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FUNGI FROM THE SALT MARSHES OF MINAS BASIN, NOVA SCOTIA

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Ascomycete and Deuteromycete species growing on *Spartina alterniflora* Loisel., *S. patens* (Ait.) Muhl., and wood blocks were examined from the salt marshes bordering on Minas Basin, Kings Co., N.S. These collections were obtained from four salt marshes and 10 intertidal salt marsh pools. Twelve Ascomycetes, 10 Deuteromycetes, and 1 Basidiomycete are reported with 9 of these species being new records for Nova Scotia.

Introduction

This investigation of the marine fungi of Nova Scotia was preceeded by 4 studies (Meyers & Reynolds 1959; 1960; Moore & Meyers 1962; Neish 1970) that considered the lignicolous marine fungi of the province. However, little attention was given to the presence and diversity of fungi inhabiting substrate other than wood.

Gessner (1977; 1978) and Gessner and Goos (1973a; b) conducted a thorough investigation into the fungal decomposition of *Spartina alterniflora* Loisel. on the salt marshes of Rhode Island. Gessner and Kohlmeyer (1976) examined the geographical distribution of filamentous fungi from species of *Spartina* of the salt marshes along the eastern coasts of North and South America. From their 12 collection sites in eastern Canada, they reported the presence of *Buergenerula spartinae* Kohlm. et Gessner, *Leptosphaeria albopunctata* (Westend.) Sacc., *L. marina* Ellis et Everh., *L. neomaritima* Gessner et Kohlm., *Lulworthia* spp, *Mycosphaerella* sp II, *Phaeosphaeria typharum* (Desmaz.) Holm., *Phoma* sp, *Pseudorobillarda* sp, *Stagonospora* sp II, and *Cladosporium* spp. No indication of their geographical distribution within eastern Canada was given. A compilation of higher filamentous fungi growing on marine *Spartina* spp. was also reported (Gessner & Kohlmeyer 1976).

Minas Basin lies at the extreme north-east end of the Bay of Fundy in the north-central region of Nova Scotia, and because of the extreme high tides and extensive salt marshes, it offers a unique habitat for the development of fungi on wood and species of *Spartina*. These salt marshes also contain intertidal pools that present an opportunity for a comparative study of the fungal flora in another type of marsh habitat.

Materials and Methods

Collections of living and dead *Spartina alterniflora* Loisel. and *S. patens* (Ait.) Muhl. were taken from both marsh areas and intertidal pools. Collections were placed in polyethylene bags and incubated at room temperatures (21-26°C) until critically examined. Samples were taken on 9 August 1975 and on 9 November 1975 and were incubated for 49 and 48 days respectively. Locations of the collection sites are presented in Figures 17 to 20.

For the investigation of lignicolous fungi, wooden blocks (*Picea sp*) measuring 10 x 12.5 x 2.5 cm were attached to wooden stakes measuring approximately 4 x 50 x 1.5 cm. They were autoclaved at 121°C for one half h on 3 consecutive days (Johnson & Sparrow 1961). On 9 August 1975, 2 blocks were submerged in each of 10 pools by pushing the stake into the soft mud that formed the substrate. On 9 November 1975, 13 of the 20 blocks were recovered and put into polyethylene bags. At the laboratory the blocks were gently scraped and washed with distilled water to remove dense algal growths. They were then incubated for 47 days in autoclaved, interlocking glass dishes.

Squash mounts of sporocarps in sea water of 30 °/oo were adequate for most identifications. Permanent slides were prepared in Turtox mounting medium and in lactophenol-cotton blue sealed with fingernail polish (Munk 1957). Unused material

Table I. Distribution of fungal species within study areas and pools.

Species	Pools										Study Areas			
	1	2	3	4	5	6	7	8	9	10	A	B	C	D
Ascomycetes														
1. *Buergenerula spartinae*			a	a							a	a		
2. *Haligena spartinae*											b	b		
3. *Halosphaeria hamata*	b	b										b		
4. *H. mediosetigera*				c										
5. *Leptosphaeria albopunctata*											b			
6. *L. contecta*					b			b	c		b	a		b
7. *L. obiones*	a		a	a				b			b	c	c	b
8. *L. pelagica*													c	
9. *Lignincola laevis*				c	b	a	a		b		b	b	b	b
10. *Lulworthia* spp.	b	b	a	c	c	c	c	b	c	b		b	a	
11. *Nais inornata*					b	b	b	b						
12. *Phaeosphaeria typharum*		c		b	b	a	b			c	b	b		b
Deuteromycetes														
13. *Alternaria alternata*					b				b	b			b	
14. *Humicola alopallonella*	b		b			b	b							
15. *Penicillium* spp.		b			b			b					b	
16. *Pestalotia* sp.											a			
17. *Phoma* spp.		b	a	c	b	a	b	b			a	a		
18. *Stachybotrys atra*									b					
19. *Stagonospora* spp.		a					b			c	b			
20. *Stemphylium maritimum*								b						
21. *Trichoderma* spp.								b					b	
22. *Zalerion maritimum*	b													
Basidiomycetes													b	b
23. *Coprinus* sp.														

a = present on 9 August 1975; B = present on 9 November 1975; and c = present on both collection dates.

was stored in 10% glycerin-sea water with 0.1 g copper sulfate per 100 ml (Johnson & Sparrow 1961). These collections were recently reexamined and dried for placement in the E.C. Smith Herbarium, Acadia University (ACAD). In some cases identified species are not represented in the herbarium because of lack of material.

Results

Fungi collected from the salt marshes and intertidal pools are listed in Table I, together with their distribution and collection dates. Table II presents the substrates for each collection.

Fungi not previously recorded from Nova Scotia are *Buergenerula spartinae* Kohlm. et Gessner, *Halosphaeria mediosetigera* Cribb et. Cribb, *Leptosphaeria con-*

Table II. Substrates from which fungi were collected.

Species	Substrate			
	Sa	Sp	Wd	Cm
Ascomycetes				
1. *Buergenerula spartinae*	+			
2. *Haligena spartinae*	+			
3. *Halosphaeria hamata*	+	+		
4. *H. mediosetigera*	+		+	
5. *Leptosphaeria albopunctata*	+			+
6. *L. contecta*	+			
7. *L. obiones*	+	+		+
8. *L. pelagica*	+			
9. *Lignincola laevis*	+			
10. *Lulworthia* spp.	+		+	+
11. *Nais inornata*	+			+
12. *Phaeosphaeria typharum*	+	+		+
Deuteromycetes				
13. *Alternaria alternata*	+		+	+
14. *Humicola alopallonella*			+	
15. *Penicillium* spp.	+		+	+
16. *Pestalotia* sp.				+
17. *Phoma* sp.	+		+	
18. *Stachybotrys atra*			+	
19. *Stagonospora* spp.	+			
20. *Stemphylium maritimum*	+			
21. *Trichoderma* spp.	+		+	+
22. *Zalerion maritimum*			+	
Basidiomycetes				
23. *Coprinus* sp.				+

Sa = *Spartina alterniflora*; Sp = *Spartina patens*; Wd = wood; Cm = culm material, plant species not identified

tecta Kohlm., *L. obiones* (Crouan et Crouan) Sacc., *Lignincola laevis* Höhnk., *Nais inornata* Kohlm., *Phaeosphaeria typharum* (Desm.) Holm., *Humicola alopallonella* Meyers et Moore, and *Stemphylium maritimum* Johnson. *Stachybotrys atra* Corda is known from terrestrial habitats in Nova Scotia.

All of these fungi, with the exceptions of *Buergenerula spartinae, Phaeosphaeria typharum* (previously reported by Gessner and Kohlmeyer 1976), and *Humicola alopallonella* (previously reported by Hughes 1968) are also new records for eastern Canada as occurring in marine environments.

New records of fungi growing on species of *Spartina* are *Halosphaeria mediosetigera* Cribb et Cribb, *Leptosphaeria contecta* Kohlm., and *Coprinus* sp. (Pers. ex) Gray.

Fungal species that occurred on the marshes and not in the pools are *Haligena spartinae* Jones, *Leptosphaeria albopunctata* (Westend.) Sacc., *L. pelagica* Jones, and *Coprinus* sp. (Pers. ex) Gray.

Fungi occurring primarily in the intertidal pools are *Halosphaeria mediosetigera* Cribb et Cribb, *Lulworthia* spp, *Nais inornata* Kohlm., *Halosphaeria hamata* (Höhnk.) Kohlm., *Alternaria alternata* (Fr.) Keissl., *Humicola alopallonella* Meyers et Moore, *Penicillium* spp, *Phoma* spp, *Stachybotrys atra* Corda, *Stagonospora* spp, *Stemphylium maritimum* Johnson, and *Zalerion maritimum* (Linder) Anastiou. The remainder of the species reported were found in both habitats.

Taxonomic Section

ASCOMYCETES

(1) *Buergenerula spartinae* Kohlm. et Gessner: Can. J. Bot. 54: 1759. 1976. Fig 1.

(2) *Haligena spartinae* Jones: Trans. Brit. Mycol. Soc. 45: 245. 1962. Fig 2.

(3) *Halosphaeria hamata* (Höhnk) Kohlm.: Can. J. Bot. 50: 1951. 1972. Fig 3.

(4) *Halosphaeria mediosetigera* Cribb et Cribb: Pap. Univ. Queensland Dept. Bot. 3: 100. 1956. Fig 4.

(5) *Leptosphaeria albopunctata* (Westend.) Sacc.: Sylloge Fungorum 2: 72. 1883. Fig 5.

Johnson (1956) and Kohlmeyer & Kohlmeyer (1964-69) described this species as 5 to 7 septate. Neish (1970) reported a Nova Scotian collection from wood that was 6 to 8 septate, with the 8 septate condition being rare. In the collections we examined from *Spartina alterniflora,* 8-septate ascospores were common, and two 9-septate spores were observed.

(6) *Leptosphaeria contecta* Kohlm.: Nova Hedwigia 6: 314. 1963. Fig 6.

(7) *Leptosphaeria obiones* (Crouan et Crouan) Sacc.: Sylloge Fungorum 2: 24. 1883. Fig 7.

Previous reports (Gessner & Goos 1973a; b) of this fungus were as *L. discors* (Sacc. et. Ellis) Sacc. et Ellis, which Gessner and Kohlmeyer (1976) considered to be a synonym of *L. obiones.*

(8) *Leptosphaeria pelagica* Jones: Trans. Brit. Mycol. Soc. 45: 105. 1962. Fig 8.

(9) *Lignincola laevis* Höhnk.: Veröffentl. Inst. Meeresforsch., Bremerhaven, 3: 216. 1955. Fig 9.

(10) *Lulworthia* spp. Sutherland: Trans. Brit. Mycol. Soc. 5: 259. 1916.

We did not attempt to identify these species because, as Gessner and Kohlmeyer (1976) note, this genus requires critical revision. Hughes (1975) presents a review of the taxonomic problems involved. Ascospores of the Nova Scotian material measured 280-370 x 2.5-5.0 μm.

(11) *Nais inornata* Kohlm.: Nova Hedwigia 4: 409. 1962. Fig 10.

(12) *Phaeosphaeria typharum* (Desm.) Holm.: Symb. Bot. Upsal. 14 (3). 1957. Fig 11.

In a previous study (Gessner & Goos 1973b) of this species occurring on species of *Spartina,* this fungus was reported as *Leptosphaeria typharum* (Rabenh.) Karst. Gessner and Kohlmeyer (1976) have pointed out that this name is a synonym of *P. typharum.*

DEUTEROMYCETES

(13) *Alternaria alternata* (Fries) Keissler: Beih. Bot. Centr. 29: 434. 1912. Fig 12.

(14) *Humicola alopallonella* Meyers et Moore: Amer. J. Bot. 47: 346. 1960. Fig 13.

(15) *Penicillium* spp. Link: Sp. Pl. Fung. 1: 69. 1824.

(16) *Pestalotia* sp. deNot: Mem. R. Acad. Sci. Torino II, 3: 80. 1839.

(17) *Phoma* spp. (Fries) Desm.: Nat. Crypt. 13:6, 1846; Sacc., Michelia 2:4. 1880.
Many of the *Phoma* species are imperfect sages of other fungi, primarily Ascomycetes. The perfect stage is needed before the identification can be completed (Gessner & Kohlmeyer 1976).

(18) *Stachybotrys atra* Corda: Icon. Fung. 1:21. 1837. Fig 14.

(19) *Stagonospora* spp. Sacc.: Syll. Fung. 3: 445. 1884.

(20) *Stemphylium maritimum* Johnson: Mycologia 48: 841. 1956. Fig 15.

(21) *Trichoderma* spp. Pers. ex Fr.: Systema Myc. III. 214. 1829.

(22) *Zalerion maritimum* (Linder) Anastasiou: Can. J. Bot. 41: 1135. 1963. Fig 16.

BASIDIOMYCETES

(23) *Coprinum* sp. (Pers. ex) Gray: Nat. Arr. Brit. pl. 1: 632. 1821.
While incubating the collection bags, 3 sporocarps of a *Coprinus* sp developed within the bags. Attempts to culture the material failed.

Discussion

Gessner (1977) suggested that the presence of fungi on *Spartina alterniflora* appeared to be related more to the condition of the host plant than to temperature, salinity, or latitude. Gessner and Kohlmeyer (1976) reported the same tendency in their study of the geographical distribution of fungi growing on species of *Spartina.* Thus, Gessner (1977) proposed that there may be a characteristic fungal flora associated with species of *Spartina,* particularly *S. alterniflora.*

The results from this study are similar to those of Gessner (1977) and Gessner and Goos (1973a; b). Fungi common to both studies are *Buergenerula spartinae, Haligena spartinae, Halosphaeria hamata, Leptosphaeria albopunctata, L. obiones, Lulworthia* spp, *Nais inornata, Phaeosphaeria typharum, Penicillium* spp, *Phoma* spp, and *Stagonospora* spp. The fungi most frequently found in the Rhode Island study were *Alternaria* spp, *Buergenerula spartinae, Leptosphaeria obiones, Phaeosphaeria typharum, Phoma* sp, and *Stagonospora* sp. (as *Septoria* sp). The more common fungi from Minas Basin were *Buergenerula spartinae, Leptosphaeria obiones, Lignincola laevis, Lulworthia* spp, *Phaeosphaeria typharum,* and *Phoma* spp. Meyers (1974) and Meyers et al. (1970) reported a predominate fungal flora of *Cephalosporium, Fusarium, Leptosphaeria, Lulworthia, Nigrospora,* and *Phoma* from the Gulf of Mexico salt marshes indicating some variability in the mycoflora between the Atlantic seacoast and the Gulf of Mexico.

Salinity of the water flooding the marshes varied greatly, especially in areas A and D (see Fig 17) where estuarine waters are mixed with the freshwaters of the Cornwallis River. Differences of distribution between the marshes were not apparent. These data agree with Gessner (1977) who suggested that host condition was more important to fungal distribution than temperature or salinity.

Spartina alterniflora growing in the pools harbored a wider diversity of fungi than plants on the open marsh. The pattern was quite consistent for aerial parts of the

plant, but a different mycota was evident on the bases of plants growing in the water of the pools. This was a more suitable habitat for the development of typically marine species.

The only exclusively lignicolous species collected in the pools (on wood blocks) were *Humicola alopallonella, Stachybotrys atra,* and *Zalerion maritimum.* We did not attempt to collect lignicolous species from the open marsh.

Seasonal differences in the abundance of certain fungi were found. The only time *Buergenerula spartinae, Halosphaeria mediosetigera,* and *Leptosphaeria albopunctata* were collected was on 9 August 1975. Gessner (1977) found that *L. albopunctata* occurred only during June and July. However, he found that *Buergenerula spartinae* could be found on virtually 100% of the *Spartina* plants from September to April.

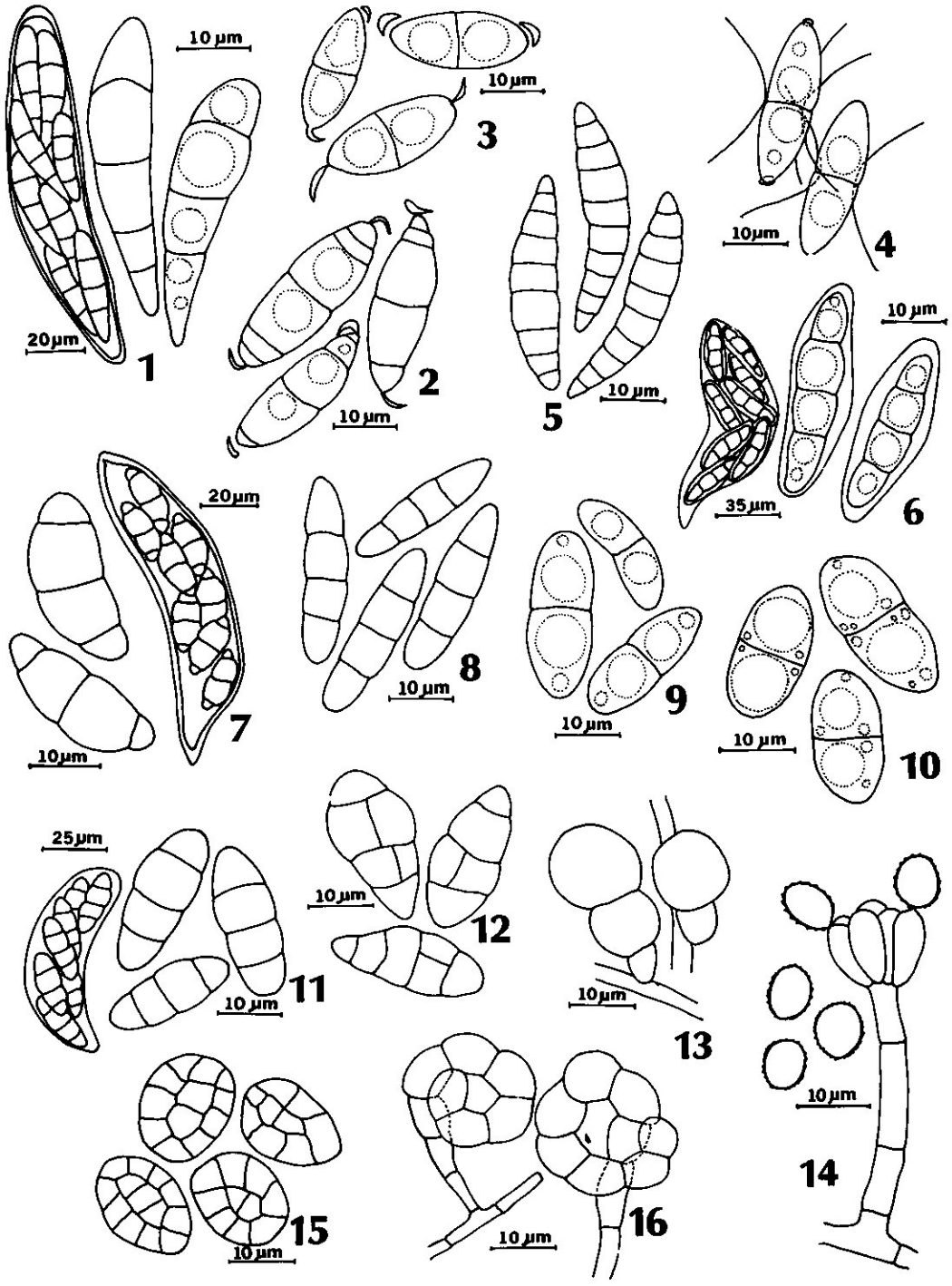
Fungi present on the 9 November 1975 collection were *Haligena spartinae, Halosphaeria hamata, Leptosphaeria albopunctata, Nais inornata, Alternaria alternata, Pencillium* spp, *Stemphylium maritimum, Trichoderma* spp, and *Coprinus* sp. Gessner (1977) found that *Halosphaeria hamata* was most common in September, *Alternaria alternata* in November, and *Leptosphaeria albopunctata* in June. *H. hamata* and *L. albopunctata* were not collected after September in a 2-year study by Gessner.

Gessner (1977) related seasonal patterns of fungal abundance to the developmental stages of *Spartina alterniflora.* In the spring, plants are invaded by weakly parasitic fungi; i.e., *Buergenerula spartinae, Phoma* spp, and *Phaeosphaeria typharum* (Gessner & Goos 1973b). Our data confirms that of Gessner and Goos (1973b). The above are followed by saprophytic fungi associated with the senescent leaves and inflorescences; the fungi we found were *H. hamata, L. albopunctata, L. obiones, L. laevis,* and *P. typharum.* These were followed by a variety of terrestrial and marine Ascomycetes on the dead standing plants and drift culm material. Fungi present were *Haligena spartinae, Leptosphaeria obiones, L. pelagica, Lulworthia* spp, and *Nais inornata.* The presence of such lignicolous species as *Halosphaeria mediosetigera, Lulworthia* spp, *Alternaria alternata,* and *Coprinus* sp suggests that these culms may be subjected to fungal attack similar to that of wood.

Gessner and Kohlmeyer (1976) have questioned whether fungi isolated by plate and moist chamber incubation techniques are normally active in a marine environment. Further studies are necessary to determine the role of fungi in the decomposition of organic matter in salt marshes.

Fig 1 *Buergenerula spartinae*, ascus and ascospores.
Fig 2 *Haligena spartinae*, ascospores.
Fig 3 *Halosphaeria hamata*, ascospores.
Fig 4 *Halosphaeria mediosetigera*, ascospores.
Fig 5 *Leptosphaeria albopunctata*, 8 and 9 septate ascospores.
Fig 6 *Leptosphaeria contecta*, ascus and ascospores.
Fig 7 *Leptosphaeria typharum*, ascus and ascospores.
Fig 8 *Leptosphaeria pelagica*, ascospores.
Fig 9 *Lignincola laevis*, ascospores.
Fig 10 *Nais inornata*, ascospores.
Fig 11 *Phaeosphaeria typharum*, ascus and ascospores.
Fig 12 *Alternaria alternata*, conidia.
Fig 13 *Humicola alopallonella*, conidia and conidiophore.
Fig 14 *Stachybotrys atra*, conidia and conidiophore.
Fig 15 *Stemphylium maritimum*, conidia.
Fig 16 *Zalerion maritimum*, conidia and conidiophore.

Figures 1 to 16 were prepared from camera lucida drawings.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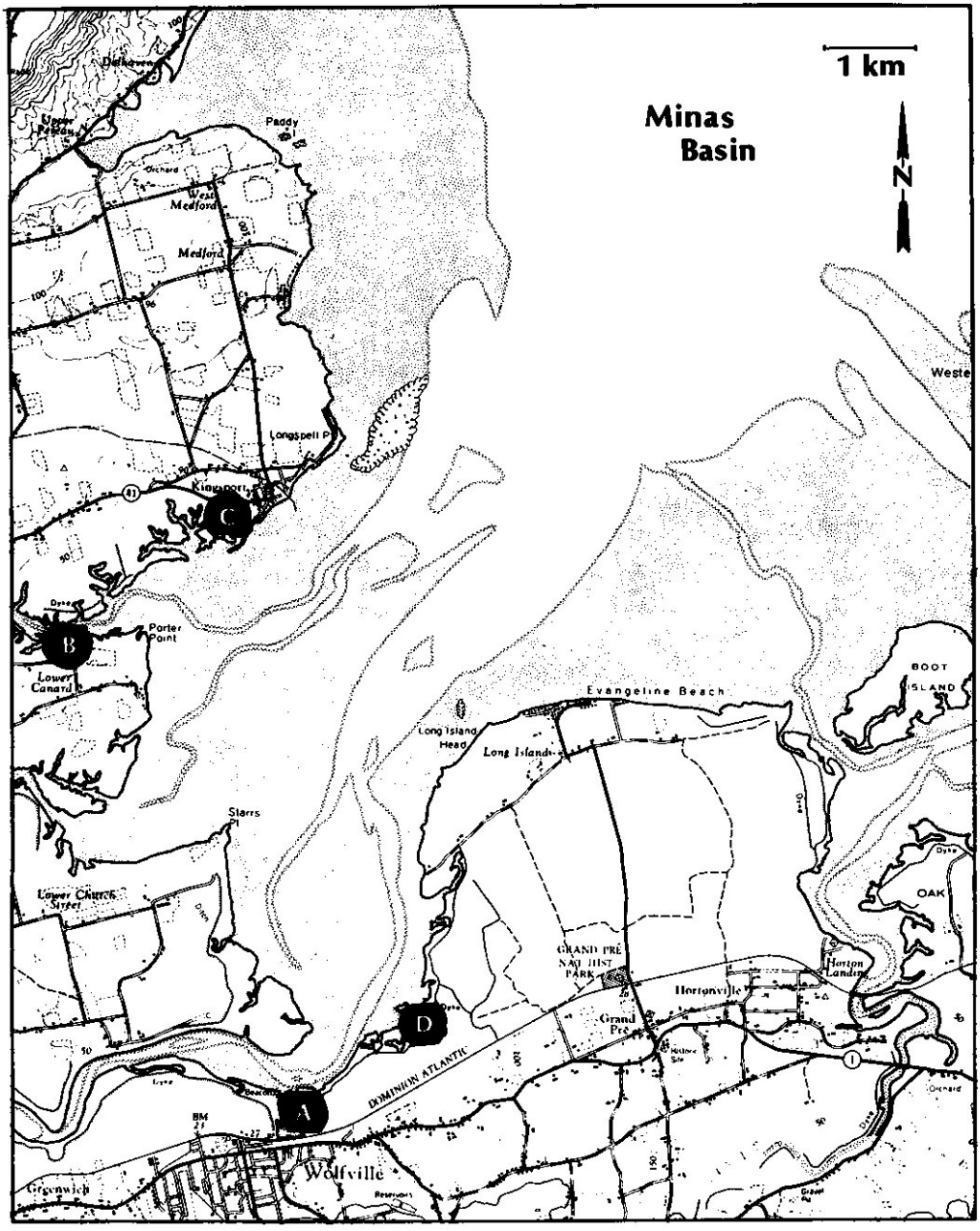

Fig 17 Map of southwest Minas Basin illustrating study areas A-D, prepared from Dept. of Energy, Mines, and Resources map 21H/1W-edit. 4ASE-Ser. A791-1967.

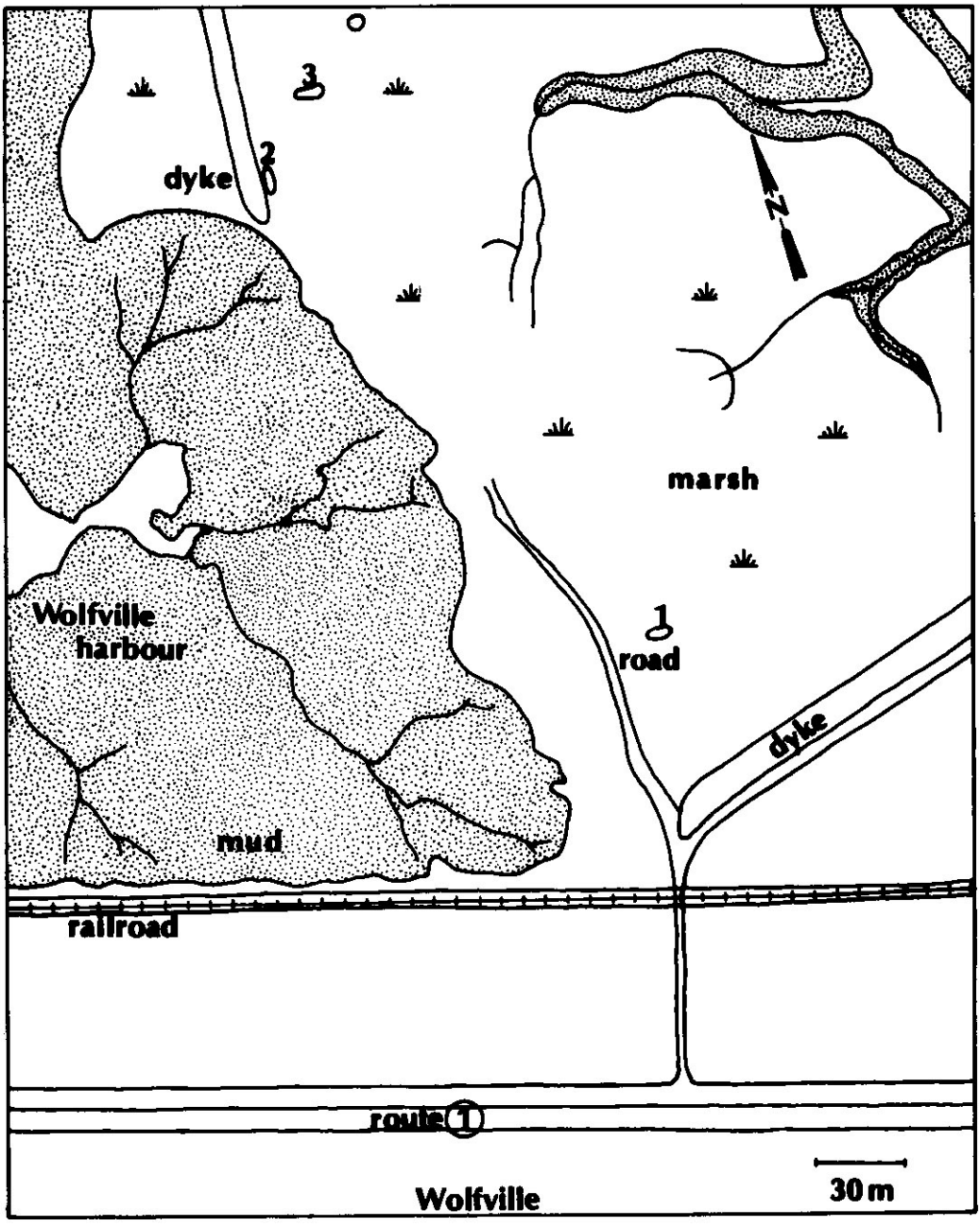

Fig 18 Study area A, location of pools 1-3.

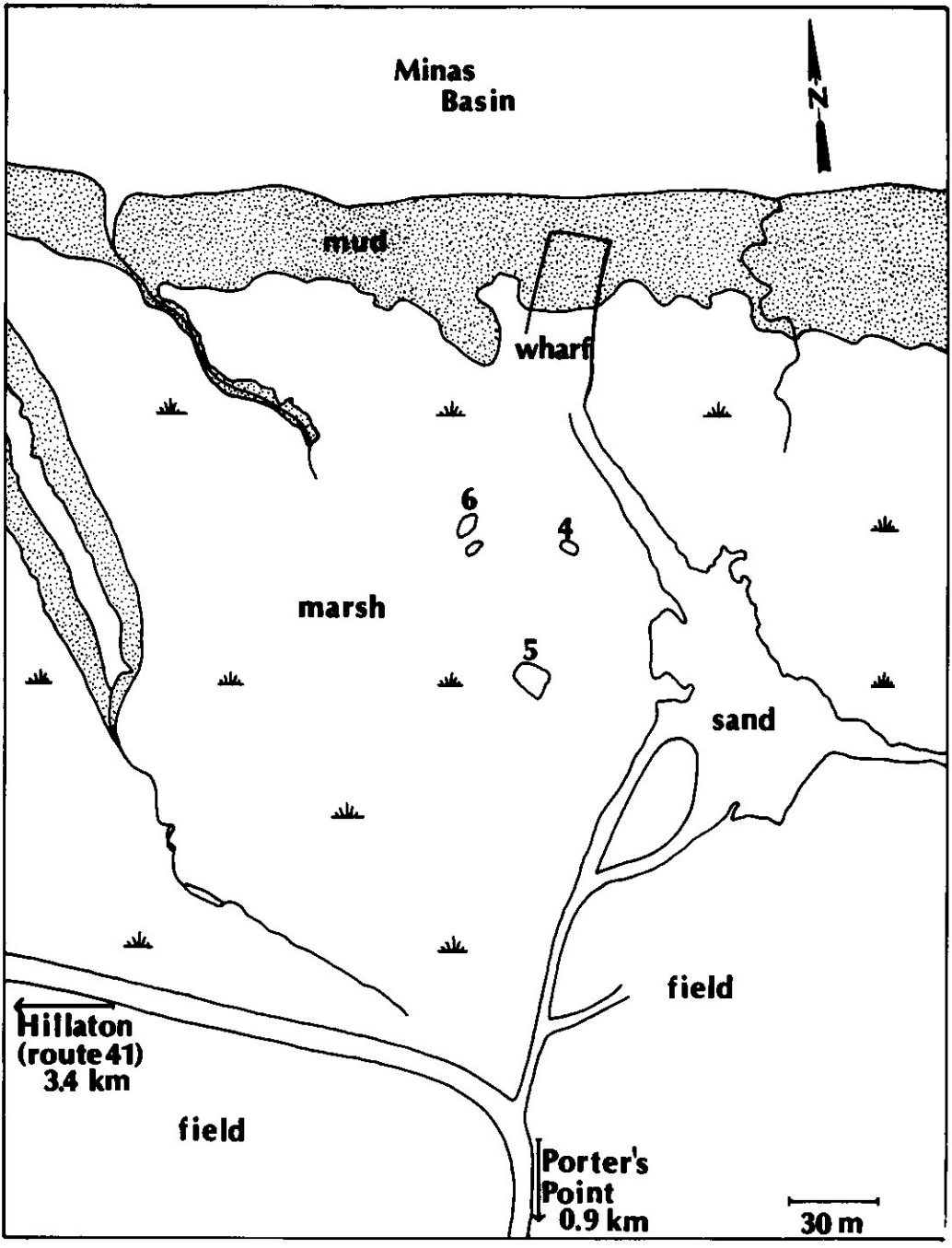

Fig 19 Study area B, location of pools 4-6.

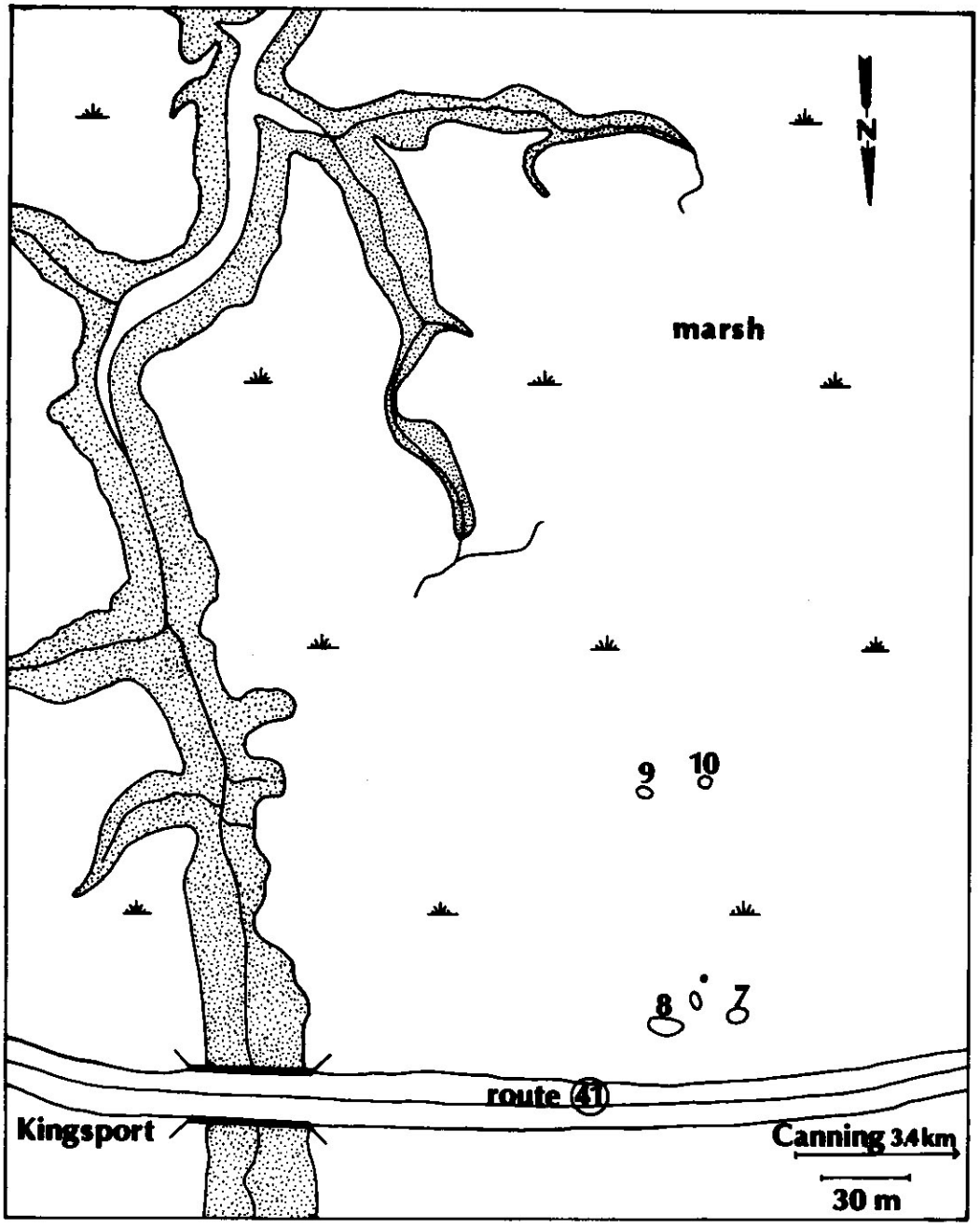

Fig 20 Study area C, location of pools 7-10; prepared from aerial photographs.

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References

Gessner, R.V. 1977. Seasonal occurrence and distribution of fungi associated with *Spartina alterniflora* from a Rhode Island estuary. *Mycologia,* 68: 477-491.

Gessner, R.V. 1978. *Spartina alterniflora* seed fungi. *Can. J. Bot.* 56: 2942-2947.

Gessner, R.V. and **Goos, R.D.** 1973a. Fungi from decomposing *Spartina alterniflora*. *Can. J. Bot.* 51: 51-55.

Gessner, R.V. and **Goos, R.D.** 1973b. Fungi from *Spartina alterniflora* in Rhode Island. *Mycologia,* 65: 1296-1301.

Gessner, R.V. and **Kohlmeyer, J.** 1976. Geographical distribution and taxonomy of fungi from salt marsh *Spartina*. *Can. J. Bot.* 54: 2023-2037.

Hughes, G.C. 1968. Intertidal lignicolous fungi from Newfoundland. *Can. J. Bot.* 46: 1409-1417.

Hughes, G.C. 1975. Studies of fungi in oceans and estuaries since 1961. I. Lignicolous, caulicolous and foliicolous species. *Oceanogr. Mar. Biol. Annu. Rev.* 13: 69-180.

Johnson, T.W., Jr. 1956. Marine fungi I. *Leptosphaeria* and *Pleospora*. *Mycologia,* 48: 495-505.

Johnson, T.W., Jr. and **Sparrow, F.K., Jr.** 1961. *Fungi in Oceans and Estuaries.* J. Cramer, Weinheim.

Kohlmeyer, J. and **Kohlmeyer, E.** 1964-1969. *Icones Fungorum Maris. Vol. I.* J. Cramer, Weinheim.

Meyers, S.P. 1974. Contribution of fungi to the biodegradation of *Spartina* and other brackish marshland vegetation. *Veroeff. Inst. Meeresforsch. Bremerhaven Suppl.* 5: 357-375.

Meyers, S.P. and **Reynolds, E.S.** 1959. Growth and cellulolytic activity of lignicolous Deuteromycetes from marine localities. *Can. J. Microbiol.* 38: 217-226.

Meyers, S.P. and **Reynolds, E.S.** 1960. Occurrence of lignicolous fungi in northern Atlantic and Pacific marine localities. *Can. J. Bot.* 38: 217-226.

Meyers, S.P., Nicholson, M.L., Rhee, J., Miles, P. and **Ahearn, D.G.** 1970. Mycological studies in Barataria Bay, Louisiana, and biodegradation of oyster grass, *Spartina alterniflora*. *La. State Univ. Stud. Coastal Stud. Ser.* 5: 111-179.

Moore, R.T. and **Meyers, S.P.** 1962. Thalassiomycetes III. The genus *Zalerion*. *Can. J. Microbiol.* 8: 407-416.

Munk, A. 1957. Danish Pyrenomycetes. A preliminary flora. *Dansk Bot. Ark.* 17: 1-491.

Neish, G.A. 1970. Lignicolous marine fungi from Nova Scotia. *Can. J. Bot.* 48: 2319-2322.