.91799	0.47132
73	3	0.77172	0.26250	0.89278	0.30104
85	3	0.77172	0.26250	0.89278	0.30104
97	3	0.35866	-2.08950	0.81425	0.05677
60	3	0.27667	0.04200	0.93772	0.63624
21	2	1.95103	3.20499	0.60064	0.00023
62	3	0.86318	1.24488	0.87213	0.20044
67	4	1.13725	1.94740	0.89017	0.28647
77	4	2.10309	5.38017	0.66464	0.00149
49	2	0.17390	0.33600	0.84092	0.10334
14	3	0.38644	-0.44800	0.91773	0.41662
34	3	0.38644	-0.44800	0.91773	0.41662
75	3	1.40000	3.00000	0.78907	0.03160
91	4	0.67409	-1.15101	0.86009	0.15615
65	3	2.64575	7.00000	0.45694	0.00001
22	3	0.00000	0.00000	0.93039	0.52431
52	3	0.02901	-2.07107	0.80334	0.04413
13	3	1.68990	4.97041	0.67338	0.00137
26	3	0.93541	0.35000	0.86037	0.12363
40	4	-0.26215	-1.68042	0.88889	0.23228
7	3	0.48772	0.42082	0.90499	0.32465
1	3	1.02559	1.85124	0.82454	0.05369
17	3	1.02559	1.85124	0.82454	0.05369
20	3	1.02559	1.85124	0.82454	0.05369
10	3	-0.38644	-0.44800	0.91773	0.41662
61	3	1.52005	2.71250	0.78143	0.02637
76	4	1.13725	1.94740	0.89017	0.28647
98	5	-0.17390	-2.10311	0.87356	0.20639
70	5	-0.37417	0.58765	0.96815	0.88901
56	4	1.58106	3.16817	0.80804	0.04920
18	3	1.11326	0.29105	0.80954	0.03755
27	3	1.96044	3.93651	0.67515	0.00143
31	3	1.96044	3.93651	0.67515	0.00143
43	3	1.96044	3.93651	0.67515	0.00143
66	3	1.78361	3.23077	0.72132	0.00613

N = 38

National Sample=GERMANY Subdivision=24 Class of CV=4

Otolith	Upper CV	Missing	Mean	Rounded	Median	Modal	Coefficient

No.	limit	n	values	age	mean age	age	age	of
variation								
6	40	8	0	3.50	4	3.0	3	30.54
29	40	8	0	3.50	4	3.0	3	30.54
33	40	8	0	3.50	4	3.0	3	30.54
37	40	8	0	3.50	4	3.0	3	30.54
11	40	8	0	3.75	4	3.0	3	31.07
30	40	8	0	3.75	4	4.0	4	31.07
5	40	8	0	2.25	2	2.0	2	31.43
48	40	8	0	5.13	5	5.0	4	32.04
55	40	7	1	4.29	4	4.0	4	32.20
9	40	8	0	3.63	4	3.5	3	32.77
39	40	8	0	4.13	4	4.0	3	32.88
15	40	8	0	3.38	3	3.0	3	35.19
23	40	8	0	3.38	3	3.0	3	35.19
24	40	8	0	3.38	3	3.0	3	35.19
28	40	8	0	3.38	3	3.0	3	35.19
54	40	7	1	4.14	4	4.0	3	35.33
32	40	8	0	4.00	4	3.5	3	35.36
41	40	8	0	4.00	4	3.5	3	35.36
59	40	7	1	4.00	4	4.0	3	35.36
46	40	8	0	4.50	5	4.0	4	35.63
35	40	8	0	3.63	4	3.0	3	35.93
2	40	8	0	2.50	3	2.0	2	37.03
45	40	8	0	3.50	4	3.0	3	37.41
53	40	7	1	4.14	4	4.0	4	37.98
57	40	7	1	4.00	4	3.0	3	38.19
47	40	8	0	4.25	4	4.0	3	39.27
50	40	8	0	3.25	3	3.0	3	39.44
42	40	8	0	3.75	4	3.5	3	39.68
69	40	7	1	4.29	4	4.0	4	39.77

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
6	3	2.33854	5.46875	0.56687	0.00010
29	3	2.33854	5.46875	0.56687	0.00010
33	3	2.33854	5.46875	0.56687	0.00010
37	3	2.33854	5.46875	0.56687	0.00010
11	3	1.35536	0.62050	0.72452	0.00476
30	4	0.63250	1.73740	0.89123	0.24416
5	2	2.82843	8.00000	0.41685	0.00000
48	5	0.51219	-0.40721	0.89994	0.29288
55	4	1.42378	2.32050	0.84092	0.10334
9	4	0.96983	1.87175	0.89123	0.24416
39	4	1.53913	2.57065	0.80906	0.03712
15	4	1.75848	3.93911	0.75666	0.01044
23	4	1.75848	3.93911	0.75666	0.01044
24	4	1.75848	3.93911	0.75666	0.01044
28	4	1.75848	3.93911	0.75666	0.01044
54	4	1.44824	1.94756	0.81599	0.05907
32	4	1.61624	2.47143	0.77050	0.01462
41	4	1.61624	2.47143	0.77050	0.01462
59	4	1.97990	4.40000	0.72062	0.00603
46	5	1.66296	3.42222	0.81555	0.04335
35	4	0.92941	0.22214	0.87719	0.18021
2	2	1.44016	0.00000	0.56631	0.00010
45	4	1.27294	0.87500	0.77583	0.01664
53	5	0.75525	1.44763	0.93439	0.60718

57	4	1.57117	1.97143	0.74938	0.01220
47	5	1.93570	4.17515	0.75281	0.00950
50	4	1.56038	3.02760	0.80956	0.03757
42	5	1.60418	3.62456	0.82252	0.05118
69	5	2.21037	5.43031	0.67406	0.00189

N = 29

National Sample=GERMANY Subdivision=24 Class of CV=5

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
16	50	8	0	4.88	5	5.5	3	40.19
38	50	8	0	3.50	4	3.0	3	40.41
63	50	7	1	3.43	3	3.0	2	40.75
4	50	8	0	2.75	3	2.0	2	42.36
36	50	8	0	3.00	3	3.0	3	43.64
44	50	8	0	3.88	4	3.0	3	44.56
3	50	8	0	2.63	3	2.0	2	45.25

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
16	5	-0.37743	-1.71277	0.88477	0.21260
38	4	0.80812	-0.22857	0.89775	0.27993
63	4	0.97402	1.00690	0.89560	0.31745
4	3	1.35536	0.62050	0.72452	0.00476
36	4	2.03670	4.90000	0.70556	0.00300
44	5	1.14081	0.12971	0.82469	0.05388
3	3	1.65191	1.35491	0.60649	0.00027

N = 7

National Sample=GERMANY Subdivision=24 Class of CV=6

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
8	60	8	0	2.75	3	2.0	2	54.11

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
8	4	1.95103	3.20499	0.60064	0.00023

N = 1

National Sample=LATVIA Subdivision=28 Class of CV=3

Otolith Upper CV Missing Mean Rounded Median Modal
Coefficient

No.	limit	n	values	age	mean age	age	age	of variation
47	30	8	0	5.75	6	6.0	6	20.26
74	30	8	0	2.25	2	2.0	2	20.57
50	30	8	0	6.75	7	7.0	7	22.05
51	30	8	0	7.25	7	7.5	7	23.02
76	30	8	0	6.88	7	7.0	7	23.88
80	30	8	0	6.75	7	7.0	7	24.73
79	30	8	0	6.88	7	7.0	7	25.12

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
47	4	-2.25893	6.20499	0.61431	0.00033
74	1	1.44016	0.00000	0.56631	0.00010
50	4	-1.17062	0.26805	0.81087	0.03877
51	5	-1.01394	0.99408	0.90721	0.33946
76	5	-2.31898	5.95883	0.65410	0.00086
80	5	-0.46088	-0.59645	0.95945	0.80477
79	6	-1.74416	4.64040	0.74417	0.00770

N = 7

National Sample=POLAND Subdivision=25 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
27	30	8	0	4.13	4	4.0	4	20.23
46	30	8	0	5.75	6	6.0	6	20.26
58	30	8	0	6.25	6	6.0	6	20.51
23	30	8	0	3.88	4	4.0	3	21.54
59	30	8	0	4.75	5	4.0	4	21.79
5	30	8	0	3.38	3	3.0	3	22.05
52	30	8	0	6.25	6	6.0	6	22.22
60	30	8	0	4.63	5	4.0	4	22.93
40	30	8	0	6.00	6	6.0	6	23.57
61	30	8	0	4.50	5	4.0	4	23.76
39	30	8	0	4.75	5	5.0	5	24.53
4	30	8	0	2.75	3	3.0	3	25.71
32	30	8	0	4.88	5	4.5	4	27.82
45	30	8	0	4.88	5	4.5	4	27.82
36	30	8	0	5.88	6	5.5	4	27.95

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
27	3	1.68990	4.97041	0.67338	0.00137
46	4	0.63250	1.73740	0.89123	0.24416
58	4	1.56038	3.02760	0.80956	0.03757
23	2	0.27653	-1.39172	0.83667	0.07147
59	2	0.64406	-2.24000	0.64291	0.00065
5	2	1.95103	3.20499	0.60064	0.00023
52	5	0.69341	2.76543	0.82507	0.05437
60	3	1.96044	3.93651	0.67515	0.00143
40	5	1.21218	3.50000	0.79561	0.02686

61	3	2.33854	5.46875	0.56687	0.00010
39	4	0.63250	1.73740	0.89123	0.24416
4	2	0.40406	-0.22857	0.82754	0.05764
32	4	2.12615	5.00300	0.68357	0.00175
45	4	2.12615	5.00300	0.68357	0.00175
36	4	0.26215	-1.68042	0.88889	0.23228

N = 15

National Sample=POLAND Subdivision=25 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
6	40	8	0	2.50	3	2.0	2	30.24
48	40	8	0	4.63	5	4.0	4	30.44
53	40	8	0	4.63	5	4.0	4	30.44
63	40	8	0	3.50	4	3.0	3	30.54
28	40	8	0	4.50	5	4.0	4	31.43
33	40	8	0	4.50	5	4.0	4	31.43
38	40	8	0	4.50	5	4.0	4	31.43
44	40	8	0	4.50	5	4.0	4	31.43
49	40	8	0	4.50	5	4.0	4	31.43
31	40	8	0	4.75	5	4.0	4	36.90
37	40	8	0	4.75	5	4.0	4	36.90
51	40	6	2	4.50	5	4.0	4	39.13

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
6	2	1.32288	0.87500	0.72410	0.00471
48	4	2.52759	6.50402	0.53852	0.00005
53	4	2.52759	6.50402	0.53852	0.00005
63	3	2.33854	5.46875	0.56687	0.00010
28	4	2.82843	8.00000	0.41685	0.00000
33	4	2.82843	8.00000	0.41685	0.00000
38	4	2.82843	8.00000	0.41685	0.00000
44	4	2.82843	8.00000	0.41685	0.00000
49	4	2.82843	8.00000	0.41685	0.00000
31	5	2.62740	7.02650	0.51807	0.00003
37	5	2.62740	7.02650	0.51807	0.00003
51	5	2.14360	5.06764	0.66706	0.00139

N = 12

National Sample=POLAND Subdivision=25 Class of CV=5

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
34	50	8	0	3.88	4	3.0	3	44.56

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)

34	5	2.47234	6.37527	0.59143	0.00019

N = 1

National Sample=POLAND Subdivision=26 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
47	30	8	0	6.50	7	6.0	6	21.76
42	30	8	0	5.38	5	5.0	5	22.10
27	30	8	0	5.25	5	5.0	5	22.19
17	30	8	0	4.63	5	4.0	4	22.93
43	30	8	0	4.63	5	4.0	4	22.93
41	30	8	0	5.88	6	5.5	5	23.08
51	30	8	0	4.50	5	4.0	4	23.76
16	30	8	0	4.38	4	4.0	4	24.24
54	30	8	0	5.13	5	5.0	5	24.32
46	30	8	0	5.63	6	5.0	5	25.03
49	30	8	0	6.25	6	6.0	6	25.30
26	30	8	0	5.50	6	5.0	5	27.49
50	30	8	0	5.25	5	5.0	4	28.34
22	30	8	0	3.63	4	3.0	3	29.26

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
47	4	2.82843	8.00000	0.41685	0.00000
42	4	1.75848	3.93911	0.75666	0.01044
27	4	2.25893	6.20499	0.61431	0.00033
17	3	1.96044	3.93651	0.67515	0.00143
43	3	1.96044	3.93651	0.67515	0.00143
41	4	2.12615	5.00300	0.68357	0.00175
51	3	2.33854	5.46875	0.56687	0.00010
16	3	2.82843	8.00000	0.41685	0.00000
54	4	2.05646	5.26040	0.68708	0.00191
46	4	2.52759	6.50402	0.53852	0.00005
49	5	2.34912	6.21714	0.63648	0.00056
26	5	2.14967	5.30469	0.69616	0.00238
50	4	1.17062	0.26805	0.81087	0.03877
22	3	1.96044	3.93651	0.67515	0.00143

N = 14

National Sample=POLAND Subdivision=26 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
20	40	8	0	4.63	5	4.0	4	30.44
25	40	8	0	3.50	4	3.0	3	30.54
31	40	8	0	6.13	6	5.0	5	34.29
38	40	8	0	4.75	5	4.0	4	36.90

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
20	4	2.52759	6.50402	0.53852	0.00005
25	3	2.33854	5.46875	0.56687	0.00010
31	5	1.50942	0.44702	0.59625	0.00021
38	5	2.62740	7.02650	0.51807	0.00003

N = 4

National Sample=POLAND Subdivision=26 Class of CV=5

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
29	50	8	0	4.00	4	3.0	3	44.32

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
29	5	2.05119	4.19421	0.66727	0.00118

N = 1

National Sample=RUSSIA Subdivision=26 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
77	30	8	0	8.25	8	8.0	8	20.23
99	30	8	0	5.75	6	6.0	6	20.26
51	30	8	0	6.13	6	6.0	6	20.35
66	30	8	0	2.25	2	2.0	2	20.57
31	30	8	0	2.50	3	2.5	2	21.38
29	30	8	0	3.25	3	3.0	3	21.76
43	30	8	0	3.25	3	3.0	3	21.76
45	30	8	0	3.25	3	3.0	3	21.76
64	30	8	0	7.88	8	7.5	7	21.93
26	30	8	0	5.38	5	5.0	5	22.10
52	30	8	0	8.25	8	8.5	7	23.13
40	30	8	0	4.00	4	4.0	3	23.15
48	30	8	0	7.25	7	7.5	9	24.17
90	30	8	0	7.63	8	7.5	7	24.22
19	30	8	0	7.75	8	7.5	7	24.63
20	30	8	0	4.13	4	4.0	3	27.30
4	30	8	0	4.88	5	4.0	4	27.82
18	30	8	0	5.00	5	4.5	4	28.28

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
77	6	-0.52233	2.58462	0.86949	0.15188
99	4	0.63250	1.73740	0.89123	0.24416

51	4	-0.30432	0.14649	0.95785	0.78978
66	1	1.44016	0.00000	0.56631	0.00010
31	1	0.00000	-2.80000	0.66679	0.00116
29	2	2.82843	8.00000	0.41685	0.00000
43	2	2.82843	8.00000	0.41685	0.00000
45	2	2.82843	8.00000	0.41685	0.00000
64	5	-0.19071	-0.56424	0.91998	0.43459
26	3	0.39433	-1.22929	0.87605	0.17574
52	6	-0.30820	-0.15502	0.97500	0.93048
40	2	0.00000	-2.10000	0.80364	0.03260
48	4	-0.29193	-1.91412	0.84897	0.09519
90	6	0.55281	0.64441	0.96904	0.88781
19	6	0.30820	-0.15502	0.97500	0.93048
20	3	0.48783	-0.98869	0.88326	0.20578
4	3	1.20983	-0.46979	0.67192	0.00132
18	4	1.61624	2.47143	0.77050	0.01462

N = 18

National Sample=RUSSIA Subdivision=26 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
57	40	8	0	1.13	1	1.0	1	31.43
82	40	8	0	6.25	6	5.0	5	33.94

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
57	1	2.82843	8.00000	0.41685	0.00000
82	6	0.88295	-0.63492	0.82754	0.05764

N = 2

National Sample=RUSSIA Subdivision=26 Class of CV=5

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
80	50	8	0	2.50	3	2.0	2	42.76

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
80	3	2.33854	5.46875	0.56687	0.00010

N = 1

National Sample=SWEDEN Subdivision=25 Class of CV=3

Otolith Upper CV Missing Mean Rounded Median Modal
Coefficient

No.	limit	n	values	age	mean age	age	age	of variation
16	30	8	0	2.25	2	2.0	2	20.57
14	30	8	0	3.88	4	4.0	4	21.54
23	30	8	0	3.50	4	3.0	3	21.60
9	30	8	0	2.88	3	3.0	3	22.29
41	30	8	0	8.50	9	8.5	8	22.67
49	30	8	0	5.88	6	5.5	5	23.08
45	30	8	0	4.38	4	4.0	4	24.24
6	30	8	0	4.50	5	5.0	5	26.56
40	30	8	0	3.88	4	3.5	3	29.06

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
16	1	1.44016	0.00000	0.56631	0.00010
14	3	-1.68990	4.97041	0.67338	0.00137
23	2	1.32288	0.87500	0.72410	0.00471
9	2	0.06784	0.74102	0.80956	0.03757
41	6	-0.63861	0.18225	0.95625	0.77450
49	4	2.12615	5.00300	0.68357	0.00175
45	3	2.82843	8.00000	0.41685	0.00000
6	4	-1.33866	2.57600	0.84667	0.09025
40	3	1.11326	0.29105	0.80954	0.03755

N = 9

National Sample=SWEDEN Subdivision=25 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
42	40	8	0	3.50	4	3.0	3	30.54
15	40	8	0	2.88	3	2.5	2	34.47
38	40	8	0	3.75	4	3.0	3	37.03
46	40	8	0	3.75	4	3.0	3	37.03
10	40	8	0	1.38	1	1.0	1	37.64

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
42	3	2.33854	5.46875	0.56687	0.00010
15	2	0.31189	-2.35848	0.73816	0.00665
38	4	2.29360	5.53086	0.62717	0.00045
46	4	2.29360	5.53086	0.62717	0.00045
10	1	0.64406	-2.24000	0.64291	0.00065

N = 5

National Sample=SWEDEN Subdivision=27 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation

31	30	8	0	7.00	7	7.0	7	21.60

Otolith No.	Age range	Skewness	Kurtosis	NV	p(H0=NV)
31	5	0.99216	1.66250	0.91749	0.41473

N = 1

Second otolith exchange

National Sample=GERMANY Subdivision=24 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
50	30	10	0	4.90	5	5.0	4	20.29
12	30	10	0	3.30	3	3.0	3	20.45
17	30	10	0	3.30	3	3.0	3	20.45
77	30	10	0	3.30	3	3.0	3	20.45
59	30	10	0	3.40	3	3.0	3	20.56
40	30	10	0	2.30	2	2.0	2	21.00
48	30	10	0	2.30	2	2.0	2	21.00
57	30	10	0	2.50	3	2.5	2	21.08
76	30	10	0	5.50	6	5.0	5	21.43
97	30	10	0	4.80	5	4.5	4	21.52
37	30	10	0	4.60	5	4.0	4	23.37
81	30	10	0	3.60	4	3.0	3	23.42
44	30	10	0	4.00	4	4.0	4	23.57
79	30	10	0	4.90	5	5.0	5	24.43
78	30	10	0	2.90	3	3.0	3	25.44
84	30	10	0	3.90	4	4.0	3	25.50
28	30	10	0	2.60	3	2.5	2	26.89
31	30	10	0	2.60	3	2.5	2	26.89
51	30	10	0	3.50	4	3.0	3	27.77
61	30	10	0	3.90	4	3.5	3	28.22

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
50	4	3	1.08469	0.9138	0.82968	0.03251
12	3	2	2.27660	4.7650	0.52836	0.00002
17	3	2	2.27660	4.7650	0.52836	0.00002
77	3	2	2.27660	4.7650	0.52836	0.00002
59	3	2	1.65772	2.0455	0.64912	0.00031
40	2	1	1.03510	-1.2245	0.59798	0.00009
48	2	1	1.03510	-1.2245	0.59798	0.00009
57	2	1	0.00000	-2.5714	0.66188	0.00042
76	4	3	0.25456	-1.4400	0.85469	0.06355
97	4	3	1.24056	0.9459	0.79245	0.01203
37	4	3	1.69057	1.8639	0.64622	0.00029
81	3	2	1.00056	-0.6655	0.72090	0.00186
44	3	3	0.99437	1.1853	0.84008	0.04297
79	4	4	2.17558	5.7506	0.67633	0.00060
78	2	2	0.16595	-0.7336	0.83523	0.03773

84	3	3	1.08469	0.9138	0.82968	0.03251
28	2	2	0.78011	-0.1461	0.78268	0.00929
31	2	2	0.78011	-0.1461	0.78268	0.00929
51	3	3	2.26983	5.3564	0.60058	0.00010
61	3	3	0.86282	-0.5216	0.81272	0.02065

National Sample=GERMANY Subdivision=24 Class of CV=3 (continued)

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
13	30	10	0	2.40	2	2.0	2	29.13
14	30	10	0	2.30	2	2.0	2	29.35
34	30	10	0	2.30	2	2.0	2	29.35
41	30	10	0	2.30	2	2.0	2	29.35

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
13	2	2	1.65772	2.0455	0.64912	0.00031
14	2	2	2.27660	4.7650	0.52836	0.00002
34	2	2	2.27660	4.7650	0.52836	0.00002
41	2	2	2.27660	4.7650	0.52836	0.00002

N = 24

National Sample=GERMANY Subdivision=24 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
38	40	10	0	4.00	4	3.5	3	31.18
49	40	10	0	3.00	3	3.0	2	31.43
21	40	10	0	3.80	4	3.5	3	32.35
24	40	10	0	2.60	3	2.0	2	32.43
42	40	10	0	2.60	3	2.0	2	32.43
11	40	10	0	2.80	3	3.0	3	32.82
52	40	10	0	2.50	3	2.0	2	33.99
56	40	10	0	4.40	4	4.0	3	34.22
45	40	10	0	2.60	3	2.0	2	37.16
71	40	10	0	2.60	3	2.0	2	37.16

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
38	3	3	0.85905	-0.9118	0.78228	0.00919
49	2	2	0.00000	-2.1295	0.77570	0.00772
21	2	4	0.46656	-0.5436	0.92444	0.38027
24	2	2	1.00056	-0.6655	0.72090	0.00186
42	2	2	1.00056	-0.6655	0.72090	0.00186
11	1	3	-0.60138	0.3962	0.88430	0.13933

52	2	2	1.35773	0.1065	0.62963	0.00019
56	3	4	0.60560	-1.1808	0.85694	0.06750
45	2	3	1.95929	4.1873	0.67680	0.00061
71	2	3	1.95929	4.1873	0.67680	0.00061

National Sample=GERMANY Subdivision=24 Class of CV=4 (continued)

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
36	40	10	0	2.50	3	2.0	2	38.87

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
36	2	3	2.26983	5.3564	0.60058	0.00010

N = 11

National Sample=GERMANY Subdivision=24 Class of CV=5

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
8	50	10	0	1.60	2	1.5	1	43.70
75	50	10	0	3.10	3	3.0	2	44.20
9	50	10	0	2.60	3	2.0	2	45.15
32	50	10	0	2.70	3	2.0	2	46.36
63	50	10	0	2.60	3	2.0	2	48.65

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
8	1	2	0.78011	-0.1461	0.78268	0.00929
75	2	4	1.39906	1.2078	0.77532	0.00765
9	1	4	0.98935	0.7509	0.87120	0.09867
32	2	4	2.40531	6.3364	0.61877	0.00015
63	2	4	2.60229	7.1354	0.55571	0.00003

N = 5

National Sample=GERMANY Subdivision=24 Class of CV=6

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
5	60	10	0	1.80	2	1.5	1	57.38

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
5	1	3	1.24056	0.9459	0.79245	0.01203

N = 1

National Sample=POLAND Subdivision=25 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
66	30	10	0	3.50	4	3.0	3	20.20

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
66	3	2	1.17851	0.5714	0.73201	0.00247

National Sample=POLAND Subdivision=25 Class of CV=3 (continued)

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
80	30	10	0	6.10	6	6.5	7	21.09
81	30	9	1	5.67	6	6.0	7	21.61
73	30	10	0	6.50	7	6.5	6	22.06
76	30	10	0	4.70	5	5.0	5	22.54
24	30	10	0	3.30	3	3.5	4	24.95
47	30	10	0	4.50	5	4.5	4	26.19

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
80	4	4	-0.22690	-1.1942	0.90430	0.23303
81	4	3	-0.23328	-1.5556	0.87413	0.13392
73	4	5	0.00000	0.2385	0.96718	0.85360
76	3	3	-0.65891	-0.4058	0.84735	0.05221
24	2	2	-0.68698	-1.0435	0.78536	0.00997
47	2	4	-0.76368	1.2754	0.88582	0.14498

N = 7

National Sample=POLAND Subdivision=25 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation

83	40	9	1	5.44	5	5.0	4	30.61
68	40	10	0	5.70	6	6.0	4	34.15
10	40	10	0	1.20	1	1.0	1	35.14
19	40	10	0	1.20	1	1.0	1	35.14

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
83	4	5	1.37400	1.6406	0.83710	0.05342
68	3	6	0.30056	-0.8781	0.93712	0.50489
10	1	1	1.77878	1.4063	0.50897	0.00001
19	1	1	1.77878	1.4063	0.50897	0.00001

N = 4

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National Sample=POLAND Subdivision=25 Class of CV=6

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
46	60	10	0	2.50	3	2.0	2	50.77
2	60	10	0	1.20	1	1.0	1	52.70

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
46	2	4	2.85252	8.3258	0.47003	0.00000
2	1	2	3.16228	10.0000	0.36024	0.00000

N = 2

National Sample=POLAND Subdivision=26 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
42	30	10	0	3.40	3	3.5	4	20.56
39	30	10	0	4.10	4	4.0	5	21.36

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
42	2	2	-0.78011	-0.1461	0.78268	0.00929
39	3	2	-0.22345	-1.7337	0.81140	0.01993

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National Sample=POLAND Subdivision=26 Class of CV=3 (continued)

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
76	30	10	0	5.90	6	6.0	7	23.23
68	30	7	3	6.43	6	7.0	7	23.52
69	30	10	0	4.00	4	4.0	4	23.57
40	30	10	0	3.10	3	3.0	3	23.80
100	30	9	1	5.11	5	5.0	5	24.83
58	30	10	0	5.30	5	5.0	5	26.76
52	30	10	0	2.10	2	2.0	2	27.03
74	30	10	0	4.60	5	4.0	4	27.50
25	30	10	0	1.10	1	1.0	1	28.75
26	30	10	0	1.10	1	1.0	1	28.75
27	30	10	0	1.10	1	1.0	1	28.75
29	30	10	0	1.10	1	1.0	1	28.75
31	30	10	0	1.10	1	1.0	1	28.75
32	30	10	0	1.10	1	1.0	1	28.75
38	30	10	0	1.10	1	1.0	1	28.75
45	30	10	0	1.10	1	1.0	1	28.75
60	30	10	0	1.10	1	1.0	1	28.75
93	30	10	0	2.30	2	2.0	2	29.35

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
76	4	4	-0.10363	-1.1691	0.92928	0.42492
68	4	4	-0.62010	-0.8094	0.91243	0.42928
69	3	3	0.99437	1.1853	0.84008	0.04297
40	2	2	-0.16595	-0.7336	0.83523	0.03773
100	4	4	1.62613	3.1524	0.79377	0.01786
58	3	4	-0.07597	-1.1546	0.90897	0.26191
52	1	2	0.09112	1.4982	0.74699	0.00364
74	3	3	0.13176	-1.8676	0.79972	0.01460
25	1	1	3.16228	10.0000	0.36024	0.00000
26	1	1	3.16228	10.0000	0.36024	0.00000
27	1	1	3.16228	10.0000	0.36024	0.00000
29	1	1	3.16228	10.0000	0.36024	0.00000
31	1	1	3.16228	10.0000	0.36024	0.00000
32	1	1	3.16228	10.0000	0.36024	0.00000
38	1	1	3.16228	10.0000	0.36024	0.00000
45	1	1	3.16228	10.0000	0.36024	0.00000
60	1	1	3.16228	10.0000	0.36024	0.00000
93	2	2	2.27660	4.7650	0.52836	0.00002

N = 20

National Sample=POLAND Subdivision=26 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
95	40	10	0	6.80	7	7.5	9	30.85
41	40	10	0	2.10	2	2.0	2	35.14

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
95	4	5	-0.30337	-1.8777	0.84963	0.05551
41	1	2	-0.16595	-0.7336	0.83523	0.03773

N = 2

National Sample=POLAND Subdivision=26 Class of CV=6

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
43	60	10	0	1.20	1	1.0	1	52.70

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
43	1	2	3.16228	10.0000	0.36024	0.00000

N = 1

National Sample=POLAND Subdivision=26 Class of CV=32

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
17	320	10	0	0.10	0	0.0	0	316.23
20	320	10	0	0.10	0	0.0	0	316.23

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
17	0	1	3.16228	10.0000	0.36024	0.00000
20	0	1	3.16228	10.0000	0.36024	0.00000

N = 2

National Sample=SWEDEN Subdivision=25 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
62	30	10	0	3.50	4	3.0	3	20.20
64	30	10	0	5.70	6	6.0	6	20.34
70	30	10	0	6.40	6	7.0	7	21.09
50	30	10	0	4.10	4	4.0	4	21.36
68	30	10	0	2.40	2	2.0	2	21.52
17	30	10	0	3.70	4	4.0	4	22.25

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
62	3	2	1.17851	0.5714	0.73201	0.00247
64	4	3	-0.34212	-1.2268	0.88294	0.13446
70	4	4	-0.58270	-0.7562	0.89817	0.19950
50	3	3	1.01794	1.8309	0.81696	0.02312
68	2	1	0.48412	-2.2768	0.64642	0.00029
17	2	3	-0.80646	1.2370	0.83687	0.03943

National Sample=SWEDEN Subdivision=25 Class of CV=3 (continued)

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
32	30	10	0	3.70	4	3.5	3	22.25
13	30	10	0	2.80	3	3.0	3	22.59
75	30	10	0	5.90	6	6.0	7	23.23
24	30	10	0	5.10	5	5.0	5	23.47
3	30	10	0	2.00	2	2.0	2	23.57
40	30	10	0	3.10	3	3.0	3	23.80
18	30	10	0	3.20	3	3.0	3	24.65
33	30	10	0	3.20	3	3.0	3	24.65
34	30	10	0	2.70	3	3.0	3	25.00
60	30	10	0	3.70	4	3.0	3	25.64
38	30	10	0	4.90	5	5.0	5	26.26
45	30	10	0	2.10	2	2.0	2	27.03
42	30	10	0	5.80	6	6.0	6	27.92
52	30	10	0	2.50	3	2.0	2	28.28
53	30	10	0	2.50	3	2.0	2	28.28

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
32	3	2	0.68698	-1.0435	0.78536	0.00997
13	2	2	0.13176	0.1786	0.79337	0.01233
75	4	4	-0.10363	-1.1691	0.92928	0.42492
24	3	4	-0.23310	-0.3685	0.95231	0.68073
3	1	2	0.00000	4.5000	0.64844	0.00030
40	2	2	-0.16595	-0.7336	0.83523	0.03773
18	2	2	-0.40749	-1.0742	0.82389	0.02784
33	2	2	-0.40749	-1.0742	0.82389	0.02784
34	2	2	0.43364	-0.2830	0.80343	0.01611
60	3	2	0.74177	-1.6402	0.69120	0.00088
38	3	4	-0.16431	-0.4297	0.92527	0.38770
45	1	2	0.09112	1.4982	0.74699	0.00364
42	3	5	-0.58091	-0.7807	0.90660	0.24688
52	2	2	1.17851	0.5714	0.73201	0.00247
53	2	2	1.17851	0.5714	0.73201	0.00247

N = 21

National Sample=SWEDEN Subdivision=25 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
1	40	10	0	1.20	1	1.0	1	35.14
8	40	10	0	1.20	1	1.0	1	35.14
14	40	10	0	1.50	2	1.5	1	35.14
15	40	10	0	1.20	1	1.0	1	35.14
36	40	10	0	3.60	4	3.5	3	35.14
20	40	10	0	1.30	1	1.0	1	37.16
23	40	10	0	1.30	1	1.0	1	37.16
35	40	10	0	1.30	1	1.0	1	37.16

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
1	1	1	1.77878	1.4063	0.50897	0.00001
8	1	1	1.77878	1.4063	0.50897	0.00001
14	1	1	0.00000	-2.5714	0.66188	0.00042
15	1	1	1.77878	1.4063	0.50897	0.00001
36	2	4	0.54352	-0.0260	0.93055	0.43727
20	1	1	1.03510	-1.2245	0.59798	0.00009
23	1	1	1.03510	-1.2245	0.59798	0.00009
35	1	1	1.03510	-1.2245	0.59798	0.00009

N = 8

National Sample=SWEDEN Subdivision=25 Class of CV=5

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
12	50	10	0	2.40	2	2.0	2	40.25

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
12	1	3	0.81329	-0.0219	0.80008	0.01473

N = 1

National Sample=SWEDEN Subdivision=27 Class of CV=3

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
36	30	10	0	2.30	2	2.0	2	21.00
19	30	10	0	2.40	2	2.0	2	21.52
34	30	10	0	2.40	2	2.0	2	21.52

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
36	2	1	1.03510	-1.2245	0.59798	0.00009
19	2	1	0.48412	-2.2768	0.64642	0.00029
34	2	1	0.48412	-2.2768	0.64642	0.00029

National Sample=SWEDEN Subdivision=27 Class of CV=3 (continued)

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
57	30	10	0	4.40	4	4.0	4	21.96
39	30	10	0	2.80	3	3.0	3	22.59
47	30	10	0	4.80	5	5.0	5	23.65
42	30	10	0	3.10	3	3.0	3	23.80
68	30	10	0	5.50	6	5.0	5	24.62
35	30	10	0	3.20	3	3.0	3	24.65
43	30	10	0	5.30	5	5.5	6	25.24
40	30	10	0	5.80	6	6.0	6	27.92
1	30	10	0	1.10	1	1.0	1	28.75
29	30	10	0	2.40	2	2.0	2	29.13
11	30	10	0	1.90	2	2.0	2	29.88

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
57	3	3	0.81329	-0.0219	0.80008	0.01473
39	2	2	0.13176	0.1786	0.79337	0.01233
47	3	3	-0.66062	-0.7090	0.85193	0.05903
42	2	2	-0.16595	-0.7336	0.83523	0.03773
68	4	4	0.83926	-0.4675	0.83555	0.03805
35	2	2	-0.40749	-1.0742	0.82389	0.02784
43	3	4	-0.33436	-0.8517	0.93446	0.47683
40	2	5	-1.75842	2.8759	0.74362	0.00334
1	1	1	3.16228	10.0000	0.36024	0.00000
29	2	2	1.65772	2.0455	0.64912	0.00031
11	1	2	-0.09112	1.4982	0.74699	0.00364

N = 14

National Sample=SWEDEN Subdivision=27 Class of CV=4

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
2	40	10	0	1.20	1	1.0	1	35.14
3	40	10	0	1.20	1	1.0	1	35.14
4	40	10	0	1.20	1	1.0	1	35.14

Otolith Minimum Age

No.	Age	range	Skewness	Kurtosis	NV	p(H0=NV)
2	1	1	1.77878	1.4063	0.50897	0.00001
3	1	1	1.77878	1.4063	0.50897	0.00001
4	1	1	1.77878	1.4063	0.50897	0.00001

National Sample=SWEDEN Subdivision=27 Class of CV=4 (continued)

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
5	40	10	0	1.20	1	1.0	1	35.14
6	40	10	0	1.20	1	1.0	1	35.14
7	40	10	0	1.20	1	1.0	1	35.14
8	40	10	0	1.20	1	1.0	1	35.14
9	40	10	0	1.20	1	1.0	1	35.14
10	40	10	0	1.20	1	1.0	1	35.14
12	40	10	0	1.20	1	1.0	1	35.14
13	40	10	0	1.20	1	1.0	1	35.14
70	40	10	0	2.10	2	2.0	2	35.14

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
5	1	1	1.77878	1.4063	0.50897	0.00001
6	1	1	1.77878	1.4063	0.50897	0.00001
7	1	1	1.77878	1.4063	0.50897	0.00001
8	1	1	1.77878	1.4063	0.50897	0.00001
9	1	1	1.77878	1.4063	0.50897	0.00001
10	1	1	1.77878	1.4063	0.50897	0.00001
12	1	1	1.77878	1.4063	0.50897	0.00001
13	1	1	1.77878	1.4063	0.50897	0.00001
70	1	2	-0.16595	-0.7336	0.83523	0.03773

N = 12

National Sample=SWEDEN Subdivision=27 Class of CV=6

Otolith No.	Upper CV limit	n	Missing values	Mean age	Rounded mean age	Median age	Modal age	Coefficient of variation
41	60	10	0	2.50	3	2.0	2	50.77

Otolith No.	Minimum Age	Age range	Skewness	Kurtosis	NV	p(H0=NV)
41	2	4	2.85252	8.3258	0.47003	0.00000

N = 1