Botanica Marina
Vol. XXIII, pp. 303–307, 1980

Studies on the Morphology of the Megaecade *limicola* of *Fucus vesiculosus* L. with Taxonomical Comments

F. X. Niell, A. Miranda* and J. P. Pazó**

Instituto de Investigaciones Pesqueras, Muelle de Bouzas, Vigo, Spain
**Instituto Español de Oceanografía, Orillamar 47, Vigo, Spain*
and
***Plan Marisquero de Galicia, Centro Experimental, Villagarcía, Pontevedra, Spain*

(Received June 6, 1979)

Abstract

Different sets of *Fucus* growing on salt marshes and mud flats of the NW of Spain were used to discuss the present validity of the species *Fucus muscoides* (Cotton) Feldman et Magne. By means of several morphological measurements the specimens studied were related by a gradual variation of characteristics. The earlier suggestion of Baker and Bohling (1916) was supported by the data obtained in this work, therefore all the specimens described in this paper must be considered as an ecad (megaecade) of different and very variable forms all beloging to one species only: *Fucus vesiculosus* L.

Introduction

The third check-list of British Marine Algae, Parke and Dixon (1976) accepted the entity *Fucus muscoides* (Cotton) Feldmann et Magne as a species of the genus *Fucus* L., whereas in the two previous check-lists (Parke and Dixon 1964 and 1968) this species was included in *F. vesiculosus* L. without any special mention to its taxonomical subspecific rank.

In two recent works (Pazó 1975 and Niell 1978) the presence of several morphological forms of *Fucus* were reported in NW Spain. The specimens found suggested the existence of a morphological cline of entities beloging to only one species, *Fucus vesiculosus.*

This is not a new suggestion, Baker and Bohling (1916) in a comprehensive work developed the same idea and made a revision of the marsh and the loose-lying-forms or migration formations from old authors (Rosenvinge 1968, Schiller 1909).

The aim of the observations and biometrical measurements presented in this paper is to provide evidence that the different forms of *Fucus* living in the marshes and mud zones in Galicia are related by a cline, having the entity of an ecad (megaecade) in the classical ecological sense of Clements (1905).

Methods

Collection sites

The specimens were collected in Larache Bay (Fig. 1) in the Ría of Vigo, but the ecad is frequently present in marshes and mudflats along this coast (it was also

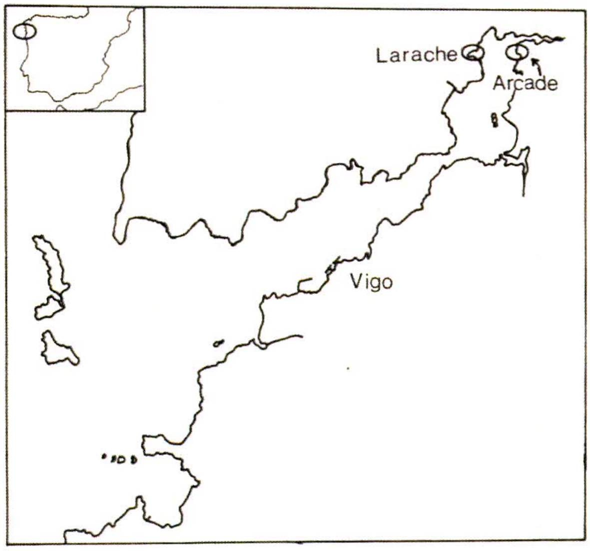

Fig. 1. Ria of Vigo showing sites of collection.

0006-8055/80/0023-0303$02.00

present in the Ría of Arosa, J. Fuentes per.com.). Plants were collected at five sites, numbered 1 to 5, downwards in intertidal zone. Level 1 and 2 were frequently patchy and they could be considered only as one group; levels 3, 4 and 5 grew on shaded muddy rocks.

After collection, the algae were transported to the laboratory, length and dichotomization measured, and then fixed in formaline. Study of the reproductive state involved measurements of the number of fruiting plants and histological observations to estimate percentage sterility. Special attention was paid to cryptoblasts. These organs were drawn from histological sections with a camera lucida and then 6 measurements were made as illustrated in Figure 2. Counts of lateral cryptoblast (L.C.) and sparse cryptoblast (S.C.) per length and surface units was made with the stereoscopic microscopy.

Finally a morphological description was made of the specimens collected in comparison with other *Fucus vesiculosus* plants living on the muddy intertidal of the Ría of Vigo.

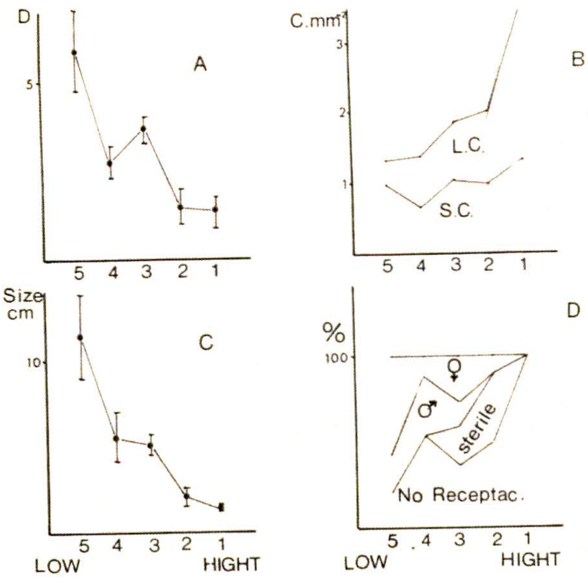

Fig. 3. (A) Number of dichotomies, (B) Density of cryptoblasts per surface unit. (C) Size of specimens, (D) Percentage of male, female, sterile and nonfruiting plants. All abscissae scale represent the level at which specimen were collected.

Results

Size and dichotomies

High level forms were smaller than low level specimens as shown in Figure 3.

Reproductive structures – The percentages of nonfruiting, sterile, male and female individuals are expressed in Figure 3. At high levels no fruiting individuals were found and morphologically the receptacles were not so filled with mucilage as those from plants growing at low levels.

Cryptoblast structures – Cryptoblasts are probably involved in the plant water balance. The higher values of protected surface to whole surface ratio being found in high level plants could be considered as an adaptative strategy. Two kinds of cryptoblast were found in *Fucus* from muddy areas in Vigo Bay: lateral (L.C.) and sparse (S.C.). On the whole, the density of cryptoblasts supports the Baker and Bohling hypothesis (1916) that the proportion of L.C. is higher in individuals from high level than in those growing at low ones.

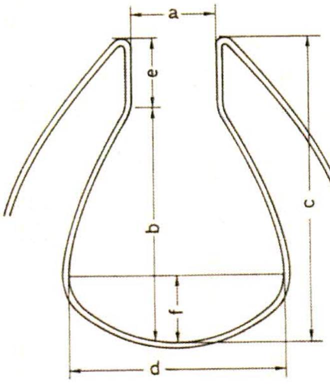

Fig. 2. Schematic morphology of a cryptoblast, showing measurements taken for calculations.

Many of the specimens studied had two distinct parts to the thallus, the lower part was coarse, with a lot of epiphytes (*Rhizoclonium*, many blue-green, etc.) and inserted into the substratum. The mid-rib was slightly marked, the high part had sometimes regrown from the basal (perennial) lower part. Density of L.C. seemed to be greater in old parts at high levels, on the contrary cryptoblasts were not so dense in low intertidal specimens. S.C. were more dense in young parts in all the specimen observed (Tab. I). The number of S.C. in young parts of the thallus was quite constant, but the differences between S.C. in old parts were evident between the specimens of high and low levels.

The different cryptoblast measurements were taken in three set of plants: set I were individuals from the high

Tab. I. Mean number of Sparce Cryptoblasts and Lateral Cryptoblasts per unit of surface (SC mm^{-2}) and length (LC mm^{-1}) in the upper (young) and lower (old) part of the thallus.

Level	Sample	S.C.		L.C.	
		Young	Old	Young	Old
High	1	0.86	0.42	1.05	1.22
	2	0.78	0.11	0.45	0.63
	3	0.75	0.29	0.36	0.47
	4	0.55	0.09	0.39	0.29
Low	5	0.75	0.15	0.27	0.17

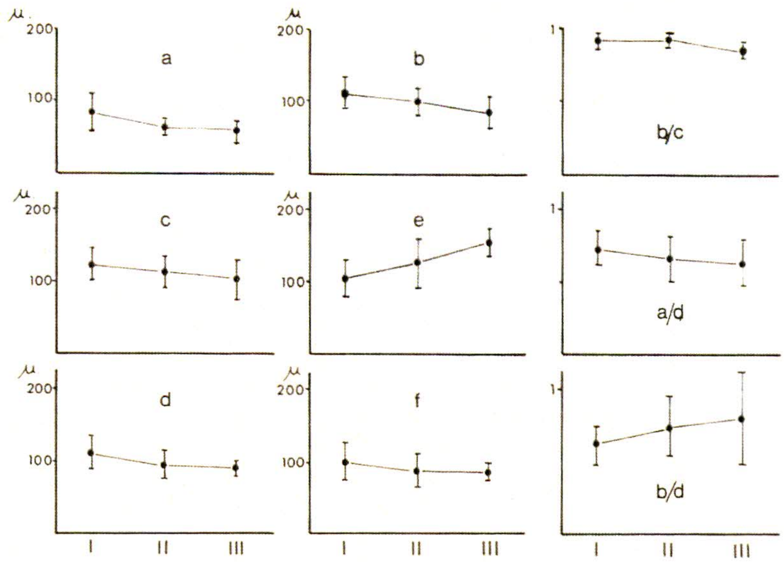

Fig. 4. Measurements on cryptoblasts (c.f. Fig. 2) in three set of *Fucus*: I, high level plants to III, low level plants.

level, set II was composed by individuals from the level 2 and in set III individuals from levels 3 and 4 were measured. In Figure 4 the changes of the different measures are presented in microns, at the same time the indexes b/c (urceolate-shape index), a/d (ostiole diameter related to the width of cryptoblast) and b/d (ellipsoidal index) were determined.

Measurements of width (d) were not significatively different. Cryptoblast from high level specimens were deeper, with larger diameters of ostiole and not so urceolate as those belonging to individuals growing at lower levels. At the same time they were more sphaeroidal and very uniform. (All measurements were tested with a z proof).

Total surface area of cryptoblast was calculated by taking their shape as a body composed of a cylinder (the basis with a diameter *a* and height *e*. Fig. 2) and an ellipsoid whose axes are b and d.

The total surface increase due to cryptoblast surface per unit surface was 9.87 times in the individuals of the set III, 14.41 times in those grouped in set II and much higher in the specimens of site I (39.07 mm^2 of cryptoblast surface per mm^2 of thallus).

Discussion

The data presented in this paper show a main trend: in that, changes were closely related to the level at which the individuals grew in the intertidal. The evidence suggest that changes are adaptative. The important question is, What are the factors responsible for these adaptative morphologies? . In fact, Baker and Bohling (1916) gave the answer sixty years ago when they said: "Dwarf habit is due to change in the vertical position of the species relatively to the side. This causes prolonged exposure, ... together with a decreased access of nutrient salts", ... and in another of their papers the same workers said: „The thallus of these plants is so plastic, that it responds to every change in environment with an almost machine like regularity".

Baker and Bohling (1916) who appreciated the variation in number of cryptosomata, questioned in their paper what factor determined the distribution of cryptosomata and what their function was. It seems evident that cryptosomata play a role in the survival of dwarf *Fucus* living for long periods without immersion. The increase of effective area and increase of surface by means of protected structures (hairs) is a general rule in plants with a controlled water economy in extreme conditions.

Taxonomical conclusions

In Figure 5, the different forms of *Fucus vesiculosus* were related from low to high levels. Plant 1, taken as reference, is spiral bears vesicles and is classified as *Fucus vesiculosus.* The main changes in plants 2 to 5 were the lost of vesicules, increase of vegetative proliferation, and reduction in the number of receptacles which were smaller and not so mucilagenous as in plants growing in low level.

From 5 to 7 in Figure 5 there is a transition from *Fucus vesiculosus* var. *lutarius* to *Fucus vesiculosus* var. *balticus* (?) in two series. The one on the top was collected at Arcade and the second one at Larache's Bay (see Fig. 1), form 9 was classified as *Fucus vesiculosus* var. *muscoides*

Fig. 5. General picture of the clination from a *Fucus vesiculosus* f. *axillaris* (1) to *Fucus vesiculosus* ec. *muscoides* (8 and 9). (2): Specimen with axillar and no lateral vesicles. (3 and 4): *Fucus vesiculosus* ecade *volubilis.* (5 to 8): *Fucus vesiculosus* ecade *cespitosus.* (8 to 9): *Fucus vesiculosus* ecade *muscoides.* (Reduction 1/4). Increasing emersion time from (1) to (10).

by comparison with the type of *Fucus muscoides* (Cotton) Feldman et Magne from Leloc (Brittany, France) sent by Dr. J. Cabioch to one of the authors (J. Pazó) and collected by Dr. G. T. Boalch. The changes between the forms 6 and 9 were those discussed in this work.

In short we accepted as the only name *Fucus vesiculosus* L. for all kinds of plants described in this paper thus agreeing with Baker and Bohling (1916) and it seems that there is no reason to maintain as different species *Fucus muscoides* (Cotton) Feldman et Magne, *Fucus balticus* J. Ag. and *Fucus lutarius* Kütz. The forms of *Fucus vesiculosus* studied in this paper have the entity of an ecad (Clements 1905) and the suggestion of Baker and Bohling (1916) to accept a megaecad *Limicola* is justified by the present data. Taxonomical names to be used in reference to this series of *Fucus* from muddy areas could be the same as those employed by Baker and Bohling: *Fucus vesiculosus* ecad *volubilis*; for plants which tend to be dwarfed, being spiral, with marginal cryptoblasts; in this ecad we include the forms 2 to 5 in plate. I. *Fucus vesiculosus* ecade *cespitosus* for plants dwarfed (3 to 6 cm height) not spiral but narrower than *F. vesiculosus* ecad *volubilis* (5 to 7, 8 in Fig. 5) and *Fucus vesiculosus* ecad *muscoides* for very dwarf plants (8 to 9 in Fig. 5).

Acknowledgements

We are gratefull to Dr. J. Cabioch and Dr. G. T. Boalch for their kindness in sending specimens of *Fucus muscoides* from Brittany, and to Mrs. Carmen Mouriño and A. Ayala for help in the preparation of this paper. We want also especially express our acknowledgement to Dr. G. T. Boalch for correcting the English and for critical advice.

References

Baker, S. M. and M. H. Bohling. 1916. On the brown seaweeds of the salt marsh. Part II. Their systematic relationships, morphology and ecology. *Linn. Journ. Botany 43*: 325–380.

Clements, F. E. 1905. *Research methods in Ecology*. Lincoln Univ. Pub. Co. 530 pp.

Niell, F. X. 1978. Catálogo florístico y fenológico de las algas superiores y cianofíceas bentónicas de las Rías Bajas Gallegas. *Inv. Pesq. 42*(2): 365–400.

Parke, M. and P. S. Dixon. 1964. A revided check list of British marine algae. *J. Mar. Biol. Assoc. U.K. 44*: 499–542.

Parke, M. and P. S. Dixon. 1968. Check list of British marine algae. Second revision. *J. Mar. Biol. Assoc. U.K. 48*: 783–832.

Parke, M. and P. S. Dixon. 1976. Check-list of British marine algae. Third revision. *J. Mar. Biol. Assoc. U.K. 56*: 527–594.

Pazó, J. P. 1975. *Autoecología y distribución de las especies del género Fucus en la Ría de Vigo*. Tesina. Fac. Ciencias Univ. Santiago de Compostela, Spain.

Rosenvinge, K. 1898. Algenvegetation ved Grønlands Kyster. *Meddelelser om Gronland, 20*.