

## THE OCCURRENCE OF COLPOMENIA PEREGRINA (SAUV.) HAMEL IN THE MEDITERRANEAN (PHAEOPHYTA, SCYTOSIPHONALES)

H. BLACKLER

Gatty Marine Laboratory, St. Andrews, Scotland

Until the beginning of this century *Colpomenia sinuosa* (Mert.) Roth was the only species of the genus known in European waters; it was first found by Mertens in 1806 off Cadiz. Mertens made drawings of it and sent them with his specimens to Roth who described it as *Ulva sinuosa* and published the description of this alga and Mertens' drawings in his *Catalecta Botanica* vol. III in that year.

At the beginning of this century a *Colpomenia* caused considerable damage to the oyster industry in France. Plants of *Colpomenia* attached themselves to the oysters in the oyster beds at Vannes and other places on the west coast of France. When the *Colpomenia* bladders became old they were filled with a mixture of air and water and caused the oysters to be buoyed up to the surface of the water and float away and be lost. This *Colpomenia* spread to the Channel coast of Brittany and Normandy and across to the Scilly Isles and along the south coast of England and became well established there early in the century.

Sauvageau (1927) observed that the *Colpomenia* responsible for the extensive damage to the oyster beds differed from *C. sinuosa* by being thinner, forming smooth bladders not thrown into folds or wrinkled, and in the origin of the hairs and the position of the sori in relation to the hairs. In *C. sinuosa* the hairs are epidermal in origin, though later appearing more deepseated due to invagination and the sori are punctate situated round the hair crypts and covered with a cuticle or pellicle which is ruptured as the plurilocular sporangia develop. Sauvageau named the *Colpomenia* which caused the damage to the oysters *C. peregrina*. This species is characterised by the thinness of the thallus, hairs arising from the sub-cortical cells not associated with the sori, which are confluent not punctate and have no pellicle over the plurilocular sporangia which are shorter than those of *C. sinuosa*. *Colpomenia peregrina* when pressed is usually of a greenish colour in contrast to the yellowish brown colour of herbarium material of *C. sinuosa*. Since the beginning of the century *C. peregrina* has spread round the coasts of the British Isles from the Scilly Isles to the Orkney's and Shetland Isles and down the east coast of Scotland and England. It was recorded from Holland in 1921 and Denmark in 1939 (Lund 1945) and later from Norway (Lund 1949).

Sauvageau found *C. peregrina* as far south as the Gulf of Gascogne in 1908 and Palminha (1951) recorded it from the Portuguese coast from Portinho da Arrábida south of Lisbon near Setubal in 1951. Until 1956 there was no record of *C. peregrina* in the Mediterranean. In June 1954, the author searched carefully for this alga at Banyuls and in the vicinity, but *C. sinuosa* was the only member of the genus present which in the field is easily distinguished from *C. peregrina* as it is thicker and the thallus is thrown into folds or wrinkles and is very like *Leathesia difformis*. However, in May 1956 Mendez Domingo found *C. peregrina* growing near the Laboratoire Arago, Banyuls.

*C. peregrina*, however, has been in the Mediterranean much longer than the summer of 1956. In the Rijksherbarium of Leiden there is a specimen collected by Dr. Koster at Naples in May 1939 and this specimen is undoubtedly one of *C. peregrina*. In March 1964 when I visited the Stazione Zoologica, Naples, to study various algae including *C. sinuosa*, the material of *Colpomenia* which was brought in, on examination proved to be *C. peregrina* which was found to be growing abundantly in Naples Bay at that time. Spores were liberated from the *Colpomenia* and cultures set up and brought back to this Laboratory. The growth of these cultures was identical with other cultures set up with spores from plurilocular sporangia on material from St. Andrews Bay, Fife, Scotland, Port Erin, Isle of Man, Plymouth on the south coast of England, or from the Californian coast of North America.

Prior to this all the specimens of *Colpomenia* from Naples have been recorded under the name of *C. sinuosa* and examination of material from Herbaria from various Museums reveals the presence of *C. sinuosa* only in Naples Bay in the past. It is evident that *C. peregrina* has migrated into the Mediterranean and Dr. Koster's specimen collected in 1939 is the first authentic material of this species which I have seen from Naples Bay.

The occurrence of *C. peregrina* at Naples and then Banyuls raises the question as to how it got into the Mediterranean. Entry to the Mediterranean is either through the Straits of Gibraltar or the Red Sea and Suez Canal. Rayss (1959) found only *C. sinuosa* in the Red Sea and states the differences between *C. sinuosa* and *C. peregrina* very clearly so that there is no question of confusion of the species. Thus as both species were in the Mediterranean prior to 1959 this would appear to support the view that *C. peregrina* had reached the Mediterranean through the Straits of Gibraltar.

The occurrence of *Colpomenia peregrina* in Naples Bay before its appearance at Banyuls can be explained by the movement of the tidal currents in the Mediterranean. The Atlantic water enters the Mediterranean through the Straits of Gibraltar and according to the Mediterranean Pilot most of the incoming water derived from the Portugal current flows along the northern coast of North Africa in an easterly direction and after Cape Bon divides into two currents, one continuing eastwards to Egypt and then north and flowing along the Israeli coast to Asia Minor and eventually into the Black Sea where it circulates and then goes off the Greek coast and into the Adriatic. The second current goes up the west coast of Italy and along the French coast. There are thus two circuits in the Mediterranean and a western and an eastern basin separated by Italy and Sicily and connected by a channel off Malta. There is a counterclockwise movement of water in both basins and the easterly flowing current in the Malta channel is common to both. The course of the second current would explain the appearance of *C. peregrina* in Naples Bay before Banyuls as it flows up the west coast of Italy and then along the French Riviera and French and Spanish coasts to just south of Cape de la Nao before turning back towards Sicily and Italy.

Mendez Domingo (1956) thought that *C. peregrina* might have reached Banyuls with *Codium fragile* which has appeared in Banyuls since the end of World War II. This, however, is not the case as *Codium fragile* was abundant at Banyuls in the summer of 1954 though there was no *Colpomenia peregrina* there then. Mendez Domingo (1956) put forward an alternative theory to the above that *C. peregrina* had appeared suddenly in the Mediterranean in the summer of 1956 as it did on the west coast of France at the beginning of the century. Dr. Koster's find of *C. peregrina* in Naples Bay in 1939 refutes this suggestion. With regard to the Malta Channel it is of interest to note that I have had material obtained by diving from Mellicha Bay on the north east coast of Malta which was all *C. sinuosa*.

Among material of *C. sinuosa* of the State Herbarium of Munich there are specimens from Istria near Trieste in the Adriatic collected in January 1914 by Dr. G. Seefeldner, which appear very similar to *C. peregrina*, so that it appears that *C. peregrina* has been in the Mediterranean for a long time. Unfortunately I have not been able to see fresh material from Trieste.

*C. peregrina* can be described as cosmopolitan in its distribution and can stand a greater range of temperature than *C. sinuosa* which is thus more restricted in its range and does not occur north of Cadiz in Europe.

If the distribution of *C. peregrina* is studied by examination of herbarium material it appears to occur from Alaska down the Pacific coast of America to Callao near Lima in Peru in South America. It grows abundantly on Vancouver Island, British Columbia, and when living material and sectioned material is examined it is identical with British or Mediterranean *C. peregrina*. There is considerable confusion in the literature with regard to the nomenclature of the Californian material of *Colpomenia*. Saunders who first found *Colpomenia* on the Californian coast described *C. sinuosa* as being thin and *C. sinuosa f. expansa* as being thick. *C. sinuosa* as described by Saunders in 1898 is really *C. peregrina* and his *C. sinuosa f. expansa* is *C. sinuosa* as both species occur on the Californian coast. When Saunders' slides are examined the differences between the species are clearly seen, *C. sinuosa f. expansa* slides show fan shaped sori of sporangia covered with a pellicle or showing this ruptured round the sori exactly as I have seen it in sectioned material of *C. sinuosa* from Malta, while in Saunders' *C. sinuosa* or *C. peregrina* this pellicle is lacking and the sori are not punctate. *C. peregrina* seems to occur in the Galapagos Islands and Easter Island, in fact its distribution down the American coast seems to follow that of the cold Humboldt current. It has been found recently on the east coast of North America on the New Brunswick coast of Canada (Blackler 1964), and north of Cape Cod in the United States (MacFarlane in Blackler 1964). It occurs from Beaufort, North Carolina, southwards to Florida where it was found washed ashore at Jupiter Inlet in 1897. Specimens from Jupiter Inlet at this time occur in many Herbaria and in all cases the material is thin and greenish in colour and like *C. peregrina*. Similar material has also been observed from the West Indies where *Colpomenia* occurs abundantly. Material like *C. peregrina* has been seen from China and Japan where there are cold currents off the coasts. Two forms seem to occur in Australia and spores from thin material from the neighbourhood of Sydney, New South Wales, have been grown in culture here and found to grow in exactly the same way as *C. peregrina* spores from Britain, California, or Naples. This Australian material when sectioned is identical with *C. peregrina* in cell structure and size, measurements of the plurilocular sporangia and their arrangement on the thallus, development of hairs and lack of pellicle over the sori.

The sudden appearance of *C. peregrina* on the Atlantic coast of France may perhaps be explained by the Gulf Stream Drift as it is a well-known fact that seeds and portions of plants can be carried in this Stream to Western European shores. In support of this, *Colpomenia* not only occurs off the Florida coast and West Indies but also off the shores of the Azores which lie in the course of the Gulf Stream. The North Atlantic Current of the Gulf Stream at about latitude 45° N flows southwards between the Azores and Spain and into the Bay of Biscay and some of this water enters the Mediterranean through the Straits of Gibraltar. *C. sinuosa* has been known from the Azores since 1894 as in the Farlow Herbarium there is a specimen collected there. The record of *C. peregrina* is the first for the Azores, and the material was collected there in 1959.

Thus from the distribution of *C. peregrina* and the course of the Gulf Stream Drift off the Azores towards Spain and into the Mediterranean and the currents in the

Mediterranean the appearance of *C. peregrina* in this sea may be explained and careful investigation of the algal flora of the Mediterranean may reveal its presence in other places than Naples and Banyuls in the future.

I wish to thank Professor Lam, formerly Director, and Dr. Koster, Curator of the Rijksherbarium, Leiden, for allowing me to have on loan specimens of *Colpomenia* including Dr. Koster's material from Naples. My thanks are due to Professor W. R. Taylor of the University of Michigan, Ann Arbor, for allowing me to see his own herbarium specimens of *Colpomenia* as well as those in the University Herbarium and for information about *Colpomenia* in the West Indies; Professor Papenfuss, the University of California, Berkeley, in whose laboratory I was able to study and culture Californian material of *Colpomenia* and also examine specimens in the Herbarium of Professors Setchell and Gardner; the Director of the Allen Hancock Foundation, the University of Southern California, Los Angeles, where I was able to see herbarium material much of it having been collected by the late Dr. Yale Dawson, formerly Curator of Cryptogamic Botany, the Smithsonian Institute, Washington, D.C.; Dr. Lamb, the Curator of the Farlow Herbarium, University of Harvard, where I was able to see specimens and slides of *Colpomenia* of De Alton Saunders who first studied *Colpomenia* on the Californian coast; the Director of the New York Botanical Garden; Dr. Hales, formerly Curator of the Cryptogamic Botany, the Smithsonian Institute, Washington, D.C.; Dr. Bourelly, the Herbarium, Museum National d'Histoire Naturelle, Paris; the Director of the Botanical Institute of the University of Naples; Dr. Beth for allowing me to see the algal herbarium in the Stazione Zoologica, Naples; Dr. Dandy, the former Keeper of Botany, the British Museum (Natural History Department), London; Sir George Taylor, the Herbarium, the Royal Botanic Gardens, Kew.

My thanks are due to the Directors of the following Herbaria for loans of specimens: — The State Herbarium, Munich; Übersee Museum, Bremen; and the Botanical Museum of the University of Copenhagen. Finally I wish to thank Miss M. Mackay of the University of Townsville, Australia, for sending fresh material from the neighbourhood of Sydney, and Dr. M. Parke and Dr. J. Jones for fresh material from Plymouth and Port Erin respectively; Dr. A. Larkum, Botany School, Cambridge, for the material from the Azores collected in 1959 when on an expedition from Imperial College London, and Mr. D. Jackson of this Laboratory for the Malta material.

In conclusion I wish to thank the American Association of University Women for their award of an International Study Grant which enabled me to study *Colpomenia* on the Pacific coast of North America, and to the Carnegie Trust for the Universities of Scotland for a travel grant which enabled me to visit the above-mentioned Universities and Institutions and study their herbarium material. The work on *Colpomenia* in Naples and here was carried out with the aid of my research assistant financed by the Science Research Council whose support I acknowledge gratefully.

#### REFERENCES

- BLACKLER, H. 1964. Some observations on the genus *Colpomenia* (Endlicher) Derbès et Solier. Seaweed Symp. 4 Biarritz: 50—54.
- LUND, S. 1945. On *Colpomenia peregrina* Sauv. and its occurrence in Danish waters. Rep. Danish Biol. Stn. 47: 1—15.
- 1949. Remarks on some Norwegian marine algae. Blyttia 7: 56—60.
- Mediterranean Pilot I. 1951. 8th ed. Admiralty Hydrographers Dept. London.
- II. 1952. 8th ed.
- MENDEZ DOMINGO, C. 1956. Sur l'existence du *Colpomenia peregrina* (Sauv.) Hamel dans la Méditerranée. Vie Mileu 8: 92—97.
- PALMINHA, F. 1951. Contribuições para o estudo das algas marinhas Portuguesas I. Bolm. Soc. port. Ciênc. nat. III, 2nd ser. (XVIII), fasc. II: 227—258.
- RAYSS, T. 1959. Contributions à la connaissance de la flore marine de la Mer Rouge. Contributions to the knowledge of the Red Sea No. 15. The Sea Fish. Res. Stn. Bull. 9, Haifa, Israel.
- ROTH, A. G. 1806. Catalecta botanica III. Leipzig.
- SAUNDERS, DE A. 1898. Phycological memoirs. Proc. Calif. Acad. Sci. 3rd ser. Bot. 1: 147—168.
- SAUVAGEAU, C. 1927. Sur le *Colpomenia sinuosa* Derb. et Sol. Bull. Stn. biol. Arcachon 24: 309—350.
- SVERDRUP, H., M. JOHNSON, & R. FLEMING, 1949. The oceans. New York.