

M. FABIANO (\*), P. SALEMI PICONE (\*), N. DELLA CROCE (\*)

## ECOLOGICAL ASPECTS OF LIGURIAN-TUSCAN SURFACE COASTAL WATERS (\*\*)

**Riassunto** — *Aspetti ecologici delle acque superficiali costiere del Mar Ligure ed Alto Tirreno.* Alcuni parametri ambientali sono stati studiati nel corso di una campagna oceanografica (11-14 novembre 1975) nelle acque superficiali del Mar Ligure e Alto Tirreno.

L'influenza degli apporti fluviali è stata evidenziata dalle variazioni di temperatura, salinità, silicati e clorofilla-a. Le concentrazioni di nitrati e fosfati reattivi risultano modificate dagli apporti urbani soltanto nell'area antistante Genova. La distribuzione delle uova e larve di pesce così come lo stato trofico delle acque rivela differenze tra acque costiere e d'altura in Mar Ligure ed in Alto Tirreno.

I risultati suggeriscono che marcate variazioni delle caratteristiche ambientali debbano ricercarsi in una più ristretta fascia costiera.

**Abstract** — Some environmental parameters investigated in surface waters of the Ligurian and North Tyrrhenian Seas over 80 stations during a sampling 4 days long (11-14 november 1975) have been studied.

The influence of rivers input in coastal areas was evidenced by temperature, salinity, silicate and chlorophyll-a variations. Only in front of Genoa, the concentrations of nitrates and reactive phosphates were modified by urban input, the distribution of fish eggs and larvae and inert material (tar and plastic) as well as the trophic state of the waters revealed differences between in-shore and off-shore waters in the Ligurian and North Tyrrhenian Seas.

The results suggest that relevant variations should be investigated in a narrow belt of the coastal waters.

**Key words** — Coastal waters, pollution, nutrients.

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(\*) Marine Environmental Sciences Institute, University of Genoa.

(\*\*) Contribution of the «Gruppo di Ricerca Oceanologica - Genova».

## INTRODUCTION

Surface coastal waters form a zone with peculiar physical, chemical and biological features whose weak equilibrium is not due only to the renewal speed of the waters masses but to terrestrial input, too.

The aim of this research is to catch the effects of urban settlements in coastal waters at different distances from the coast through the analysis of parameters that can intervene to modify the biological production of waters.

The contemporaneity of the observations in contiguous litoral areas with different morphology of coast and sea-bed allows to compare the observed situations considering also that the meteorological conditions at the time can interfere in modifying the effects of terrestrial input.

## METHODS

The Ligurian-Tuscan coastal area considered stretches approximately for 190 miles. The sampling, which concerns a sea area of about 2222 square miles, was carried out night and day during four days (11-14 November 1975) on 80 stations at increasing distance from the coast and fan-shaped with vertices in Genoa, La Spezia and Leghorn (Fig. 1A).

At every station the following data have been recorded: temperature measures at 0 and -5 m; salinity measures at -5 m by means of Beckman RS 5-3 salinometer with immediate readings ( $\pm 0.5^{\circ}\text{C}$  and  $3\text{‰}$ ); transparency measures by Secchi disk. At every station water samples have been collected at -5 m by Van Dorn bottles for the analysis of dissolved oxygen, silicate, nitrate, nitrite, phosphate and chlorophyll-a according to STRICKLAND and PARSONS (1968).

At the same time, between a station and the following one a hyponeustonic sledge with silk-net (mouth  $30 \times 15$  cm, mesh  $275 \mu$ ) was towed for 10' at a speed of one knot for the collection of zooplankton samples that, fixed in formalin 4%, allowed to count all the fish eggs and larvae. For the same samples tar and plastic particles were drawn out; whose gravimetric measures were effected by Mettler H 54 AR balance. Wet weight was determined af-

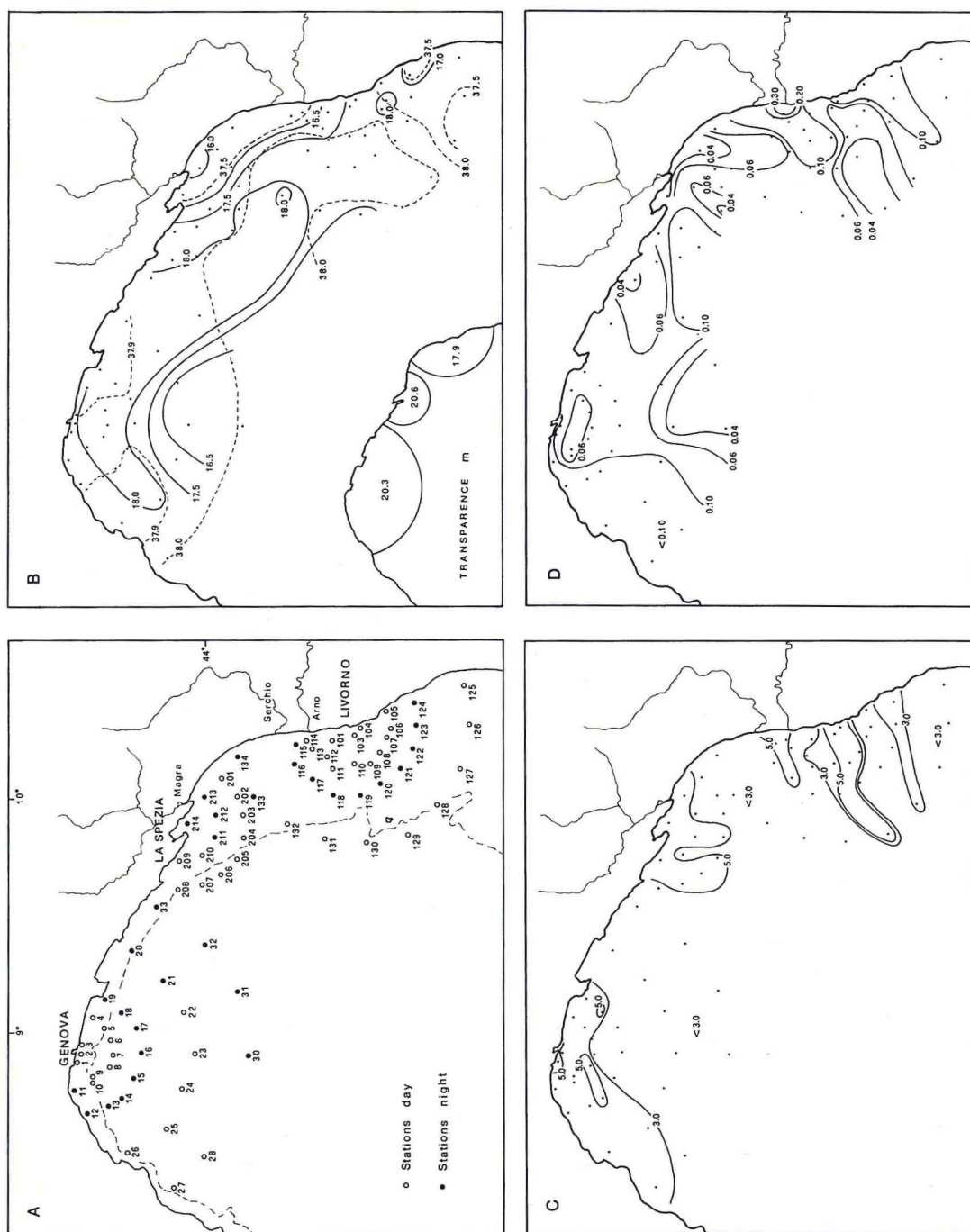


Fig. 1 - A - Sampling stations; B - Surface distribution of temperature (°C), salinity (‰) and average values of transparency; C and D - Surface distribution of silicates (µg. at/l) and phosphates (µg. at/l.).

ter washing the material in distilled water and drying in absorbing paper; while dried weight after putting it into a thermostate at 60°C for 24 h and into an essicator for 15'.

*Hydrological observations: temperature, salinity, oxygen and transparency*

The distribution of the surface temperature values shows the presence of colder waters in the area in front of the coast from La Spezia gulf to the Arno mouth. In this area the minima values of salinity were recorded; such values together with the thermic minima values show a local and massive seasonal input of river waters, which can be attributed to the Magra, Serchio and Arno rivers (Fig. 1B). In the sampled area the oxygen's concentrations are normal (with supersaturation values of about 102%). As in the last stretch of Arno «spesso spinti deficit di saturazione» (IRSA, 1973) were found, we might think that such deficit — if they really existed at the time of research — were compensated in the neighbourhood of the mouth of the river.

Transparence measures show values ranging from 11 to 26 m in front of Genoa and La Spezia and from 9 to 32 m in front of Leghorn (Fig. 1B); these values accord with those found during a previous survey in Ligurian sea (DELLA CROCE, 1978).

*Observation on the trophic state of the waters: nutrients and chlorophyll-a*

As regard silicates, higher concentrations than those observed in the Mediterranean (McGILL, 1965) were found at the stations closer to urban centres and to the mouths of the rivers. In some of these areas, the distribution of silicates assume a tongue shape. That makes to think that other factors intervened in shaping this picture.

Nitrate concentrations show the presence of values greater than 5  $\mu\text{g. at N-NO}_3/\text{l}$  in the waters in front of Genoa; values of such extent were not found on the tuscan-ligurian continental shelf in front of La Spezia and Leghorn (Fig. 2). In such platform area, which has a greater biological load in comparison with the ligurian area, rivers inputs haven't changed nitrate concentrations of coastal waters; as such input do not exist in the genoese waters; it might be that the high concentrations found there reflect the influence of the urban settlement.



Nitrite concentrations ( $0.17 \mu\text{g. at N-NO}_2/\text{l.}$ : average value) fall within those known for coastal waters (VACCARO and RYTHER, 1960) and they don't seem to be influenced either from river inputs or from urban inputs.

As regards reactive phosphate concentrations it must be pointed out that the highest values were found around the Arno mouth ( $0.31 \mu\text{g. at P/l.}$ ) and in front of Genoa harbour ( $0.26 \mu\text{g. at P/l.}$ ); however that was not noticed in the waters in front of other towns or rivers mouths (Fig. 1C).

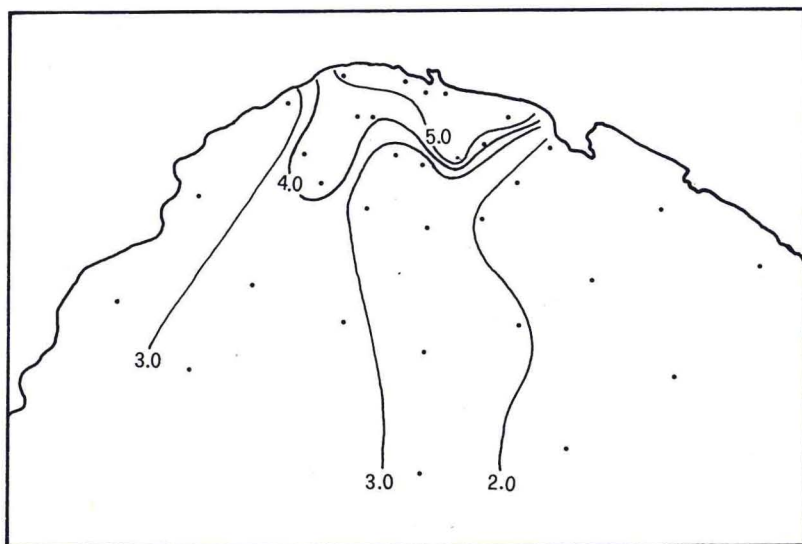


Fig. 2 - Surface distribution of nitrates ( $\mu\text{g. at N-NO}_3/\text{l.}$ ).

Chlorophyll-a shows concentrations higher than  $3 \mu\text{g/l}$  in the area in front of the rivers mouths (Magra, Serchio and Arno) (Fig. 3). The phytoplankton biomass so calculated is hidden by the rich vegetable detritus carried by the river waters and also evidenced by the presence in some hyponeustonic samples — collected on the tuscan continental shelf — of freshwater plants as *Lemnia* and *Wolffia*, typical of surface in a stagnant environment.

#### *Ichthyoneustonic observations: fish eggs and larvae*

Fish eggs reach higher concentrations only in some areas of

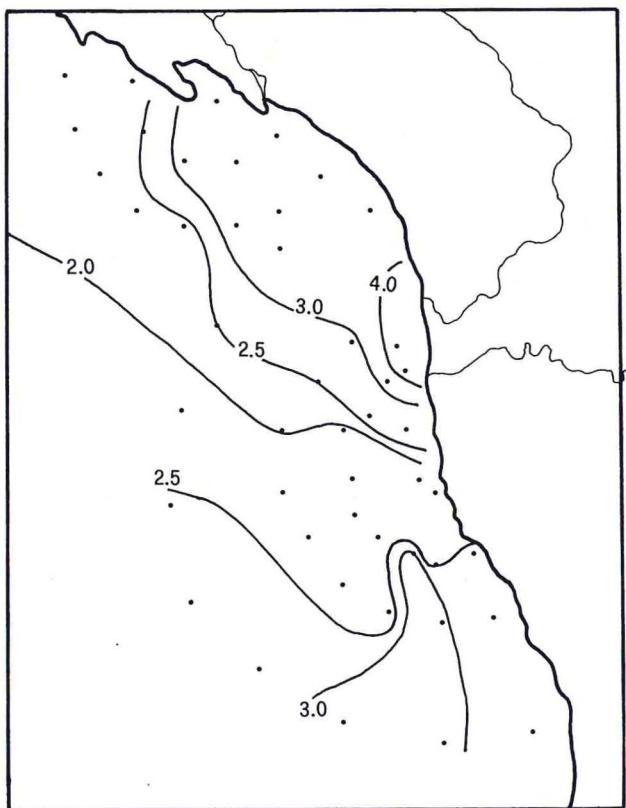


Fig. 3 - Surface distribution of chlorophyll-a ( $\mu\text{g/l}$ ).

the coastal stretch corresponding to continental shelf. This distributive aspects shows a different continuity degree that must be connected with the dynamic of surface coastal transport in the tuscan-ligurian waters (Fig. 4A).

It must be noticed that in proximity to the mouths of the rivers and in some areas of the ligurian-tuscan coast, the eggs are absent, or present in a small number. Furthermore the pelagic waters of Genoa gulf do not reveal, at the moment, deposition phenomena, but show the highest number of larvae, which; on the contrary, are poor or absent in neritic waters (Fig. 4B).

#### *Observations on suspended solids: tar and plastic particles*

Considering the area near the three towns, tar and plastic

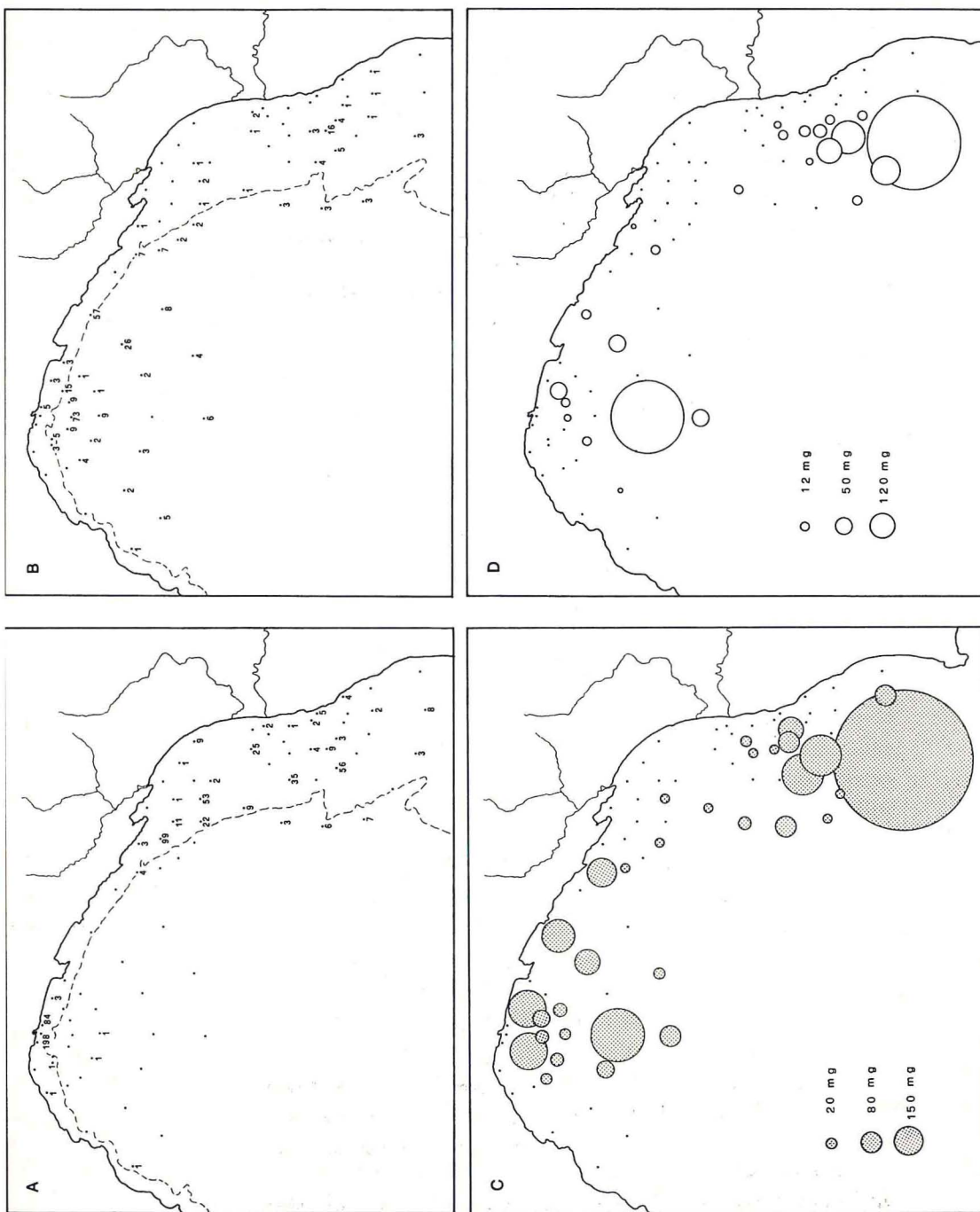


Fig. 4 - A and B - Distribution of fish eggs and larvae (in number/station); C and D - Concentrations of tar and plastic particles (mg/station).

particles show higher concentrations in front of Leghorn where they appear «amassed», and low concentrations in Genoa gulf where they result more «scattered» (Fig. 4C, 4D).

The plastic particles collected look mainly laminar and flexible, they have different density and opacity and because of that they may be classified as «E» and «F» COLTON types (1974).

In the whole examined area, the average concentration of tar in relation to the observed stations results of 2.0 mg/mc (Wet weight). Such a data are distinctly lower than the average values found in the Mediterranean (37.0 mg/mq according to HORN, 1968 and 9.7 mg/mq according to MORRIS, 1975), where the area with the highest concentrations of tar are located in the Ionian and Alboran seas. The concentrations recorded in the Ligurian sea result similar to those calculated by the same authors for the central and south Tyrrhenian sea.

## CONCLUSIONS

1 - This autumnal research pointed out some effects of the river waters of the Arno, Serchio and Magra on the coastal waters. Such freshwater input, which occur only in some periods of the year, cause in the coastal area between La Spezia and the Arno mouth a decrease in temperature (gradient  $1.6^{\circ}\text{C}$ ), in salinity (gradient  $1.1\text{‰}$ ), in proximity to rivers mouths, and an increase in silicate concentrations (gradient  $4.7 \mu\text{g. at Si/l}$ ). In this coastal area, phosphates show higher concentrations near the Arno mouth (gradient  $0.17 \mu\text{g. at P/l}$ ). In the same area the increased concentrations of chlorophyll-a (gradient  $1.38 \mu\text{g/l}$ ) expressed the value of the phytoplankton biomass and of the considerable quantity of vegetable detritus carried by the freshwaters.

2 - The influence of the outflow of the largest urban and industrial settlements, located along the Ligurian and Tuscan coastal arch, avoid sampling mesh. Only the stations placed in front of Genoa harbour are deeply affected by the urban flowed waters, which are responsible of the concentration increases of nitrates (gradient  $0.17 \mu\text{g. at N-NO}_3\text{/l}$ ) and phosphates (gradient  $3.48 \mu\text{g. at P/l}$ ).

3 - On the ground of resulting data, the ligurian-tuscan surface coastal waters are free from evident alterations of their tro-



phic state in this seasonal period, which however shows differences between the neritic tuscan waters and the pelagic ligurian waters.

4 - As far as fish eggs and larvae concerned, we must note their different distribution. As the former are mainly present in the tuscan neritic waters and the latter in the ligurian pelagic ones, it is not to be excluded that this picture is connected with the transport operated by the cyclonic surface current.

5 - The concentrations of tar and plastic particles, higher in the south-west of Leghorn but however weak in comparison with other values recorded in different Mediterranean areas, held chiefly a meaning of monitoring survey.

6 - Nutrient concentrations have hardly shown (and only in the waters in front of Genoa and near the Arno mouth) the effect of the anthropogenic impact. These observations make believe that such impact is of limited level; it is therefore necessary, for a more accurate survey, to adopt a different sampling strategy with a thicker network of stations in the waters directly adjacent to the towns and to the mouths of the rivers.

#### BIBLIOGRAPHY

- COLTON J.B. Jr., KNAPP F.D., BURNS B.R. (1974) - Plastic particles in surface waters of the northwestern Atlantic. *Science*, **185**, 491-497.
- DELLA CROCE N. (1980) - Misure di trasparenza nelle acque del Mar Ligure e Alto Tirreno. *Atti 3° Congr. A.I.O.L.*, Sorrento, 18-20 dicembre 1978, 145-154.
- HORN M.H., TEAL J.M., BACKUS R.H. (1970) - Petroleum lumps on the surface of the sea. *Science*, **168**, 245-246.
- ISTITUTO DI RICERCA SULLE ACQUE (1973) - Relazione sulla qualità delle acque superficiali in Italia. *Istituto di ricerca sulle acque*, C.N.R. Roma, Rapp. 42 b, 1-293.
- Mc GILL D.A. (1965) - The relative supplies of phosphate, nitrate and silicate in the Mediterranean Sea. *Rapp. Proc. verb. Réunion. Comm. int. Explor. Scient. Mer Médit.*, **18** (3), 737-744.
- MORRIS B.F., BUTLER J.N., ZSOLNAY A. (1975) - Pelagic tar the Mediterranean Sea, 1974-75. *Environmental Conservation*, **2** (4), 275-282.
- STRICKLAND J.D.H., PARSONS T.R. (1968) - A practical handbook of sea water analysis. *Fish. Res. Bd. Canada Bull.*, **167**, 1-311.
- VACCARO R.F., RYTHER J.H. (1960) - Marine phytoplankton and the distribution of nitrite in the Sea. *J. Cons. int. Explor. Mer.*, **25**, 260-271.

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