

# ON THE GEOGRAPHICAL DISTRIBUTION OF *PELVETIA SILIQUOSA* TSENG ET C. F. CHANG

(Abstract)

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Some years ago, we published a new species of *Pelvetia*, namely, *P. siliquosa* and briefly discussed its distribution<sup>[1]</sup>. This species was reported from the eastern coast of the Shantung Peninsula, from Dairen on the Liaotung Peninsula and from South Huangcheng Island of the Miaotao Islands at the Strait of Pohai. Since 1955, more data on the distribution of this plant have been accumulated, showing its much wider distribution than we first thought. According to the new data, at the Shantung Peninsula, the southern limit of its distribution has extended to Jushan Hsien, southwest of Sumen Island, Wenting Hsien, formerly the southern-most limit of its distribution, and the northern limit still remains at Chimeng Island. At the Strait of Pohai, the *Pelvetia* is still limited to South Huangcheng Island of the Miaotao Islands. At the Liaotung Peninsula, tons of collections have been made, showing its wide distribution in this area, extending eastward to Ching Hsien and Changhai Hsien (the Changshan Islands), westward to Port Arthur and further to Changhsing Island, Fu Hsien in the Gulf of Pohai (cf. Fig. 1). On the basis of the data now available, it is possible to attempt on a more thorough discussion on the geographical distribution of *Pelvetia siliquosa* in relation to the conditions of the currents along the China coast.

Before the discussion, it is necessary to note that plants of this species grow on middle littoral rocks, and are, therefore, exposed to the drying effect of air and sun several hours a day. Being a perennial, its thalli have to pass through hot summers and cold winters; therefore, the species is found only in such places where the summers are not too hot, generally not over 25°C, and the winters not too cold, generally above 1–2°C. The *Pelvetia* generally grows in places where water flows swiftly but wave action is not too strong. In sheltered places, its thalli are much more profusely branched and grow larger, generally 6–12 cm. to as much as 14.5 cm. high while on exposed rocks they are more simple in branching and much smaller in stature, generally only 5–7 cm., rarely reaching 8 cm. high.

A knowledge of the nature and movement of the surface currents along the North China coast is prerequisite to a better understanding of the distributional

dynamics of *Pelvetia siliquosa*. According to Kuan<sup>[2]</sup>, the surface currents along the China coast are primarily wind-driven currents, which are, however, influenced by the Kurosiwo and by eddy currents resulting from the specific configuration of the China coast. In the summer, the current flowing along the western Korean coast moves northward and passing through the northern part of the Yellow Sea, enters the Gulf of Pohai, and owing to the semi-closed nature of the Pohai, seawater concurrently flows out from Pohai and, moving southward along the Shantung and Kiangsu coasts, produces a coastal current moving contrarily to the direction of the wind in the summer<sup>[4]</sup>. In April to May, a branch of the Kurosiwo starts to move close to the China coast and in August, this current, after passing through the Yellow Sea off the eastern coast of the Shantung Peninsula, divides into 2 branches. One of these branches turns eastward and moves southward along the western Korean coast while the other turns westward, part of it entering the Gulf of Pohai via the channel between Laotiasan, Port Arthur, of the Liaotung Peninsula on the north and south Huangcheng Island of the Miaotao Islands on the south, and part of it turning southward, mixing with the water mass coming out from the Pohai, and moving southward along the eastern coast of the Shantung Peninsula. In the other months of the years, the flowing direction of the surface current along the China coast is in accord with the direction of the wind, from north to south.

It should be noted that *Pelvetia siliquosa* matures sexually and liberates eggs in the summer, especially in August to September. During this period, fertilized eggs, assisted by the movement of the surface current, will be dispersed from one place to another and when successfully attaching to a favorable substrate, will germinate and grow at its new "home". Of course, the lapse of time between the fertilization of the eggs and their arrival at the substrate must not be too long, otherwise they will not be able to retain their viability, for which other factors are also involved. Under favorable conditions, the *Pelvetia* will eventually be successfully established in the new locality.

Another problem to be dealt with here concerns with the species of *Pelvetia* reported from southern and southwestern Korea. Okamura reported that typical plants of *Pelvetia wrightii* were collected from Sekito near Tomanko in the northern part of Eastern Korean coast and dwarf plants of the same species from Fushan, Karuto, Mokpho and Zetsuyeito<sup>[6]</sup>. Okamura was surprised to find *Pelvetia wrightii* which is a native of the colder region as far south as Mokpho; in fact this is the only species of the colder region found in the southern and southwestern coast of Korea which is strongly influenced by the warm Tsushima Current. Japanese phycologists have followed Okamura in the interpretation of the *Pelvetia* collected from different places of Korea. However, we have reasons to question the validity of the view point of the Japanese phycologists, although we have not had the opportunity of studying Okamura's and others' specimens. In order to explain the occurrence of *P. wrightii* on the southern and southwestern coasts of Korea, Okamura had to assume that these regions were subjected to the influence of a certain cold current; he speculated that in the winter, the cold Lyman current would be strong enough to reach the southern and southwestern Korean coasts<sup>[6]</sup>. According to our present knowledge of the currents in the Japan Sea<sup>[4, 8]</sup>, Okamura's assumption cannot be established. As to the occurrence of typical *P. wrightii* in northeastern Korea near the mouth of the Toman River, as claimed by Okamura, there is a possibility, since in the summer, minor branches of the Tsushima Current, after arriving at the western part of Hokkaido, appear to turn westward reaching quite close to the northern coast of eastern Korea.

It has been reported that the thalli of *Pelvetia* of the southern and western

Korea are harvested by the Koreans and exported to China for food<sup>[5]</sup>. We have also learned that, before the war, merchants from Weihaiwei and Chefoo often went to western Korea to purchase the commercial *Pelvetia*, known on the market as "Luchiaotsai", since local production of this seaweed in China was not enough to meet the demands of the people. We have investigated into the species problem of the marketed *Pelvetia* from various sources, and to date, all the "Luchiaotsai" samples obtained from the market belong to *P. siliquosa* and none to *P. wrightii*.

On the basis of the conditions of the surface current along the Korean coast and of the commercial samples obtained from the Chinese markets, we believe that the *Pelvetia* of southern and southwestern Korea are nothing but *P. siliquosa*. Thus, this *Pelvetia* has the following three distributional centers: southern and western Korea, Liaotung Peninsula (including South Huangcheng Island) and eastern coast of Shantung Peninsula.

It would be of interest to speculate on the original "home" of *P. siliquosa*, i. e., the place it has speciated. It is our opinion that the genus *Pelvetia* has originated in northern Europe in an early geological era when average sea water temperature was higher than today, and then dispersed via the northern seas to Asia and finally to Pacific North America. Later, because of changes in water temperature, the *Pelvetia* in many places were annihilated and the continuity of the distribution was broken and the *Pelvetia* of these three continents were isolated from each other. Being plants of the upper or middle littoral regions, they were subjected to great influences of the different oceanographic conditions of these places, thus resulting in the formation of the European, the Asian and the Pacific American species. In Asia, the direction of the distribution of *Pelvetia* is apparently from north to south and perhaps once upon a time, there was a continuity of the distribution of *Pelvetia* from southeastern to northeastern Korea and Hokkaido. Changes in oceanographic conditions caused the annihilation of Korea *Pelvetia* except those of the southern region, resulting in the isolation of southern Korean *Pelvetia* from the others and subsequently in the speciation of the present species, namely, *P. siliquosa*. Further distribution of this species from southern Korea to southwestern and western Korea, then to the Liaotung Peninsula, and finally to the Shantung Peninsula might be readily explained on the basis of the present-day oceanographic conditions. The suggested distributional phenomenon is in good accord with the movement of the Kurosiwo and its branches in the Yellow Sea region.

The distribution of *Pelvetia siliquosa* at the Liaotung Peninsula and its vicinity confirms the suggestion that a branch of the Kurosiwo flows into the Pohai via the strait between the Peninsula and the northern islands of the Miaotao Islands. That the *Pelvetia* is not found in Chefoo and Weihaiwei is also in accord with the condition of the movement of the Kurosiwo; in the summer, a small branch of the Kurosiwo, after reaching close to the Liaotung Peninsula, turns southward, but because of the outflow from Pohai via the strait between the southern islands of the Miaotao Islands and the Shantung Peninsula, the Kurosiwo is forced to move away from the coast, not reaching Chefoo and Weihaiwei, and eventually mixes with the coastal current, moving close to the eastern part of the Shantung Peninsula in its southward flow. Tsingtao lies on the concave coast between two projecting points, namely, the Shantung Peninsula on the north and the Yangtze River mouth in the south; this part of the coast, near which are many small eddy currents, is beyond the influence of the Kurosiwo. This, together with other facts, may serve to explain why the *Pelvetia* is not found in the Tsingtao region. Of course, by artificial transplantation, it is not impossible that this alga will grow well in Chefoo, Weihaiwei and even Tsingtao.