

# ON THE REGIONAL DIVISION OF THE MARINE ALGAL FLORA OF THE WESTERN NORTH PACIFIC

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Although in the discussions of the geographic distribution of the marine algae in the western part of the North Pacific, the marine algal flora of this vast area has been variously divided by phycologist, there is, as yet, not a single satisfactory system for its regional division since in some cases the proposed floristic regions are too large and inclusive resulting in their heterogenous nature and in other cases, they are too minute or classified according to their political nature. In the present paper, an attempt is made to propose a system of objectively dividing this vast area into a number of major floristic regions, based on the following two principles:

1. That the seas must be considered first, since they are more or less isolated geographical units and in the ages of their existence floras more or less peculiar to each of them must have been evolved.

2. That the oceanic currents must also be concurrently considered, since they are the principal agents in the geographic distribution of the marine algae, hence directly influencing the floristic components of the regions concerned.

Besides, the distribution of certain indicator species is sometimes of great help in dividing the neighboring regions. On these bases, the western part of the North Pacific has been divided into the following 16 floristic regions:

1. Western Bering Sea, including the eastern and southeastern coasts of Kamchatka.
2. Northern Ochotsk Sea, including the western coast of Kamchatka, the Ochotsk Sea coast of Soviet Asiatic mainland and the eastern coast of Saghalien.
3. Southeastern Ochotsk Sea, including the Kurile Islands, except the western coast of Kunasiri Island.
4. Southwestern Ochotsk Sea, including the Ochotsk coasts bordering southern Saghalien, northern Hokkaido and western Kunasiri Island.
5. Northeastern Japan Sea, including the entire western coast of Hokkaido.
6. Northwestern Japan Sea, including the coasts bordering the Tartar Strait, Soviet Maritime Provinces and eastern Korea down to about 38° N.

7. Southwestern Japan Sea, including the southeastern coast of Korea.
8. Southeastern Japan Sea, including the coasts of western Honshu and Northwestern Kyushu.
9. Northern region of the Pacific Japanese coast, including that of Hokkaido and northern Honshu down to south of Kinkwashan (about 38° N).
10. Southern region of the Pacific Japanese coast, including that from nearby Kinkwashan on Honshu down to southern Kyushu.
11. Western Yellow Sea, including the China coast bordering the Pohai and the Yellow Sea.
12. Eastern Yellow Sea, including the Korean coast of the Yellow Sea.
13. Western East China Sea, including the China coast bordering the East China Sea.
14. Eastern East China Sea, including the southwestern coast of Kyushu and the Ryukyu Islands.
15. Northern South China Sea, including the China coast and northern Viet Nam coast bordering the South China Sea.
16. Southern South China Sea, including the Taiwan Island, the Pratas Island, Hainan Island and the islands and mainland to their south.

An attempt to determine the nature of the marine algal flora of these regions has also been made chiefly on the basis of the surface water temperature. The famous phycologist William Albert Setchell has proposed to divide the oceans and seas into 9 major floristic zones on the basis of the isotherm, i. e., average surface water temperature of the warmest summer month, namely August: Upper boreal and upper austral 0 (or below)  $-10^{\circ}\text{C}$ , lower boreal and lower austral  $10-15^{\circ}\text{C}$ , north and south temperate  $15-20^{\circ}\text{C}$ , north and south subtropical  $20-25^{\circ}\text{C}$  and tropical  $25-30^{\circ}\text{C}$ . It is hereby suggested that equal emphasis must be paid to the isocryme, i. e., average surface water temperature of the coldest winter month, namely February, since this is the temperature which limits the northward distribution (in the case of the northern hemisphere) of the tropical and subtropical algae; that it is not necessary to give the upper boreal and upper austral zone wider ranges of temperature than the others, while for the temperate region, wider ranges must be allowed; and that while a range of five degrees may indicate the optimum temperature for the growth and reproduction of seaweeds, it is necessary to give a wider range of temperature, the second temperature range, which may be termed the favorable temperature range for the growth and reproduction of the seaweeds of the region concerned. As a matter of fact, with the exception of the tropic, the arctic and antarctic, most of the coastal regions have their range of temperature between the isotherm and the isocryme way over 5 degrees; in places like Tsingtao for instance, this value is as much as 24—25 degrees. It is therefore suggested that while classification of the zones is still to be made on the basis of five degrees ranges, an additional range of five degrees above and another five degrees below the original range be given to each zone thus resulting in regions overlapping each other in their second temperature ranges. It follows that the five temperature zones may be divided as follows:

1. Upper Boreal (and Upper Austral): I,  $<0-5^{\circ}\text{C}$ ; II,  $<0-10^{\circ}\text{C}$ .
2. Lower Boreal (and Lower Austral): I,  $5-10^{\circ}\text{C}$ ; II,  $0-15^{\circ}\text{C}$ .
3. Temperate (North and South): I,  $10-20^{\circ}\text{C}$ ; II,  $5-25^{\circ}\text{C}$ .
4. Subtropical (North and South): I,  $20-25^{\circ}\text{C}$ ; II,  $15-30^{\circ}\text{C}$ .
5. Tropical: I,  $25-30^{\circ}\text{C}$ ; II,  $20->30^{\circ}\text{C}$ .

It has further been suggested that determination of the nature of the marine flora of a certain region must be based not only on the above mentioned temperature ranges for the different zones, but also on a due consideration of the oceanic currents washing the particular coast concerned and

to some extent also of some of the floristic components. On these bases, the nature of the above mentioned 16 regions has been suggested (see Table I), among which are 3 regions predominately upper boreal, 3 lower boreal, 5 temperate, 3 subtropical and 2 tropical.

If considered purely from the point of view of floristic origin, a marine alga may be a northern species (upper and lower boreal) originated in the colder seas, a southern species originated in the warmer seas (tropical and subtropical) or an intermediate species (temperate) originated in the temperate waters. The northern species tend to distribute southward with the help of the cold currents and the southern species northward with the help of the warm currents. The intermediate species tend to distribute in both directions, since the intermediate regions in which they are originated are usually affected by both kinds of currents. In the case of the marine algal flora of the western North Pacific, as shown in Table I, the southern element composing of somewhat over 1000 species appears to be dominant and is undoubtedly Indo-West Pacific in nature; the northern element composing of not more than 500 species is Bering-Ochotsk in nature and the intermediate elements belong to the various seas concerned, such as the Japan Sea and the China Seas.