BIOOCEANOGRAPHIC ZONING OF THE SEA OF JAPAN

Bobkov A.A.

Saint-Petersburg State University, Saint-Petersburg, Russia

Introduction

Present sketch resulting from rather a vast work finished several months ago, takes aim to aggregate existing opinions of scientists of some marine about natural borders of biotopes and biocenosis of the Sea of Japan as basis for working-out of the unified approach to zoning of its water area.

Research Methods

Oceanological Approach

Oceanological zoning of the Sea of Japan should be based on joint generalization of all most significant for a water area elements of circulation and distribution of basic hydrophysical parameters. The basis for it can serve chart schemes of allocation of water masses, permanent currents, fronts, zones of vergence, complemented by verbal description of structural features of hydrophysical fields. Such information is contained in numerous publications on the Japan Sea. As a base chart we shall accept Fig. 8 published by Yarichin (1991) which shows boundaries of conventional regions of the Sea of Japan.

Biogeographical Approach

In marine biogeography the zoning is traditionally made separately for thickness of waters and bottom. Such division is caused by sharp differences in geographical distribution of population in pelagial and benthal having in the basis cardinal differences of movable (liquid) and immovable (solid) biotopes (Beklemishev, 1969; Parin & Nesis, 1986). Correctness of plotting of watershed can promote hydrobiological and ichthyological data, as it is known that the biogeographical boundaries are quite definitely linked to hydrological structure of ocean and coincide with borders of main cells of oceanic circulation – fronts, zones of convergence and divergence of currents (Yashnov, 1963; Beklemishev, 1969; Karedin, 1987; Antsulevich & Bobkov, 1992), therefore biooceanographic division of ocean in limits of surface and intermediate waters, most important in fishery attitude, appears in essence possible (Parin & Nesis, 1986).

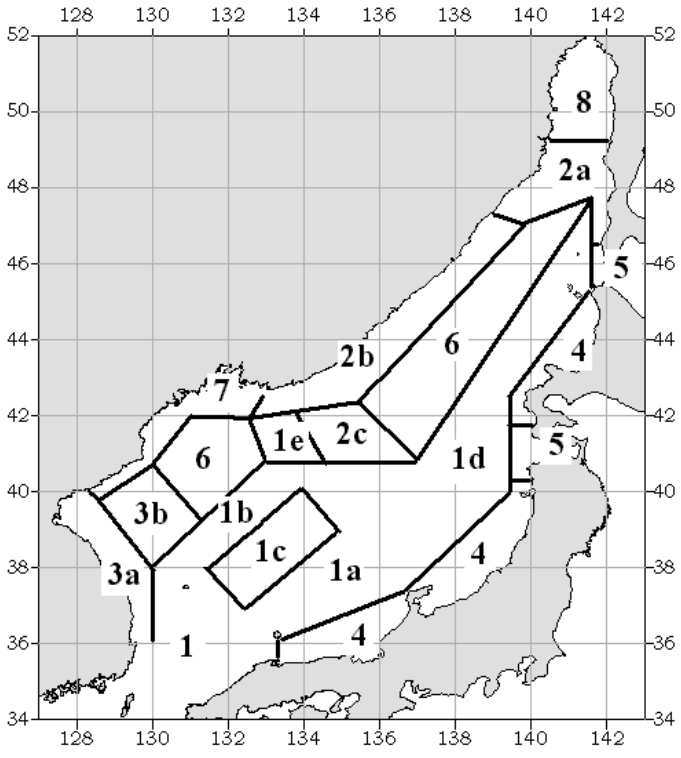

Fig. 1. Biooceanographic zones of the Sea of Japan

Discussion

Logic terminating of operation should be the comparison of oceanological and biogeographical bases of zoning as it is made in Fig. 1. On its basis the preliminary oceanographic representation about probable zoning of the Sea of Japan following from scanned literature with the careful analysis of illustrations contained in it, is laid, complemented by views of biogeographers drawn in their charts or given in the form of descriptions on

distribution of some species of marine organisms.

Fig. 1 schematically reflects boundaries of circulation pattern and interacting water masses in a surface layer of the sea. This Figure corresponds to average field of distribution without dependence on range of variability of various spatial-temporal scale, in particular, seasonal and synoptic.

Two conceptual notes should be made which, quite naturally, can be contested:

1) accepted in the majority of the publications scanned by us, the global division of a water area of the Japan Sea into northern and southern halves (for a surface layer) seems to us inexpedient. It is explained, first of all, by that hydrological front passes in diagonal direction but not in latitudinal one, and is available obvious asymmetry of water basin. It can be stated that even in the northern part (with the exception, maybe, of most northern part of the Tatar Strait), the effect of Tsushima Warm Current is felt. In connection to this, it is more correctly to speak for region northwards from 40°N "eastern" and "western" parts meaning under it spheres of separate influence both the Primorye and Tsushima currents. At such approach the quite pertinent subdivision of shore regions on subregions follows, where this effect is kept safe by a principle of "geographical zonality", and that actually takes place as it is seen in scheme of A.K. Leonov (1960);
2) the open part of the sea should be considered separately from a shelf and be subdivided on hydrological features but the approach thus can be double. On the one hand, the exterior counters of concrete areas which are taking place, for example, under effect of Primorye, Tsushima and other currents should be marked, both on the part of shores, and on the part of fluid borders, in particular – in zones of mixture of waters. On the other hand, it is possible to consider proved, that even inside sphere of effect of permanent currents are isolated separate sea subregions resulting, for example, from dynamic instability of currents themselves given origin to quasi-stationary or migrating eddies of various range: remaining in waters, for example, of Tsushima Current they, nevertheless make different on their oceanographic parameters a phenomena. The application of these backgrounds, as a rule, depends on representativity of a material.

In present case we entirely relied upon the references, but from some share of interpretation of attracted graphs and charts. At development of our judgement about possible zoning of a water area of the Sea of Japan, we have found necessary to introduce into lexicon the term "system of waters" scoring thus branching of transiting here permanent currents having common genetic sources.

1 – **Water System of the Tsushima Current** dominant on the most part of the Japan Sea water area which can be subdivided: 1a – main stream of the Tsushima Current, 1b – East -Korean Current, 1c – waters originating in internal waters of the Tsushima Current itself as a result of its dynamic instability and eddying in central part of the sea above the Yamato Bank, 1d– extension of the Tsushima Current main stream including branches into Tsugaru, La-Perouse (Soya) and Tatar Straits, 1e – western branch of Tsushima Current departing from East-Korean Current approximately on 40°N in direction of the Peter the Great Bay.

2 – **Water System of the Primorye Current** determining hydrological regime nearby Russian shore consisting of 3 basis items: 2a – Liman (Shrenk) Current, 2b – main stream of the Primorye Current, 2c – extension of the Primorye Current (*i.e.* South-Primorye Current).

3 – **coastal waters of the Korean shore** it is expedient to distinguish a separate element as this corner site of the Asian continent from Peter the Great Bay up to an exit into the Korean Strait fill transformed intermixed waters of various origin. Besides it, as follows from the various schemes and it is well visible on satellite images, the Korean shore has in general quasi-stationary circulation, however, very often all area from the North-Korean Current towards open sea is occupied by anticyclonic or cyclonic eddies moving, accordingly, towards the east or west which lifetime is up to several months. 3a – North-Korean Current, 3b – transformed waters.

4 – **coastal waters of the Japanese shore** localized along the coast depending on a configuration of coastal line. In essence, it is secondary water masses (Beklemishev, 1969).

5 – **waters of straits** regime of which is determined mainly by intensity of water exchange between the Japan Sea and adjacent areas of the Okhotsk Sea and the North-West Pacific. The basic role is played by tidal variability most developed in northern straits (Leonov, 1960; Bobkov & Foux, 1997). The Korean Strait to them to refer, probably, does not follow because its regime is almost fully affected by the Pacific

Ocean waters which share in a water balance of the Japan Sea is about 90%. More detailed subdivision we do not make, though it is doubtless that the hydrological regime of Tatar, La-Perouse and Tsugaru Straits is quite specific.

6 – **zone of mixture** identified to a standing hydrological (basic, subarctic *etc*.) front of the Japan Sea. Maintaining general extension from north-east to south-west, this band is more expressed northward from 40°N, also coincides with a divergence zone of waters (Yarichin, 1982). But at traverse of Vladivostok the zone of mixture should be interrupted to give place to an outflow of waters of the South-Primorye Current, and on the contrary – inflow (episodic, periodic or constant) of the Tsushima warm waters stretching towards Peter the Great Bay. It should be marked that basically all "the Korean corner" presents an extensive band of water mixture sources of which – Primorye and Tsushima currents and also water of up-welling. In such case in "the Korean corner" the local, secondary hydrological fronts of seasonal character can be formed. One of them can take up position nearby Peter the Great Bay where the Primorye Current turns away from a shore; the second one should be originated along western boundary of the East-Korean Current.

7 – **waters of Peter the Great Bay** isolating from other areas, the particular regime of which is known for a long time.

8 – **waters of northern part of the Tatar Strait** distinguishing from adjacent waters because of cumulative action of climatic factors and morphology.

In favor of offered zoning gives evidence the chart of color and transparence of sea water after Uda borrowed from Leonov (1960, p. 450). These observations are nowadays thoroughly forgotten, nevertheless quite informative so far as each water mass composing circulation features, has the hydrooptical properties, visual on an eye.

Fig.1 also renders concrete oceanological background of zoning of the Japan Sea in view of hydrobiological features of region, and if to apply to charts of biogeographers, it is possible to note that borders of biogeographical division, down to a rank of provinces, in many respects coincide with oceanological regions. Some notes flowing out of the analysis of both oceanological and biogeographical charts are listed below:

1) in the Tatar Strait the boundary of contacting waters should have a diagonal directivity from north-east to south-west, as it follows from works Kun & Meshcheryakova (1954); Galkin (1955); Brodsky (1957); Kun (1975) *etc.*, so far as shores are washed by two quite different on their hydrophysical characteristics water masses - extension of the main stream of the Tsushima Current and the Liman Current, and this fact influences strongly biocenosis. So, fauna of some marine representatives, in particular hydroids living by Moneron Island, is identical to their characteristics Peter the Great Bay, north-east of Hokkaido and Southern Kuril Islands affected by the Tsushima Warm Current and its continuation – Soya Current (Antsulevich, 1987 and 1992; Antsulevich & Bobkov, 1992);
2) the expediency of distinguishing of a zone of mixture in separate region is accorded with plankton data for pelagial. Between that it is obvious, that the hydrological front of the Japan Sea showing borders of the zone of mixture, is better featured by oceanographers than hydrobiologists. The configuration of this region, especially to the south of 40°N, has latitudinal direction and it is probable, that at this site it includes waters of regions III and IV from Kun`s scheme (Kun, 1975);
3) places in which the zone of mixture approaches to shores can be stated on benthos organisms (Galkin, 1955; Gur'yanova, 1972; Golikov, 1980; Gul'bin, 1980; Kafanov, 1982; Kafanov & Nesis, 1982), though it is obvious, that by virtue of a multiplicity of reasons influencing ecology of concrete species, these sites of bathyal coincide only in general;
4) the permanent currents of the Sea of Japan influence distribution of marine organisms not only in pelagial but also on the sea shores, as it follows from biogeographical illustrations, gradually decreasing number of heat-loving species introduced with Tsushima Warm Current in direction from the south to north (Kafanov, 1982). Thus, in neretic area nearby the coast, where are formed local ("secondary" on terminology of Beklemishev) water masses, the independent populations of species rigidly tackled to a particular site of coastal water area can be developed (Beklemishev, 1969). In this connection the subdivision of a shelf on subregions is quite justified;

5) the expediency of isolation of water area of Peter the Great Bay as well as northern part of the Tatar Strait in separate regions does not contradict with neither oceanological nor biogeographical subdivisions.

Concluding Remarks

Biooceanographic zoning of a water area is obviously important meaning that it gives a basis for study of natural-geographical complex of the Sea of Japan, that is the important requirement for rational usage of its resource potential and marine culture. For successful fishing of many pelagic fish objects dwelling in the Japan Sea or migrating through its water area (salmons, Pacific saury *etc.*) the correct zoning promotes revealing of sites most favorable for their catch concentrations or wintering, according to their areals and range optimum biotic and abiotic factors. In particular, the position of a zone of mixture (front) and feeding base (zooplankton) in many respects can predetermine seasonal saury migrations one path of which towards the Okhotsk Sea and the South Kuril Area and back runs via the Sea of Japan (Shuntov, 1967; Gong, 1984; Bobkov, 1995).

References

1. Antsulevich A.E. & Bobkov A.A. 1992. Oceanological foundations of biogeographical zoning of waters of the South Kuril Area // J. Oceanology. Vol. 32. N 5. P. 910-916.
2. Antsulevich A.E. 1987. Hydroids of the shelf of the Kuril Islands / Leningrad. 165 p.
3. Antsulevich A.E. 1992. Observations on the hydroid fauna of the Kuril Islands // J. Marine Sciences. Vol. 56. P. 213-216.
4. Beklemishev K.V. 1969. Ecology and biogeography of the open ocean / Moscow. 291 pp.
5. Bobkov A.A. 1995. Soya Current and its influence on distribution and migration of marine organisms in the South Kuril Area / St. Petersburg. 17 pp.
6. Bobkov A.A. & Foux V.R. 1997. Tidal origin of thermohalinic anomalies in the La-Perouse Strait // Proc. 12th Int. Symposium on Okhotsk Sea and Sea Ice. P. 242-247.
7. Brodsky K.A. 1957. Fauna of CALANOIDAE and zoogeographical zoning of northern Pacific and adjacent waters // Proc. USSR Academy of Sciences. Moscow-Leningrad. 222 pp.
8. Galkin Yu.I. 1955. Gasteropods molluscs TROCHIDAE of Far-Eastern and northern seas of USSR // Proc. Zoological Institute.
9. Golikov A.N. 1980. Molluscs BUCCININAE of the World Ocean / Fauna of USSR. Part 5-2. Molluscs. Leningrad.
10. Gong H. 1984. Distribution and movements of Pacific saury COLOLABIS SAIRA (Brevoort) in relation to oceanographic conditions in water off Korea / Pusan. 172 pp.
11. Gul'bin V.V. 1980. Fauna and some features of ecology of gasteropods molluscs of littoral of the northern Sea of Japan / Coastal plankton and benthos of northern part of the Sea of Japan. Vladivostok. P. 93-105.
12. Gur'yanova E.F. 1972. Zoogeographical zoning of a sea / Fauna of the Tonkine Golf and conditions of its existence. Leningrad. P. 8-21.
13. Kafanov A.I. & Nesis K.N. 1982. Concluding remarks / Marine biogeography. Moscow. P. 300-306.
14. Kafanov A.I. 1982. Cainozoic history of malakofauna of the northern Pacific shelf / Marine biogeography. Moscow. P. 134-176.
15. Karedin E.P. 1987. Regularity of distribution, biology, fishing / Recommendations on search and fisheries of Pacific saury (a short textbook for fishers). Vladivostok. P. 4-28.
16. Kun M.S. & Meshcheryakova I.M. 1954. Distribution of zooplankton in the Sea of Japan // Izvestiya TINRO. Vol. 39. P. 358-360.
17. Kun M.S. 1975. Zooplankton of the Far-Eastern seas. Moscow. 150 pp.
18. Leonov A.K. 1960. Sea of Japan / In: Regional oceanography. Part I. Leningrad. P. 291-463.
19. Parin N.V. & Nesis K.N. 1986. Biogeography of the Pacific Ocean / Biological resources of the Pacific Ocean. Moscow. P. 61-75.
20. Shuntov V.P. 1967. Pacific saury of the Sea of Japan // Izv. TINRO. Vol. 56. P. 51-66.
21. Yarichin V.G. 1982. Some features of horizontal movement of waters in the Sea of Japan north of 40°N // Proc. FERHRI. N 96. P. 86-95.
22. Yashnov V.A. 1963. CALANUS GLACIALIS and CALANUS PACIFICUS as indicators of water masses of the Pacific seas // J. Zoological. Vol. 42. N 7. P. 1005-1021.
23. Yurasov G.I. & Yarichin V.G. 1991. Currents of the Sea of Japan. Vladivostok. 175 pp.