Effect of Water Flow Rate and Washing Duration on the Recovery Rate of Ichthyoplankton from a Bongo Net

Naoaki Kono

Abstract   The number of ichthyoplankters in the samples under four different flow rates (74, 97, 114 and 128 liters/min) over 10 min washing were compared to determine the procedure necessary to fully recover ichthyoplankton from a Bongo net after a tow.   All recovery rates at and after 2 min washing in the four flow rate conditions did not differ significantly from each other.   It was estimated that the optimal flow rate was 106 liters/min.   Further, it was found that too strong as well as too weak flow rate can reduce recovery efficiency.   A washing procedure of the optimal flow rate and 1 min washing is judged sufficient to fully recover (>99%) the ichthyoplankton from a Bongo net.

Key words: Bongo net, ichthyoplankton, recovery rate, washing

Bongo nets are fitted with a pair of cylindrical-conical nets fixed to a ring frame (McGowan and Brown 1966).   This net is recommended as the best collection gear for fish eggs and larvae, as minimum net avoidance occurs owing to the bridle-free and high porosity characteristics of the net (Smith and Richardson 1977, Mori 1981).   Although the structure and towing procedure have been described in detail (Smith and Richardson 1977), the time required to wash the ichthyoplankton fully into the cod-end has not been precisely assessed as well as the other kinds of plankton nets.   The manual merely states "this operation usually takes only a few minutes per net".   This paper aims to determine the procedure necessary to fully recover the ichthyoplankton from a Bongo net by comparing samples under various washing conditions.

Collections of ichthyoplankton were conducted at 19 stations (ranging from 25 to 100 m bottom depths) in the western part of the Seto Inland Sea, Japan, on board the RV 'Shirafuji-maru' (138 t) during the daytime in May 1997 and June 1998.   The Bongo net used in this study was 3 m in length, 0.7 m in mouth diameter, and has 335 μm mesh openings.   The gross gauze area of each net is 5.3 m^2.   An oblique tow at 2 knots from the near-bottom to the surface was made at each station.   The net after each tow was washed down from the outside with a 24 mm-caliber salt water hose under one of four different flow rates; i.e., 74, 97, 114 and 128 liters/min flow rates were adopted at 3, 6,

4 and 6 stations, respectively.   Washing and sampling procedures were performed on deck as follows: both nets were washed for 0.5 min, and then collections in each cod-end were separately sampled (Sample I); secondly, the washing and sampling was done in the same manner for the same period (Sample II); thirdly, a 1 min washing series was repeated 4 times (Samples III to VI); finally a 5 min washing was done (Sample VII).   This gave a total washing time of 10 min.   During each washing, after one side of both nets was washed from the upper part to the lower part at a distance approximately 2 m apart from the hose nozzle, then the other side was done in the same way.   The procedure was repeated within the designed duration.   The shape of the hose nozzle was deformed by applying pressure from the washer's fingers so that washing seawater streamed down the net in a wide as possible area.   All samples were fixed in buffered 10% seawater formalin immediately and preserved prior to analysis.   Recovery rate up to Sample i, Rr (i), in each collection was determined as the percentage number relative to N, the number of ichthyoplankters accumulated from Sample I to Sample VII;

$$Rr(i) = \frac{\Sigma x_i}{N} \times 100 \quad i = \mathrm{I}, \cdots, \mathrm{VII},$$

where x_i is the number of ichthyoplankters in Sample i.

The number of ichthyoplankters collected varied from 523 to 8,634 eggs and larvae, with the mean
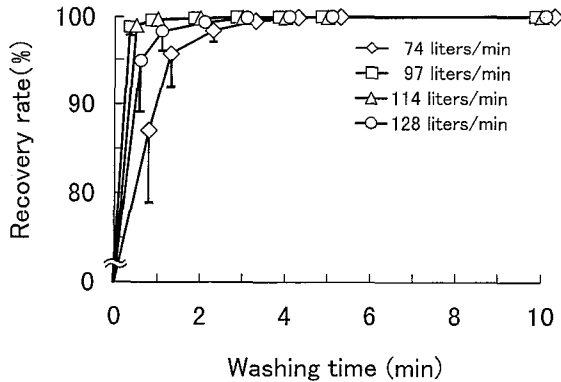
Fig. 1. Changes of recovery rates (%) with increasing wash-
ing time (min) at four different flow rates (liters/
min).
Vertical bars represent the standard deviation which
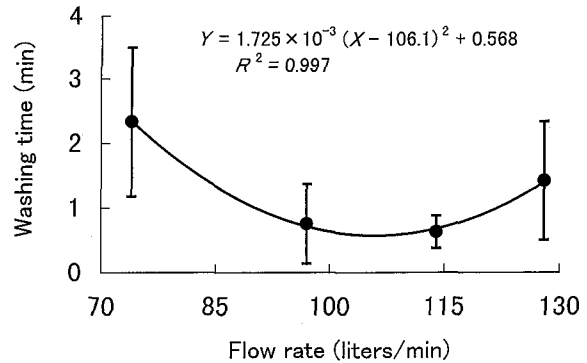for better clarity is given for one side only.

Fig. 2. Change in washing time (min) for full recovery
(>99.0%) of ichthyoplankton at four different flow
rates (liters/min).
Vertical bars represent the standard deviation.

value of 3,603. Clupeidae, Scorpaenidae, Gobiidae
and Japanese anchovy, *Engraulis japonicus* were abun-
dant taxa in the samples. In the first 0.5 min (Sample
I), the recovery rate varied between 87.0% (74 liters/
min) and 99.1% (114 liters/min) (Fig. 1). After 2 min
washing, 98.5% or more of the ichthyoplankton were
recovered in all conditions. All recovery rates at and
after 2 min washing did not differ significantly from
each other (Duncan's new multiple range test, $p >$
0.05). Fig. 2 shows the required washing time to
recover >99% of the ichthyoplankton in the four condi-
tions. The washing times of 74 and 128 liters/min
flow rates were significantly longer than those of 97
and 114 liters/min (Duncan's new multiple range test,
$p < 0.05$). This suggests that too strong as well as too
weak flow rate can reduce the recovery efficiency.
The relationship between the washing time (Y, min) and
the flow rate (X, liters/min) can be expressed by a sec-
ond order equation:

$$Y = 1.725 \times 10^{-3} (X - 106.1)^2 + 0.568.$$

Consequently, the washing time was estimated to be at
a minimum in the case of 106 liters/min. Therefore,

within conditions of this study, the washing procedure
of ca. 100 liters/min flow rate and 1 min washing is
judged sufficient to fully recover the ichthyoplankton
from a Bongo net.

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ボンゴネット洗浄時における卵仔魚の回収率への
流量と洗浄時間の影響

河野　悌昌

　曳網後のボンゴネットを途中で試料を回収しつつ延べ10分間洗浄し，魚卵と仔魚について洗浄時間に対する回収率の変化を調べた。4つの流量条件下において，洗浄開始から2分後以降の回収率間に有意差は認められなかった。99%を回収するために必要な時間は114, 97, 128, 74 l/min の流量区の順に短く，弱い流量と同様，強すぎる流量でも回収効率が低下することが示唆された。最も回収効率のよい流量は 106 l と推定された。この流量で1分間の洗浄を行えば、ボンゴネット内の魚卵と仔魚を十分に回収できると考えられた。