

II. SCIENTIFIC PAPERS SUBMITTED FROM SESSIONS

3. Biodiversity Program

A. Biodiversity of island ecosystems and seasides of the North Pacific

Productivity of Japanese Scallop *Patinopecten Yessoensis* (IAY) Culture in Posieta Bay (Sea of Japan)

Larissa A. GAYKO

**Institute of Marine Biology, Far East Branch, Russian Academy of Sciences
Vladivostok, 690041, Russia.**

ABSTRACT

Data collected over 14 years from Posieta Bay are analyzed to determine the relationship between the hydrometeorology and hydrobiological characters of scallops. The annual development cycle of cultivated Japanese scallop *Patinopecten yessoensis* (Jay) is delineated. The average water and air temperature, points of temperature transition over 0°C, sums of "heat" and variability of temperature for each period and the duration of ice cover is evaluated to determine the statistical significant predictors to provide schemes for increasing production.

INTRODUCTION

Climatology is used to explore the productivity of sea farms, in particular, scallop farms of Primorye. The intensive development of sea farming in the Primorye in recent years has created conditions where it is becoming very important to determine the productivity of the farms.

To predict the long-term productivity of scallops, one must study the hydrology (water temperature, salinity, ice cover, water mass stratification, and wave activity), meteorology (air temperature, direction and speed of wind, precipitation, and sunshine) and solar activity (Wolf number) effects on Japanese scallop and on the method of cultivation. The major aim of this study was evaluate possible hydrometeorological predictors to forecast the long-term impact on sea farm scallop productivity in the South Primorye.

This study is the first stage of our research. Mori (1975) produced the first paper on this topic which was followed by studies of other scientists (Belogrudov and Skokleneva, 1983; Belogrudov, 1986; Kucheryavenko, 1986; Gabayev, 1987).

MATERIAL AND METHODS

The area of the study was the Experimental Sea Base "Posieta" where bivalve mollusks have been cultivating since 1970. Hydrometeorological Station (HMS) "Posieta" observations are used from data that has been collected since 1931 (Fig. 1). All culture operations from the production of spat to commercial production are performed in natural conditions. From 1970-74 scallop spat is collected using shells and since 1975 a net consisting of an envelope and a filter is used. The net consists of 10 sacs attached one to another (Belogrudov, 1986). The timing of spat release is determined by the change in the gonadal index according to Ito et al. (1975). The sea surface water temperature, at Posieta HMS, was measured 4 times a day, air temperature 8 times a day, using standard procedures. The average daily temperature is used in the analysis. The duration of the ice

period is determined from the date of the first appearance of ice to the date of complete disappearance. The variability ratio is used to calculate water temperature as follows:

$$V = s * t^1 * 100\% \quad (1)$$

The sum of "heat" for different periods of scallop development represents the sum of the daily averaged water temperatures throughout the period of observations.

RESULTS AND DISCUSSION

The analysis of data indicated that there are four annual development periods for cultivating scallops :

- Period I - wintering(t_1);
- Period II - a stable water temperature transition over 0°C to the beginning of spawning (t_2);
- Period III - plankton development (t_3);
- Period IV - beginning to full larvae settlement (t_4).

The duration of Period I (days) agrees with the ice period. Periods II, III and IV are calculated using the average daily water temperature, the provision of heat or "heat" sum and the coefficients of variation (Table 1). Correlation analysis indicates that scallop spat density is dependent on the following variables:

- duration of the ice period (t_1 , days);
- duration of Period II;
- heat sum for Period II;
- variability of water temperature during spawning period (V , %).

The density is approximated by a linear regression (Table 2). Scallop spat density and ice period duration are the best correlates (inverse relationship) (Fig. 2). The medium and high values of spat density are recorded when spawning began but no earlier than the 19-22 June in 1976, 1977, 1979 and 1983. The negative effect of the water temperature variability during spawning on subsequent scallop spat density is due to the lack of the larvae's ability to adapt to sharp fluctuations. A rather stable water temperature (Period III) with $V = 5.49\%$ corresponds to the most productive year (1983). It is one third to two times as great as in other years (Table 1).

CONCLUSION

The data indicate that the duration of ice is the most significant hydrometeorological parameter. There is a linear dependency between the density of spat settlement and the following parameters: the period from stable water temperature transition over 0°C to the beginning of settlement, the stability of water temperature during spawning, and the sum of heat in the prespawning period. In the future these parameters will be used to project spat density.

REFERENCES

- Belogrudov, E.A., and H.M. Skokleneva. 1983. Forecasting of the time of the collectors settlement and spat quantity of scallops, p.10-13. In V.G. Markovtsev [ed.] Mariculture in the Far-Eastern region. Vladivostok, TINRO. (in Russian)

- Belogrudov, E.A., 1986. Cultivation, p.201-211. In P.A.Motavkin [ed.] Japanese scallop *Mizuhopecten yessoensis* (Jay). Institute of Marine Biology, Vladivostok, Far-East Science Centre, Academy of the USSR. (in Russian)
- Gabaev, D.D. 1987b. Long-term forecast of spate of commercial species of bivalves setting on the collectors, p.99-100. In The 3 d All-Union Congress of Oceanologists, Abstracts, Ocean Biology Section, part 1. Leningrad, Arctic and Antarctic Research Institute. (in Russian)
- Ito, S., H. Kanno, and K. Takahashi. 1975. Some problems on culture of the scallop in Mutsu bay. Bull. of the Mar. Biol. Stat. of asamushi. 15:89-100.
- Kutcheryavenko, A.V., L.G. Makarova, N.N. Konovalova, G.V. Polycarpova. 1986. The state and prospects of mollusc culture in the Bay of Minonosok (the Gulf of Posjet), p.57-64. In V.G. Markovtsev [ed.] Mariculture in the Far-Eastern region. Vladivostok, TINRO. (in Russian)
- Milekovsky, S.A. 1973. Speed of active movement of pelagic larvae of marine bottom invertebrates and their ability to regulate their vertical position. Mar. Biol. 23:11-17.
- Mori, K. 1975. Seasonal variation in physiological activity of scallops under culture in the coastal waters, of Sanriku district, Japan, and a physiological approach of a possible cause of their mass mortality. Bull. of the Mar. Biol. Stat. of Asamushi. 15:59-79.

TABLES AND FIGURES

Table 1. Temperature conditions in different periods of scallop larval development.

| Year | 0°C - beginning of spawning | | | | Beginning of spawning - beginning of settling | | | | Beginning of settling - full settling | | | |
|------|-----------------------------|---------|----------|--------|---|---------|----------|--------|---------------------------------------|---------|----------|--------|
| | t ₂ days | t °C | St °C | V % | t ₃ days | t °C | St °C | V % | t ₄ days | t °C | St °C | V % |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1975 | 51 | 6.1 | 341.1 | 62.7 | 39 | 15.4 | 598.6 | 14.6 | 41 | 19.8 | 813.4 | 11.6 |
| 1976 | 69 | 5.2 | 360.9 | 74.4 | 26 | 15.4 | 401.4 | 11.4 | 24 | 17.9 | 429.6 | 9.9 |
| 1977 | 57 | 6.0 | 341.4 | 64.4 | 26 | 14.0 | 364.0 | 8.3 | 39 | 18.4 | 716.0 | 21.4 |
| 1978 | 53 | 5.0 | 263.4 | 59.5 | 31 | 13.5 | 418.5 | 9.4 | 29 | 19.0 | 550.1 | 9.9 |
| 1979 | 58 | 5.8 | 337.5 | 60.5 | 29 | 15.4 | 446.6 | 12.3 | 33 | 19.5 | 643.5 | 7.3 |
| 1980 | 55 | 5.1 | 278.8 | 62.5 | 29 | 14.8 | 430.3 | 13.8 | 27 | 18.7 | 504.1 | 7.7 |
| 1981 | 47 | 4.7 | 221.8 | 69.7 | 33 | 12.3 | 406.5 | 15.0 | 32 | 16.3 | 521.0 | 10.4 |
| 1982 | 61 | 5.3 | 323.3 | 69.2 | 29 | 13.1 | 379.9 | 16.3 | 32 | 19.7 | 628.8 | 9.2 |
| 1983 | 62 | 6.2 | 368.9 | 57.4 | 29 | 13.2 | 383.1 | 5.5 | 27 | 15.3 | 413.0 | 15.0 |
| 1984 | 42 | 5.5 | 229.3 | 65.7 | 24 | 13.8 | 331.4 | 12.7 | 34 | 19.2 | 652.8 | 9.2 |

Table 2. Parameters of linear regression.

| No | Type of regression | a | b | R |
|----|--|---------|---------|----------|
| 1 | 2 | 3 | 4 | 5 |
| 1 | r - duration of ice period (t ₁ , days) | 5492.6 | - 35.24 | - 0.8182 |
| 2 | r - duration of period from 0°C until spawning (t ₂ , days) | -781.24 | 20.82 | 0.565 |
| 3 | r - sum of water temperatures from 0°C until spawning (°C) | -712.1 | 3.527 | 0.672 |
| 4 | r - variability of water temperature during spawning (V, %) | 1132.4 | - 66.61 | - 0.726 |

Note: The regression is of a type: R = a + bx, where r - scallop spat density, individuals/m², x - variables (factors), a and b - constants, R - correlation coefficient.

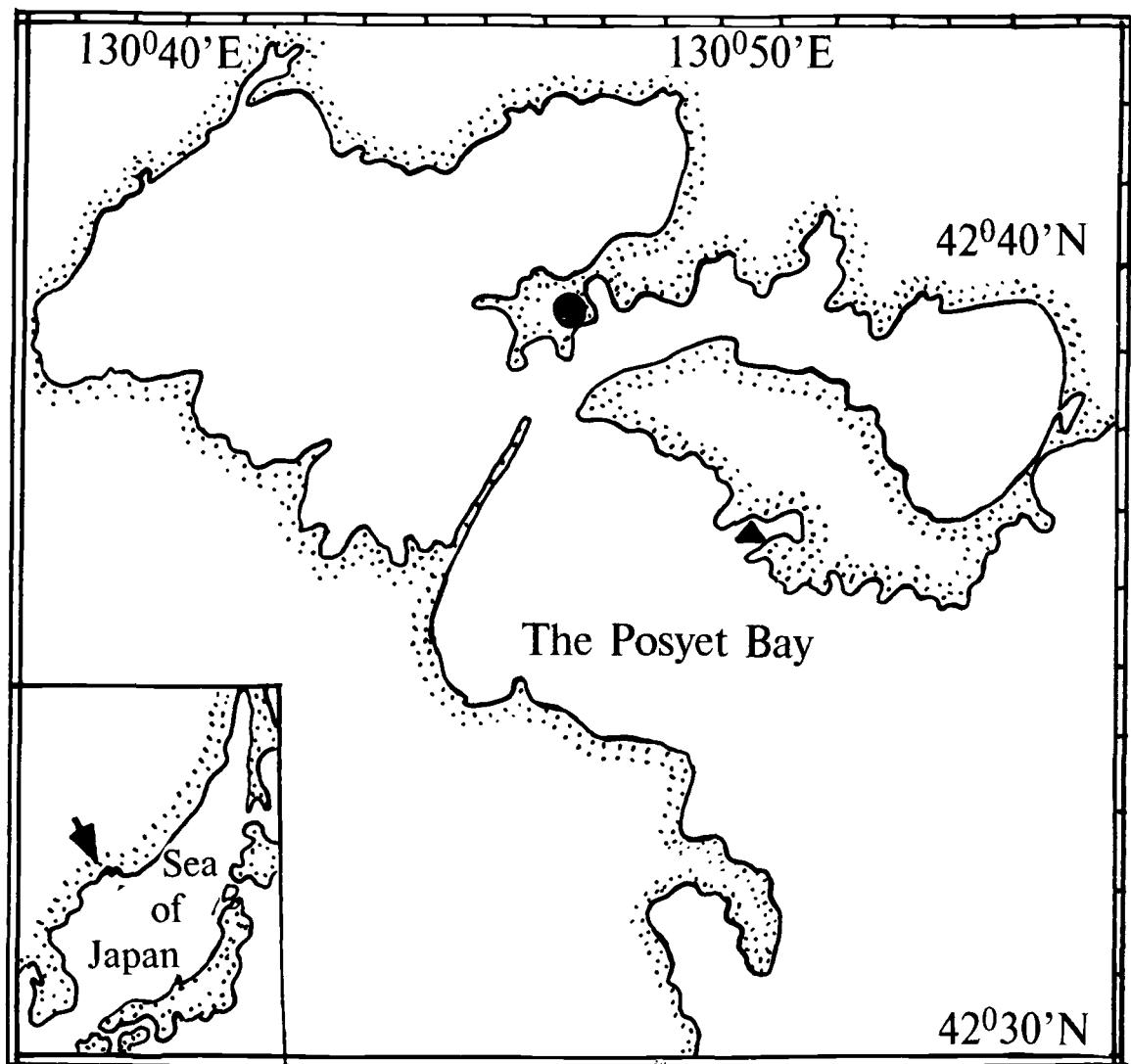


Fig. 1. The Posiet Bay.

- - position of Posieta Meteorological Station,
- ▲ - position of Experimental Mariculture Station.

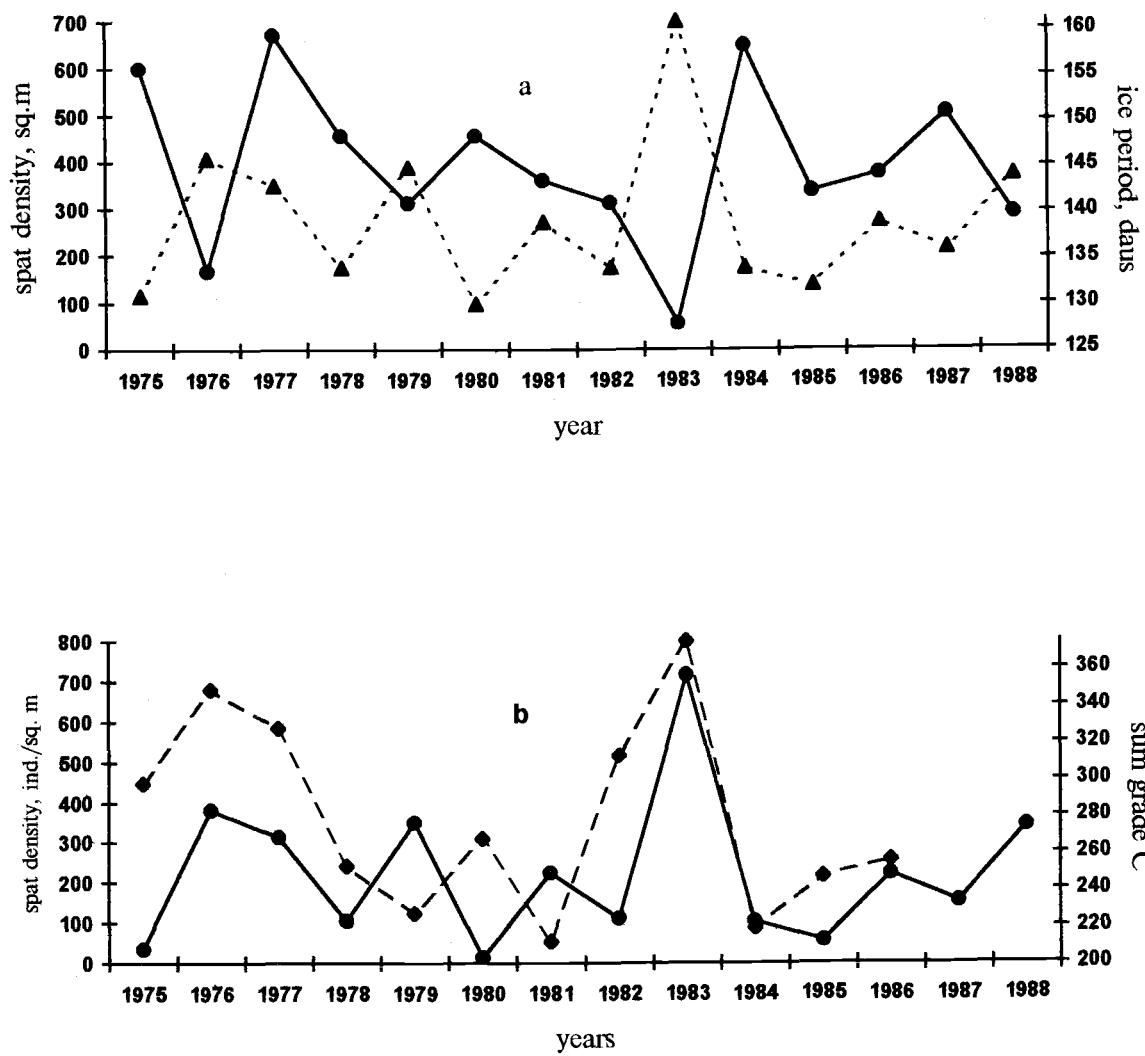


Fig. 2. Year-to-year dynamics of scallop spat density (ρ , individ/m²) and hydrometeorological parameters in Posiet Bay:
 a) ● - ρ , (1), ▲ - τ_1 , duration of ice period, days (2),
 b) ● - ρ , (1), ◆ - Σ , sum of "heat" from the date of water temperature rise over 0°C to the beginning of spawning, °C (2).

III. Appendices

1. List of Acronyms

| | |
|---------------|--|
| ADCP | Acoustic Doppler Current Profiler |
| ALACE | Autonomous Lagrangian Circulation Explorer (float) |
| BIO | Biological Oceanography Committee |
| CCCC | Climate Change and Carrying Capacity |
| CREAMS | Circulation Research of the East Asian Marginal Seas |
| CTD | Conductivity, Temperature, Depth profiler |
| FEB RAS | Far East Branch of Academy of Sciences |
| FERHRI | Far East Hydrometeorological Research Institute |
| FIS | Fisheries Science Committee |
| ITSU | International Coordination Group for the Tsunami Warning System in the Pacific |
| IUGG | International Union of Geodesy and Geophysics |
| JEBAR | Joint Effect of the Baroclinicity and Bottom Relief |
| JFA | Japan Fisheries Agency |
| PICES | North Pacific Marine Science Organization |
| POC | Physical Oceanography and Climate Committee |
| POI | Pacific Oceanological Institute |
| RAFOS | Listening float (SOFAR spelled backwards) |
| Sakhalin NIRO | Sakhalin Research Institute of Fisheries and Oceanography |
| TCODE | Technical Committee on Data Exchange |
| TINRO | Pacific Research Institute of Fisheries and Oceanography |

2. List of Participants

| | | |
|-------------------------|---------------------------------|----------------|
| 1. Ablaev, A.G. | POI | Vladivostok |
| 2. Anikiev, V.V. | IO RAN | Moscow |
| 3. Aota, M. | Hokkaido University | Japan |
| 4. Azbukina, Z.M. | IBP | Vladivostok |
| 5. Bakunina, I.Y. | PIBOC | Vladivostok |
| 6. Barkalov, V.Y. | IBP | Vladivostok |
| 7. Bashmatchnikov, I.L. | St. Petersburg State Univ. | St. Petersburg |
| 8. Beamish, R.J. | Pacific Biological Station | Canada |
| 9. Belyaev ,V.A. | TINRO | Vladivostok |
| 10. Belan, T.A. | FERHRI | Vladivostok |
| 11. Bocharnikov, V.N. | PIG | Vladivostok |
| 12. Bocharov, L.N | TINRO | Vladivostok |
| 13. Bogdanov, K.T | SOI | Moscow |
| 14. Bruney, J. | Exxon Ventures | U.S.A. |
| 15. Biryukova, I.V. | TINRO | Vladivostok |
| 16. Bregman, Y.E. | TINRO | Vladivostok |
| 17. Brownell, R.L. | Southwest Fish. Science Center | U.S.A. |
| 18. Bulatov, N.V | TINRO | Vladivostok |
| 19. Bulanov, V.A. | Inst. of Marine Tech. Problem | Vladivostok |
| 20. Budaeva, V.D. | FERHRI | Vladivostok |
| 21. Bychkov, A.S. | POI | Vladivostok |
| 22. Cherbadgy, I.I. | IMB | Vladivostok |
| 23. Cheranyev, M.Y. | POI | Vladivostok |
| 24. Dashko, N.A. | FERHRI | Vladivostok |
| 25. Darnitskiy, V.B. | TINRO | Vladivostok |
| 26. Dolganova, N.T. | TINRO | Vladivostok |
| 27. Diakov, Y.P. | KamchatNIRO | P. Kamchatsky |
| 28. Diakov, B.S. | TINRO | Vladivostok |
| 29. Dulepova, E.P. | TINRO | Vladivostok |
| 30. Dzizyurov, V.D. | TINRO | Vladivostok |
| 31. Efremov, V.V. | IBM | Vladivostok |
| 32. Fadeev, N.S. | TINRO | Vladivostok |
| 33. Fou, V.R. | St. Petersburg State University | St. Petersburg |
| 34. Figurkin, A.L. | TINRO | Vladivostok |
| 35. Firsov, P.B. | FERHRI | Vladivostok |
| 36. Freeland, H.J. | Institute of Ocean Sciences | Canada |
| 37. Gayko, L.A. | IBM | Vladivostok |
| 38. Gladyshev, S.V. | POI | Vladivostok |
| 39. Glebova, S.Y. | TINRO | Vladivostok |
| 40. Goncharenko, I.A. | IACP | Vladivostok |
| 41. Gorbarenko, S.A. | POI | Vladivostok |
| 42. Herbeck, E.E. | IACP | Vladivostok |
| 43. Ignatova, N.K. | PIG | Vladivostok |
| 44. Ilynskiy, E.N. | TINRO | Vladivostok |
| 45. Ivanov, O.A. | TINRO | Vladivostok |
| 46. Ivankov, V.N. | Far East State University | Vladivostok |
| 47. Ivanova, A.A. | FETIFIE | Vladivostok |

| | | | |
|-----|--------------------|---------------------------------|----------------|
| 48. | Ivanov, V.V. | IMG & G | Y. Sakhalinsk |
| 49. | Kashiwai, M. | Hokkaido Natl. Fish. Res. Inst. | Japan |
| 50. | Karnaukhov, A.A. | POI | Vladivostok |
| 51. | Kawasaki, Y. | Hokkaido Natl. Fish. Res. Inst. | Japan |
| 52. | Keigwin, L.D. | Woods Hole Oceanogr. Inst. | U.S.A. |
| 53. | Krupnova, T.N. | TINRO | Vladivostok |
| 54. | Kim, G.Y. | Inst. Water & Ecolog. Problems | Khabarovsk |
| 55. | Kilmatov, T.R. | POI | Vladivostok |
| 56. | Kiselev, A.M. | PIG | Vladivostok |
| 57. | Kozlov, V.F. | POI | Vladivostok |
| 58. | Khrapchenkov, F.F. | POI | Vladivostok |
| 59. | Khramushin, V.N. | SakhNIRO | Y. Sakhalinsk |
| 60. | Kukharenko, L.A. | IMB | Vladivostok |
| 61. | Kuzmin, V.A. | Green Cross | Vladivostok |
| 62. | Lapko, V.V. | TINRO | Vladivostok |
| 63. | Lapshina, V.I. | TINRO | Vladivostok |
| 64. | Lee, J.C. | Pusan Fishery University | Korea |
| 65. | Lebedev, G.A. | Arctic Antarctic Res. Inst. | St. Petersburg |
| 66. | Lobanov, V.B. | POI | Vladivostok |
| 67. | Luchin, V.A. | FERHRI | Vladivostok |
| 68. | Luchsheva, L.N. | TINRO | Vladivostok |
| 69. | Luk'yanov, P.A. | PIBOC | Vladivostok |
| 70. | Martynov, A.V. | Computer Center SB RAS | Novosibirsk |
| 71. | Manko, Y.I. | IBP | Vladivostok |
| 72. | Makarov, V.G. | POI | Vladivostok |
| 73. | Maximenko, N.A. | IO RAS | Moscow |
| 74. | Moiseichenko, G.V. | TINRO | Vladivostok |
| 75. | Moroz, V.V. | POI | Vladivostok |
| 76. | Mooers, C.N.K. | University of Miami | U.S.A. |
| 77. | Mikhailov, V.V. | PIBOC | Vladivostok |
| 78. | Mikheev, A.A. | SakhNIRO | Y. Sakhalinsk |
| 79. | Mitrofanov, Y.A. | POI | Vladivostok |
| 80. | Mishukov, V.F. | POI | Vladivostok |
| 81. | McFarlane, G.A. | Pacific Biological Station | Canada |
| 82. | Muratov, L.F. | POI | Vladivostok |
| 83. | Nagata, Y. | Mie University | Japan |
| 84. | Nelezin, A.D. | FERHRI | Vladivostok |
| 85. | Nikitin, A.A. | TINRO | Vladivostok |
| 86. | Nishiyama, T. | Hokkaido Tokai University | Japan |
| 87. | Nikolenko, L.P. | TINRO | Vladivostok |
| 88. | Novikov, Y.V. | TINRO | Vladivostok |
| 89. | Nor, A.V. | POI | Vladivostok |
| 90. | Ono, S. | Hokkaiminyu Newspaper Co. | Japan |
| 91. | Ozerin, V.K. | TINRO | Vladivostok |
| 92. | Pack, V.V. | POI | Vladivostok |
| 93. | Pestereva, N. | Far-Eastern State University | Vladivostok |
| 94. | Petrov, A.G. | FERHRI | Vladivostok |
| 95. | Polyakov, D.M. | POI | Vladivostok |
| 96. | Pozdnyakova, L.A. | IMB | Vladivostok |

| | | | |
|------|------------------------|-----------------------------|----------------|
| 97. | Preobrazhenskaya, T.V. | IMB | Vladivostok |
| 98. | Preobrazhensky, B.V. | PIG | Vladivostok |
| 99. | Prelovsky, V.I. | PIG | Vladivostok |
| 100. | Probatova, N.S. | IBP | Vladivostok |
| 101. | Polomoshnov, A.M. | SOGI | Okha, Sakhalin |
| 102. | Polyakova, A.M. | POI | Vladivostok |
| 103. | Ponomarev, V.I. | POI | Vladivostok |
| 104. | Pischalnik, V.M. | SakhNIRO | Y. Sakhalinsk |
| 105. | Pushnikova, G.M. | CakhNIRO | Y. Sakhalinsk |
| 106. | Reznikov, B.I. | POI | Vladivostok |
| 107. | Riser, S.C. | University of Washington | U.S.A. |
| 108. | Ro, Y.J. | Chungnam Natl. University | Korea |
| 109. | Rogachev, K.A. | POI | Vladivostok |
| 110. | Rosly, Y.S. | Amur NIRO | Khabarovsk |
| 111. | Rykov, N.A. | FERHRI | Vladivostok |
| 112. | Salomatin, A.S. | POI | Vladivostok |
| 113. | Savelyeva, N.J. | POI | Vladivostok |
| 114. | Savin, A. | TINRO | Vladivostok |
| 115. | Sekine, Y. | Mie University | Japan |
| 116. | Semkin, B.I. | PIG | Vladivostok |
| 117. | Seledets, V.P. | PIG | Vladivostok |
| 118. | Skirina, I.F. | PIG | Vladivostok |
| 119. | Silina, A.V. | IMB | Vladivostok |
| 120. | Sosnin, V.A. | POI | Vladivostok |
| 121. | Sycheva, E.V. | IACP | Vladivostok |
| 122. | Shatilina, T.A. | TINRO | Vladivostok |
| 123. | Shevtsov, V.P. | POI | Vladivostok |
| 124. | Sundukova, E.V. | PIBOC | Vladivostok |
| 125. | Talley, L.D. | Scripps Inst. Oceanogr. | U.S.A. |
| 126. | Temnykh, O.S. | TINRO | Vladivostok |
| 127. | Tkalin, A.V. | FERHRI | Vladivostok |
| 128. | Tyukov, I.Y. | Far East State University | Vladivostok |
| 129. | Varlaty, E.P. | POI | Vladivostok |
| 130. | Varlamov, S.M. | FERHRI | Vladivostok |
| 131. | Vlasova, G.A. | POI | Vladivostok |
| 132. | Volkov, A.F. | TINRO | Vladivostok |
| 133. | Victorovskaya, G.I. | TINRO | Vladivostok |
| 134. | Vvedenskaya, T.L. | KamchatNIRO | P. Kamchatsky |
| 135. | Wang, A.T. | Exxon | U.S.A. |
| 136. | Wespested, V.G. | Alaska Fish. Science Center | U.S.A. |
| 137. | Wooster, W.S. | University of Washington | U.S.A. |
| 138. | Yakunin, L.P. | Far East State University | Vladivostok |
| 139. | Yurasov, G.I. | POI | Vladivostok |
| 140. | Zolotov, O.G. | Kamchat NIRO | P. Kamchatsky |
| 141. | Zvyagintseva, T.N. | PIBOC | Vladivostok |
| 142. | Zhabin, I.A. | POI | Vladivostok |
| 143. | Zhukova, N.V. | IMB | Vladivostok |
| 144. | Zuenko, Y.I. | TINRO | Vladivostok |



120012510190

HMSC

GC
781
.P5351
no.6PICES Scientific Report No.6,
1996: Proceedings of the
Workshop on the Okhatsk Sea
and Adjacent Areas.
120012510190

DATE

ISSUED TO

HMSC

GC
781
.P5351
no.6PICES Scientific Report No.6,
1996: Proceedings of the
Workshop on the Okhatsk Sea
and Adjacent Areas.
120012510190