THE SPREADING OF FISSIDENS CRASSIPES WILS. (MUSCI) IN THE NETHERLANDS

P. A. FLORSCHÜTZ, S. R. GRADSTEIN and W. V. RUBERS

Instituut voor Systematische Plantkunde, Rijksuniversiteit Utrecht

SUMMARY

In the last few years a rapid spreading of *Fissidens crassipes* Wils. along the main rivers in the Netherlands has been observed. The distinguishing characteristics, the distribution, ecology, and reproduction of the species are discussed. It is suggested that the spreading results from a raise in water temperature in the rivers due to the discharge of increasing quantities of warm cooling water by the industries.

1. INTRODUCTION

Up to recent years *Fissidens crassipes* Wils. was considered to be a very rare moss species in the Netherlands (JOUSTRA 1959). It was known from three localities, all of them situated along the main rivers. In 1969 we collected *Fissidens crassipes* in a number of localities along the rivers Rhine, Maas, Waal, and IJssel. Additional new localities were discovered in 1970 and 1971. In many places the species was growing abundantly, forming dense mats. The apparently rapid spreading of the species in the Netherlands in recent years raised our interest and we tried to investigate possible causes of this spreading.

2. DISTINGUISHING CHARACTERISTICS

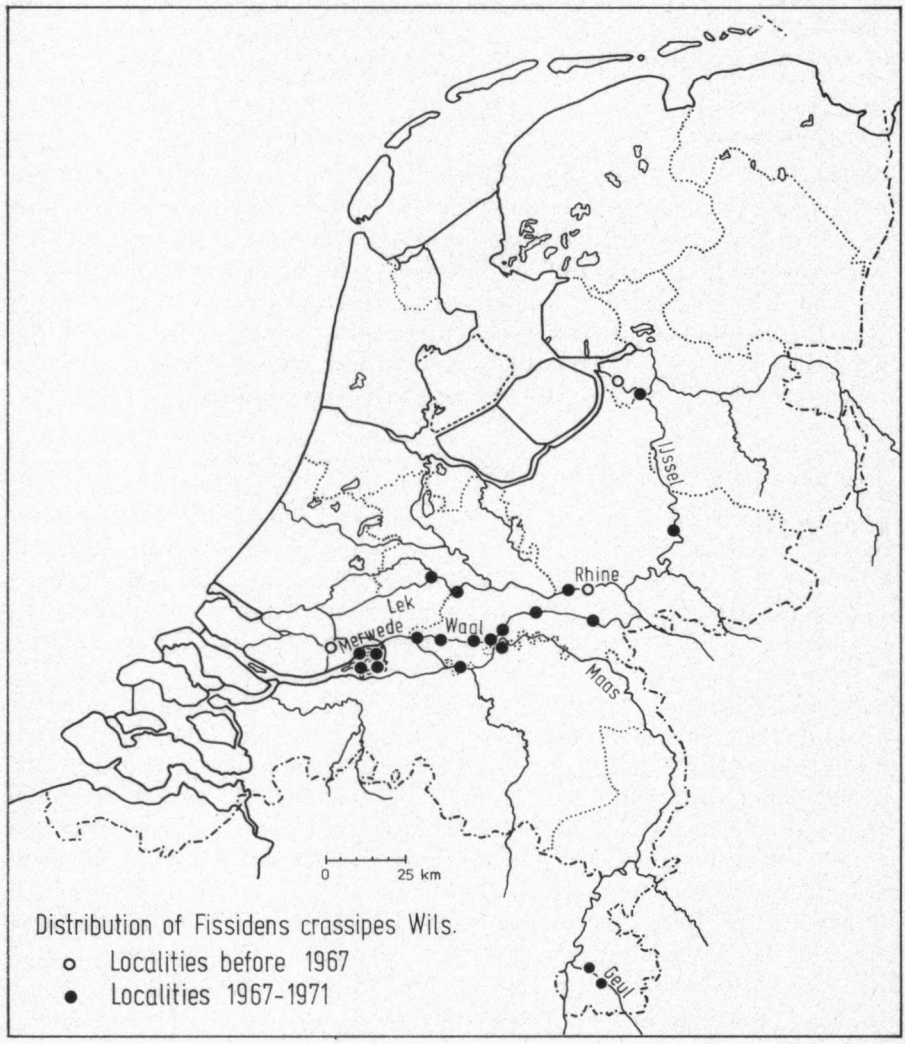
Morphologically *Fissidens crassipes* Wils. is a variable species. The margin of the leaves, generally complete and one or more cell-layers thick, may be partially or completely lacking. The size of the cells in the upper part of the leaves varies considerably: 12–28μ. The sheathing part of the lamina of the leaves may be longer or shorter than the apical part of the lamina, rarely both parts are equal in length.

In the Netherlands the species might be confused with the rather common *Fissidens bryoides* Hedw. (VAN ZANTEN & DURING 1970). The inflorescences furnish the principal differential characters. In *F. crassipes* the antheridia are terminal and surrounded by a conspicuous perigonium; in *F. bryoides* the antheridia are scattered along the stem in the leaf axils. The archegonia are terminal in both species, but in *F. crassipes* they are surrounded by distinctly prolonged perichaetial leaves (width-length ratio = 1: 5–6) whereas in *F. bryoides* the perichaetial leaves are hardly prolonged (1 : 4). Young and sterile plants of the two species are very hard to tell apart. We found that in young, sterile *F. crassipes* the width-length ratio of the leaves half-way up the stem is 1 : 3.5–4.5; in young sterile *F. bryoides* the ratio is 1 : 2.5–3.5. When examining

young colonies of the species one should always look for male or female plants which are usually present in *F. crassipes.*

3. DISTRIBUTION

In addition to extensive field collecting, materials of Dutch *Fissidens crassipes* present in the University herbaria of Groningen (GRO), Leiden (L), and Utrecht (U), and in some private herbaria, have been re-examined. To ensure that collections of *F. crassipes* had not been misidentified in the past, we also checked the herbarium materials of *F. bryoides* collected in possible *F. crassipes* habitats. No *F. crassipes* was discovered among them.



Localities of *F. crassipes* in the Netherlands *(fig.1)*:

Rhine and Lek:	Doorwerth (Nannenga-Bremekamp, 1950, U)
	Culemborg (Rubers, 1971, U)
	Vianen (Rubers, 1969, U)
	Wageningen (Florschütz *et al.*, 1969, U)
Waal:	Opijnen (Rubers, 1969, U)
	Dalem, Herwijnen, Ophemert, Ochten, Oosterhout (Florschütz *et al.*, 1969, U)
	Varik: (Florschütz *et al.*, 1970, U)
IJssel:	Kampen (Top, 1883, L)
	Zutphen (de Boer, 1967, GRO, L)
	Zwolle (Bruggeman-Nannenga, 1970, U)
Maas:	Hedel, Heerewaarden (Florschütz *et al.*, 1970, U)
Biesbosch and Merwede:	Dordrecht (van der Sande Lacoste 1843, 1848, L)
	Brabantse Biesbosch (During, 1967, herb. D.; field trip Bryologische Werkgroep, 1969, GRO & herb. van Zanten)
Geul:	Between Houthem and Meerssen, Chaloen near Valkenburg (Bruggeman-Nannenga, 1971, U)

General distribution: Southern, Central, and Western Europe.

4. ECOLOGY AND REPRODUCTION

In the Netherlands *Fissidens crassipes* grows along the rivers in the zone of vertical water fluctuations, preferably on bricks and wooden poles ("perkoenpalen") at the bottom of coffer dams. In winter and spring, during high water levels, the species grows submerged. *Fissidens crassipes* is a characteristic element of a moss community in which *Leptodictyum riparium* also frequently occurs *(table 1)*. This community belongs to the Leptodictyo-Fissidentetum

Table 1. Leptodictyo-Fissidentetum crassipedis Philippi 1956

Number of record	1	2	3	4
Area, m^2	0.2	0.1	0.3	0.3
Bryophytes cover %	40	60	40	75
Fissidens crassipes	2.3*	3.3	2.3	4.4
Leptodictyum riparium	2.2	2.2	2.2	1.2
Bryum argenteum		+.2	+.2	
Leskea polycarpa	+.2			
Bryum sp.				1.2
Bryum klinggraeffii				+.2
Funaria hygrometrica				+.2

Legenda. Record nr. 1. Varik, 23–10–1970, basalt block on coffer dam
2. Varik, 23–10–1970, wooden pole
3. Hedel, 23–10–1970, brick
6. Heerewaarden, 23–10–1970, brick

* abundance and sociability according to the Braun-Blanquet scale.

crassipidis Philippi 1956, described from small branches of the river Rhine in S. W. Germany. Synonymous with this is the Fissidens crassipes-Cinclidotus riparius association Allorge 1921 from the Vexin Français and the Moselle (VON HÜBSCHMANN 1967). The Dutch *Fissidens crassipes* community seems to differ from this association in the absence of *Cinclidotus* sp. (see below).

The substrate on which *F. crassipes* grows is usually covered by a thin layer of mud inhabited by green and blue algae. Dense mats of young plants typically develop on a caulonema (= secondary protonema sensu SIRONVAL 1947). This growth-form is known in several genera of acrocarpous mosses (*Phascum, Funaria, Pleuridium*) and described as "Rhizoidsprossung" by MEUSEL (1935). The caulonema consists of vigorous, nearly unbranched, brown, rhizoid-like strands. On bricks the strands form a criss-cross network in the mudlayer. On wood the strands form a parallel filament system adapted to the fibrous structure of the substrate*). The buds originate very close to each other *(fig. 2)* and

Fig. 2. Caulonema strand with two buds of Fissidens crassipes, one of them developing into a juvenile plant. Distance between the buds 0.1 mm. 300 x.

* FIALA (1968) showed that on artificial agar-agar media species of *Fissidens* form their own specific protonema pattern which can be used as a taxonomic tool. Our data strongly suggest that the form and pattern of the protonema in one species varies in relation to the structure of the substrate.

are well fixed to the substrate by the caulonema. Locally a short green chloronema branch is formed; we did not find buds on these branches.

Juvenile plants germinating from the buds soon get detached from the caulonema and form a dense bundle of rhizoids at the base of the stem. These rhizoids serve as a hold during further development of the plants. When growing just above the water level, the species is able to expand rather rapidly, as was seen both in the field and in the laboratory. Old plants die off after a period of prolonged drought.

Two kinds of diaspores were seen in the field. In several localities great numbers of capsules with mature spores were present. Also the plants appeared to be rather fragile and able to regenerate from stem fragments or detached leaves. The germination of the diaspores was tested in the laboratory. Leaves detached from stems were placed on brick and kept in a moist atmosphere at room temperature. In a few months colonies of young plants developed from caulonemata that expanded rapidly on the substrate. Spores treated in the same way failed to germinate.

5. DISCUSSION

The question should be raised whether *Fissidens crassipes* merely has been overlooked in the Netherlands. Therefore we compared the Dutch distribution data of *F. crassipes* with those of *Cinclidotus fontinaloides* (including the closely related *C. riparius*), a moss species also restricted to habitats along our main rivers. Although the two species have a slightly different ecology in the Netherlands, *Cinclidotus* mainly growing on limestone blocks, *F. crassipes* being found on brick and wood* – the species are always growing close to each other in the field. According to TOUW (1963) *Cinclidotus* was known from at least 15 localities in the Netherlands. No new localities have been recorded in recent years. In the past *F. crassipes* was collected less often than *Cinclidotus*; now it is far more common than the latter species, so it must have spread strongly and is not likely to have been formerly overlooked. We collected *F. crassipes* in nearly every locality we visited along the rivers. No localities could be found yet in the Dutch upstream part of the Maas. Generally the species seems to be more common in the western part of the country now, as shown by *fig. 1.*

A few years ago the northernmost mass-occurrence of *F. crassipes* did not reach further than S. W. Germany (PHILIPPI 1956; DÜLL, personal communication). The poor resistance of the species to frost seems to determine the northern limits of its area. In the last few years the average water temperature in the Dutch main rivers has increased as a result of the voiding of warm cooling water by the industries. According to LEENTVAAR (1970) the increase amounts to about 2 °C. In recent years there has been hardly any ice drift on the Rhine. It therefore seems probable to us that *Fissidens crassipes* could invade the

* Except in S. Limburg along the Geul where the species was discovered quite recently. Here *F. crassipes* inhabits exclusively limestone blocks!

Netherlands through this rise in water temperature. Dispersal both by means of spores and vegetative parts and the quick formation of caulonemata on suitable substrates favour a rapid spreading.

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