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Precision and Consistency of Size Measurements for Northern Shrimp (*Pandalus borealis*)
in the West Greenland Bottom Trawl Survey

by

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Abstract

An experiment on precision and standardisation of length measurement of Northern shrimp was carried out in the beginning the 2001 West Greenland Bottom Trawl Survey. Repeated measurements of individual shrimp and mixed samples of shrimp with a slide calliper showed that precise results are achievable. Trials with experienced personnel demonstrated clearly that some comparative training and standardisation of the measurement routine is essential in order to avoid bias and to ensure consistency.

Introduction

Standardisation and training are basic requirements in order to achieve any reliable size measurements at all. To maintain a high precision is, however, not an easy task if changing personnel is involved in the measurement routine, as it has been the case during the West Greenland Trawl Survey for Northern shrimp in particular during the most recent years.

The West Greenland Bottom Trawl Survey conducted by the Greenland Institute of Natural Resources has usually been carried in four parts, each with duration of approximately two weeks. About half of the scientific crew was replaced after each cruise leg, and 10 different persons were involved in measuring more than 120 000 shrimp during the survey in 2001.

Although it has always been avoided to exchange the entire team in order to ensure consistency, the question were raised to which extent the interpretation of details in the length-age distributions were affected by a potential bias of the underlying size measurements related to the current practice (Carlsson and Kanneworff, 2000).

The present study has been carried out in order to prove the quality of the present procedure and, if necessary, to establish new guidelines for future surveys.

Material and Methods

A series of exercises on measuring shrimp size were performed onboard of RV Paamiut in the beginning and during the last leg of the West Greenland Bottom Trawl Survey in 2001. Oblique carapax length of Northern shrimp was measured with a slide calliper to the nearest 0.1 mm. Different persons measured individual shrimp and mixed samples of shrimp repeatedly. It was ensured that the individual shrimp were measured in the same order in the case of samples treated twice by the same persons or by two different ones. All personnel participated in this study were familiar with the method as they had previously measured numerous shrimp. Nonetheless, preliminary results

indicated some discrepancies. Hence, further training exercises were conducted during subsequent cruise legs and consistency of the measurements were proven again in the end of the survey.

Results and Discussion

Size frequencies with fitted normal distributions and summary statistics for two different individual shrimp measured repeatedly are shown in Figure 1 indicate fairly precise estimates of the mean with coefficients of variations amounting to about 0.5 %.

Length data grouped into intervals of 0.5 mm, which is the current practice for the analysis of length-age distributions (Carlsson and Kannevorff 2000), from a shrimp sample measured twice by the same person revealed not the same distribution (Fig. 2). The differences in the summary statistics were small, but significant concerning the mean (paired t-test, $P < 0.001$). However, the differences of the paired values did not indicate a systematic effect (Fig. 2, right panel) and thus the deviations might have been due to the relative low sample size.

Length distributions and mean values of a sample measured by two different persons prior to standardisation showed discrepancy (Fig. 3, upper panels). The means were significant different (paired t-test, $P < 0.001$) and the paired values indicated a systematic deviation (Fig. 3, upper right panel). After agreeing on details of the measurement procedure, in particular concerning the exact location of the track to be measured between the posterior orbit to the posterodorsal margin of the carapax (e.g. Bergstøm, 2000), a new sample was selected and then inconsistency between measurements of the two persons disappeared (Fig. 3, lower right panel). The summary statistics became nearly identical with no significant difference of the mean values at the 5 % level (paired t-test). However, some dissimilarities in the length distributions remained (Fig. 3, lower left panels), but these can be regarded as random.

Results for a sample measured by three different persons during the last part of the survey are given in Table 1a. The summary statistics were quite similar with no significant difference of the mean values at the 5 % level (ANOVA, Tab. 1b).

Conclusions

Precise results of carapax length of shrimp are achievable using slide callipers, but the enforcement of comparative measurements conducted on a regular basis during different parts of the survey is an essential requirement in order to avoid bias and to ensure consistency, especially if changing personnel is involved in the measuring routine. Consequently, the interpretation of details in overall length-age distributions is only reliable if this basic requirement is met. However, the observed systematic deviation between two unstandardized series of measurements was small (0.3 mm CL on average) compared to annual growth increment (about 34 mm CL; Carlsson and Kannevorff, 2000), and a simulation based on a more extended data set would be needed to study the effect of bias on length at age analyses.

Acknowledgements

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References

- Bergstøm, B.I., 2000. The Biology of *Pandalus*. *Advances in Marine Biology* 38: 57-245.
 Carlsson, D.M., and P. Kannevorff, 2000. Stratified-random Trawl Survey for Northern shrimp (*Pandalus borealis*) in NAFO Subareas 0 + 1 in 2000. NAFO SCR Doc. 00/78. Serial No. N 4335.

Table 1. a) Summary statistics for a sample of 21 shrimp measured by three different persons during the last part of the survey, b) corresponding ANOVA results.

a)

	Person D	Person E	Person F
Mean	21.22	21.20	21.21
Standard deviation	1.13	1.08	1.20
Standard error	0.25	0.23	0.26
Range	4.30	4.50	4.80
Coefficient of variation	0.0534	0.0507	0.0567

b)

Source of variation	SS	df	MS	F	P-value	F crit
Between Groups	0.004	2	0.002	0.001	0.999	3.159
Within Groups	76.672	57	1.345			
Total	76.676	59				

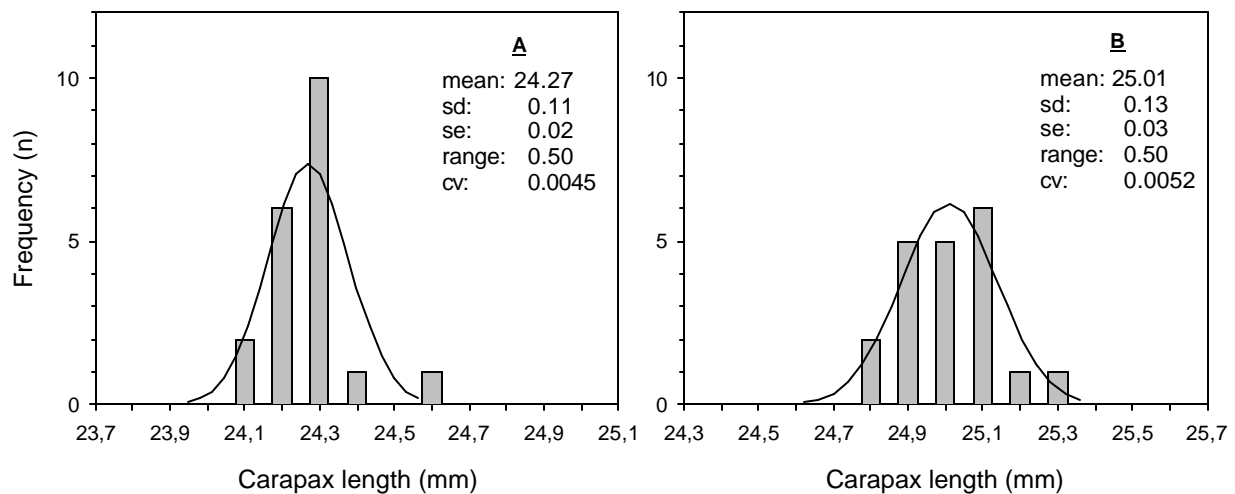


Fig. 1. Size frequencies with fitted normal distributions and summary statistics for two different individual shrimp measured 20 times by person A and B, respectively (sd: standard deviation, se: standard error, cv: coefficient of variation).

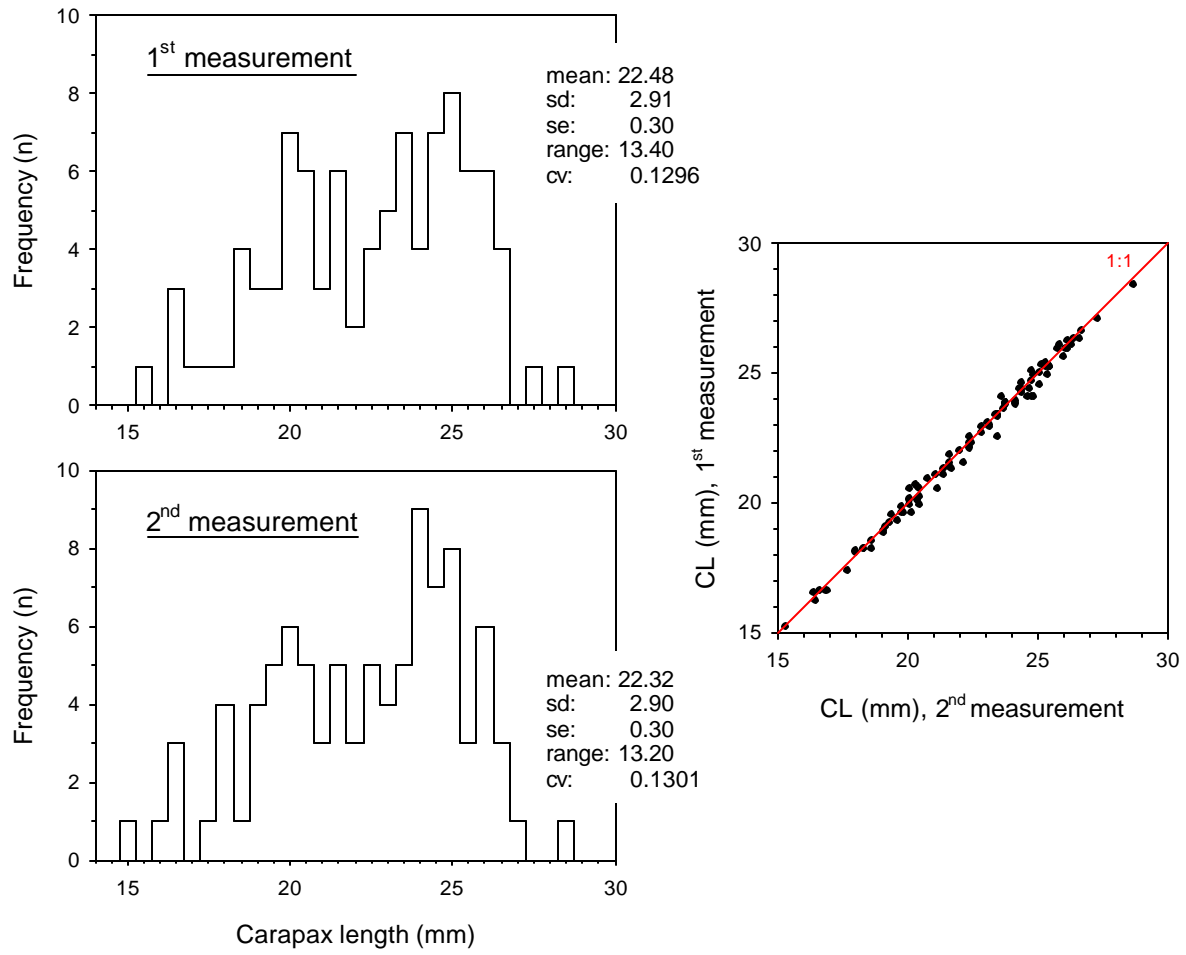


Fig. 2. Length distributions and summary statistics for a sample of 94 shrimp measured twice by the same person (sd: standard deviation, se: standard error, cv: coefficient of variation).

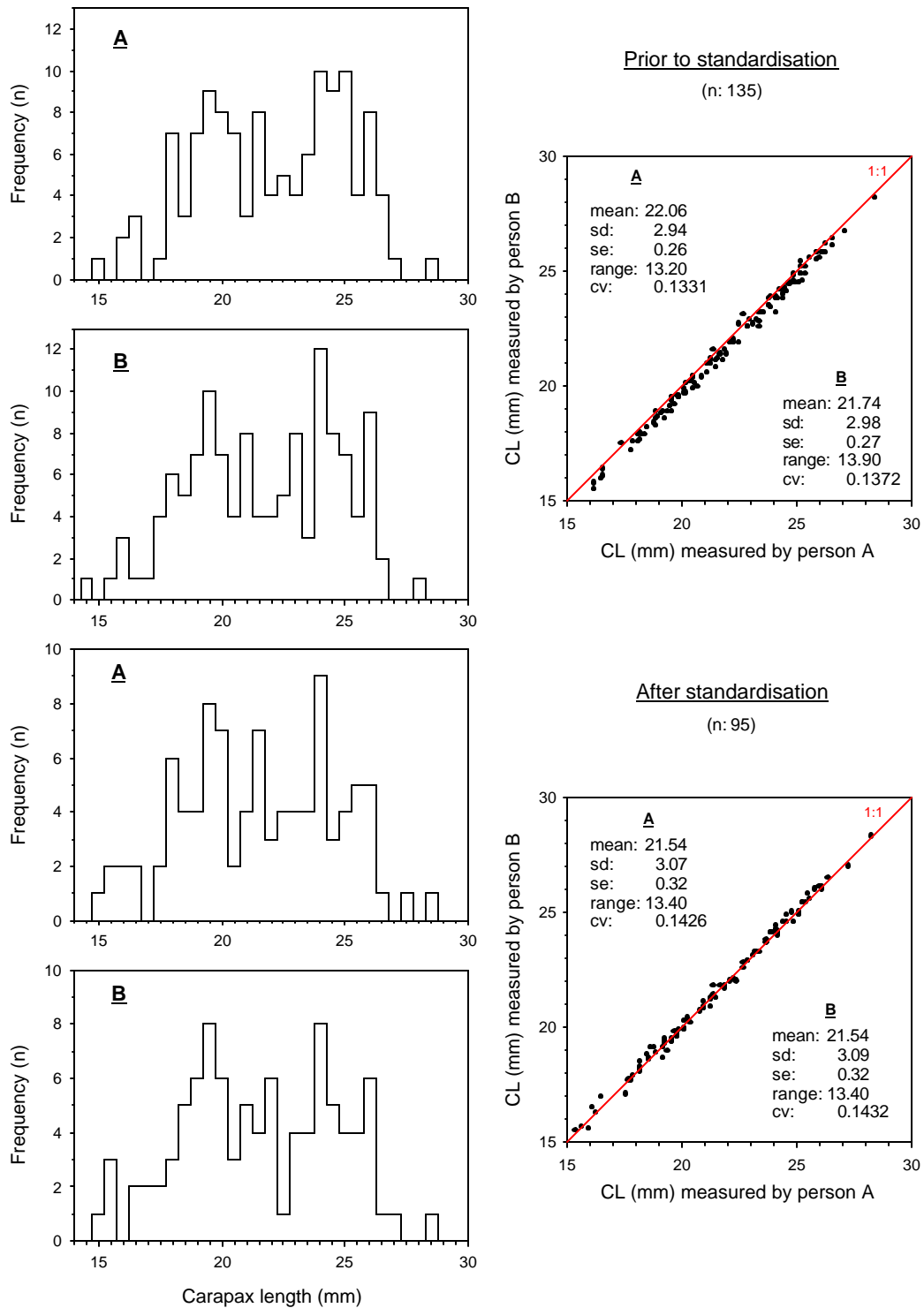


Fig. 3. Length distributions and summary statistics for two different samples of shrimp measured by two different persons prior and after standardization (n: sample size, sd: standard deviation, se: standard error, cv: coefficient of variation).