Occurrence of mushroom spores in faeces of adult ewes and lambs at Stóra-Ármót, 1995 and 1996. EKO-2 lamb project

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ICELANDIC SUMMARY

Skýrsla þessi var unnin fyrir Rannsóknastofnun landbúnaðarins, en verkefnisstjóri var Jóhann Þórsson. Verkefnið er samnorrænt (EKO-2 lamb project) og í því eru könnuð áhrif sveppaneyslu sauðfjár á magn geislavirks sesíns (^{134}Cs eða ^{137}Cs) í lambakjöti. Skýrslan fjallar um fjölda hattsveppagróa í sauðataði, en finnist slík gró í taðinu er gert ráð fyrir að sauðkindin hafi étið hattsveppi. Einnig eru tíundaðir þeir hattsveppir sem safnað var í beitarhólfinu í Stóra-Ármóti, Hraungerðishreppi, Árnessýslu (reitnúmer 4061, í 10x10 km reitakerfinu, 30-40 m.y.s.) sýnatökudagana 1. ágúst og 6. september bæði árið 1995 og 1996. Í hattsveppum í Skandinavíu hefur mælst upp í tífalt meira magn geislavirkra efna en í gróðrinum í kring og hefur því til dæmis mátt skýra aukna geislavirkni dádýrakjöts að haustlagi með sveppaáti þeirra. Taðsýni úr 7 fullorðnum ám og 7 lömbum (tekin 4 sinnum, alls 56 sýni) voru tekin beint í poka, þurrkuð og möluð og 0,0015 - 0,003g af þessu taðdufti var sett á smásjárgler og leitað þar að hattsveppagróum í 5 mínútur. Árið 1995 fundust gró í 18 af 28 sýnum, þar af leifar af sveppavef í 5 sýnum. Árið 1996 fundust gró í 12 sýnum af 28, og leifar sveppavefs í 4 þeirra. Algengasta sveppategundin í beitarhólfinu var *Stropharia semiglobata* og eins voru gró hennar algengust í taðinu, fundust í 14 sýnum. Ýmis önnur brún, misjafnlega stór, sporbaugótt gró fundust í taðsýnunum og voru þau talin tilheyra tegundum af ættkvíslunum *Psilocybe* eða *Panaeolus*. Stutt og digur dökkbrún gró voru álitin tilheyra tegund(um) af *Coprinus* ættkvíslinni en einu gróin fyrir utan gró *S. semiglobata*, sem tókst að greina með nokkurri vissu til tegundar, voru afar stórvörtótt gró *Inocybe* ógreindrar tegundar númer 1, sem safnað var í beitarhólfinu sama dag og taðið var tekið. Við sveppavefjarbútana héngu oftast eitt eða fleiri gró, þau voru öll ljósbrún, nokkuð hólklaga með ávalan framenda. Af þeim sveppum sem fundust í beitarhólfinu var aðeins ein tegund með gró af svipaðri lögun, *Inocybe* ógreind tegund númer 2, en gróin á vefjarbútunum geta auðveldlega tilheyrt einhverri óþekktri tegund. Líklega kenndu 3 ær lömbum sínum að éta sveppi, þótt ekki sé það sannað með þessari tilraun. Í september 1995 var sveppaát tilraunasauðkindanna mest en þá fundust að meðaltali 3,29 gró í taði fullorðinna en 1,57 gró í taði lamba en mánuði áður var það minnst, 0,86 gró hjá fullorðnum og 0,57 hjá lömbum.

1 INTRODUCTION

In this report the number of mushroom spores in each of the 56 faecal samples from Stóra-Ármót, Southern Iceland in 1995 and 1996 is presented. Also the number of mushrooms of each species collected at the 4 collection dates with a brief description of their spores.

Mushrooms are known to have 10 times higher levels of radiocaesium than the plants in the same area (Dahlberg *et al.* 1997) and thus if eaten by sheep may cause higher radiocaesium levels in their meat. Such an increase in roe deer meat and faeces during the autumn was explained by ingestion of mushrooms by the deer (Strandberg & Knudsen 1994).

In a study of plant selection by two oesophageal fistulated sheep grazing in a birch forest enclosure in Hallormsstadarskógur, mushroom appeared in the enclosure in late August 1981. The mushrooms were eaten by both sheep, and were up to 17% of their total consumption at that time (Anna G. Thórhallsdóttir & Ingvi Thorsteinsson 1993). These fragments of mushrooms were not identified further. Studies by Anna Gudrún Thórhallsdóttir and co-workers on sheep have shown that initially lambs learn from their mothers what to eat and what to avoid but later try for themselves and learn what to eat and what not from the experience following ingestion of a particular food (Anna G. Thórhallsdóttir & Ingvi Thorsteinsson 1993).

If sheep eat mushrooms, spores should be found in their faeces in proportion to the intake of mushrooms. To find out if Icelandic sheep, adult ewes and their lambs eat mushrooms, samples of their faecal material were collected (directly from the sheep), dried, ground and examined for mushroom spores. Mushrooms growing in the experimental plot were collected, dried and their spores compared to those found in the faeces.

2 METHODS

There were 4 collection dates for faeces and mushrooms; 1st of August 1995, 6th of September 1995, 1st of August 1996 and 6th of September 1996. Faeces was collected directly from the sheep, dried at 60°C and ground. For analysis of mushroom spores, a 0,0015-0,003 g sample of powdered faeces was placed in a drop of water on a microscope slide, and spread out to fit the cover glass. Examined for spores for 5 minutes and their colour, shape and size recorded in an attempt to identify them to a mushroom genus or species.

The mushrooms from each date were placed in one container and dried at 60°C. The dried mushrooms were sorted as to a species (taxa) and counted. From a specimen of each species, a small part of the gills was examined for spores and their colour, shape and size used to separate the taxa and when possible to identify the species.

3 RESULTS AND DISCUSSION

The number of mushroom spores found in each sample is shown in tables 1-8. In 1995 spores were found in 18 of the 28 samples but in 1996 in 12 of 28 samples. In 9 samples

fragments of fungal tissue were found (see tables 1-8). These fragments were pale in colour, granular in texture and attached to most of them were one or more spores, fragment size from 30x25 µm to100x40 or 80x95 µm. In one fragment the hyphae were well preserved but in most of them individual hyphae were not clearly separated, for details on fragment size and number of spores attached see tables 9 and 10.

Looking at the number of mushrooms collected at the experimental plot (table 11) and the mean of spores found in faecal samples from a particular date (tables 1-8), the mean of spores is lowest, ewes 0.86 and lambs 0.57, on 1st of August 1995 when only 7 mushrooms were collected. The highest mean, ewes 3.29 and lambs 1.57, is on 6th of September 1995 when 33 mushrooms were collected. The highest number of mushrooms (99), was collected on 1st of August 1996, all but one *Stropharia semiglobata* but on 6th of September 1996 the 48 mushroom collected belonged to 14 species (taxa), representing the greatest species diversity. Thus very few mushrooms in the area may result in lower count of spores in the faeces. The increased variety of mushroom species did not seem to result in increased number of spores found in the faeces.

At each collection date the mean of spores in faeces of ewes was higher than or even to that of lambs, the number of spores usually highest in the samples where fragments of fungal tissue were found.

At all 4 collection dates, *Stropharia semiglobata* was the most common species and so were its spores in the faeces, found in 14 samples. However, the spores attached to the tissue fragments were light brown and nearly cylindrical with a round apex, 10-14x4-6 µm, *Inocybe* sp. 2 being the only species from the experimental plot with spores close to that description. The spores and tissue fragments may well belong to a different unknown species. Brown, ellipsoid spores, smaller than those of *S. semiglobata*, were found in several samples those presumably belonging to more than one species of the coprophilous fungi of the genera *Psilocybe* and *Panaeolus*. Short, (dark) brown spores were also encountered probably belonging to one or more species of *Coprinus*. Apart from *S. semiglobata*, the only other species which could be identified both as spores in one sample of faeces (ewe number 812, 06.09.1995) and as sporocarps from the plot was *Inocybe* sp. 1. Its coarsely nodulate spores were first counted as spores, then incorrectly considered a debris (a spore would not be like that!) but when the mushrooms from that date were examined and one with such spores was found, the “debris” was reinstated as spores.

No white (hyaline) spores were found in the faecal samples, the only dark brown spores found were those subglobose-(angular), presumed to belong to *Coprinus* sp., and no ellipsoid to cylindrical dark brown spores were found. None of the spores from the faeces were of *Leccinum scabrum*, the brown birch boletus.

In August 1995 spores were found in faeces of 3 ewes but only one of them had lamb which had ingested mushrooms. In September 1995 all sheep had spores in their faeces and all but one of the lambs. In August 1996 two of the ewes had spores in their faeces and so did their lambs and 4 other lambs. In September 1996 three ewes had spores in their faeces and so did one of their lambs while the other lamb that had spores in its faces had a mother that had ingested mushrooms in August but not in September. Thus in 1995 ewe number 22 ate mushrooms on both sampling dates and so did its lamb number 150 but in September 1995 mushrooms were eaten by all experimental sheep except one lamb. In 1996 ewe number 16 and its lamb number 149 ate mushrooms on both sampling dates,

tissue fragments found in both samples from the mother and in one from its lamb. The other ewe which ate mushrooms in August (but not in September), number 313, had a lamb (number 171) which did so on both sampling dates. Thus based on this experiment some sheep may introduce their lambs to mushrooms as part of their food. In 1995 mushroom intake increased from August to September but not in 1996.

4 REFERENCES

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Table 1. Number of mushroom spores in faecal samples from ewes 01.08.1995.

Ewes number	number of spores	fungal tissue
17	0	
22	3	
205	0	
209	0	
224	1	
812	2	
816	0	

SD= 1.2150
mean =0.8571
No fungal tissue was observed

Table 2. Number of mushroom spores in faecal samples from lambs 01.08.1995.

Lambs number	number of spores	fungal tissue
118	0	x
150	1	
151	0	
154	3	
158	0	
164	0	
166	0	

SD= 1.1339
mean = 0.5714
In one sample two fragments of fungal tissue were observed.

Table 3. Number of mushroom spores in faecal samples from ewes 06.09.1995.

Ewes number	number of spores	fungal tissue
17	2	x
22	4	
205	2	
209	8	x
224	1	
812	4	
816	2	

SD= 2.3604
mean = 3.2857
In two samples a fragment of fungal tissue was observed.

Table 4. Number of mushroom spores in faecal samples from lambs 06.09.1995.

Lambs number	number of spores	fungal tissue
118	2	
150	1	
151	3	
153	0	
158	1	
164	1	x
166	3	x

SD= 1.1339
mean= 1.5714
In two samples a fragment of fungal tissue was observed.

Table 5. Number of mushroom spores in faecal samples from ewes 01.08.1996.

Ewes number	number of spores	fungal tissue
16	6	x
203	0	
209	0	
313	3	
411	0	
418	0	
420	0	

SD= 2.3604
mean= 1.2857
In one sample a fragment of fungal tissue was observed.

Table 6. Number of mushroom spores in faecal samples from lambs 01.08.1996.

Lambs number	number of spores	fungal tissue
90	1	
117	3	x
118	0	
123	3	
132	0	
149	1	
171	1	

SD= 1.2536
mean= 1.2857
In one sample a fragment of fungal tissue was observed.

Table 7. Number of mushroom spores in faecal samples from ewes 06.09.1996.

Ewes number	number of spores	fungal tissue
16	5	x
203	0	
209	0	
313	0	
411	2	
418	0	
420	1	

SD= 1.8645
mean= 1.1429
In one sample a fragment of fungal tissue was observed.

Table 8. Number of mushroom spores in faecal samples from lambs 06.09.1996.

Lambs number	number of spores	fungal tissue
90	0	
117	0	
118	0	
123	0	
132	0	
149	5	x
171	1	

SD= 1.8645
mean= 0.8571
In one sample a fragment of fungal tissue was observed.

Table 9. Type of spores in faeces of ewes and lambs at Stóra-Ármót 1995.

	number of spores	size of tissue µm	mushroom species or spore color shape and size
Ewes number	**01.08.1995**		
17	0		
22	3		2 *Stropharia semiglobata* 1 *Panaeolus* sp. ?(sp. 13x7 µm, ellipsoid)
205	0		
209	0		
224	1		1 *Psilocybe* sp. ? (sp. 13x8 µm, brown, asymmetrical, oval-ellipsoid)
812	2		1 *Psilocybe* sp. ? (sp. 9x6 µm, brown, smooth-walled, ellipsoid) 1 Unknown (sp. 10x4µm, light brown, ellipsoid-cyl., covered with hyaline material)
816	0		
Lambs number	**01.08.1995**		
118	0	size ?	No spores on tissue
150	1		1 Unknown (sp. 8x5 µm, brown, smooth-walled, short-ellipsoid)
151	0		
154	3		3 *Stropharia semiglobata*
158	0		
164	0		
166	0		
Ewes number	**06.09.1995**		
17	2	32x22	1 *Coprinus* sp. ?, (sp. 8x7 µm, brown, smooth-walled, subglob. to hexagonal) 1 Unknown (*Inocybe* ?), (sp. 14x4.5 µm, light brown, short-clavate), on tissue
22	4		3 *Stropharia semiglobata* 1 Unknown, (sp. 14x6 µm, brown, spindle shaped, smooth-walled)
205	2		1 *Coprinus* sp. ?, (sp. 11x10 µm, brown, subglobose, smooth-walled) 1 *Cortinarius* sp. ?, (sp. 12x6 µm, brown, rough-walled, short-spindle shape)
209	8	100x 40	1 *Stropharia semiglobata* 7 Unknown (*Inocybe* ?), (sp. 12-13x4 µm, light brown, cylindrical, tapering to base, smooth-walled), all on tissue
224	1		1 Unknown, (sp. 10x7 µm, pale brown, oval, cracks or ridges on surface)
812	4		2 *Stropharia semiglobata* 2 *Inocybe* sp. 1, (sp. brown, surface with big warts, shape irregular)
816	2		1 *Stropharia semiglobata* 1 Unknown (*Cortinarius* ?), (sp. 7x7 µm, brown, some sides angular, surface irregularly ornamented)
Lambs number	**06.09.1995**		
118	2		2 *Stropharia semiglobata*
150	1		1 *Stropharia semiglobata*
151	3		1 *Stropharia semiglobata* 2 *Coprinus* sp.?, (sp. 8x5-8 µm, dark brown, subglob. to triangular)
153	0		
158	1		1 Unknown (*Inocybe* ?), (sp. 10x5 µm, light brown, cylindrical, surface nearly smooth)
164	1	80x95	1 *Coprinus* sp. ?, (sp. 10x9 µm, dark brown, oval-(angular), smooth-walled). No spores on tissue
166	3	65x40	1 *Stropharia semiglobata* 2 Unknown (*Inocybe* ?), (sp. 11.5-12x6 µm, pale brown, nearly cylindrical with round apex, smooth-walled), on tissue

Table 10. Type of spores in faeces of ewes and lambs at Stóra-Ármót 1996.

	number of spores	size of tissue µm	mushroom species or spore color shape and size
Ewes number	**01.08.1996**		
16	6	58x45	1 Unknown, (sp. 10x6 µm, dark brown, oval, smooth-walled) 5 Unknown (*Inocybe* ?), (sp. 10x5 µm, brown, nearly cylindrical, smooth-walled), on tissue
203	0		
209	0		
313	3		1 Unknown, (sp. 12x6 µm, light brown, ellipsoid-cyl., smooth-walled) 2 Unknown, (sp. 11x8 µm, brown, broad-ellipsoid, few big warts on surface)
411	0		
418	0		
420	0		
Lambs number	**01.08.1996**		
90	1		1 *Stropharia semiglobata*
117	3	44x30	3 Unknown (*Inocybe* ?), (sp. 12x6 µm, light brown, ellipsoid- cyl., smooth-walled), on tissue
118	0		
123	3		3 *Stropharia semiglobata*
132	0		
149	1		1 Unknown, (sp. 8x3 µm, light brown, cylindrical, smooth-walled)
171	1		1 *Stropharia semiglobata*
Ewes number	**06.09.1996**		
16	5	70x30	5 Unknown (*Inocybe* ?), (sp. 12x6 µm, light brown, ellipsoid- cyl. broadest at the apex, smooth-walled), on tissue
203	0		
209	0		
313	0		
411	2		2 *Stropharia semiglobata*
418	0		
420	1		1 Unknown, (sp. 12x6 µm, light brown, spindle shaped)
Lambs number	**06.09.1996**		
90	0		
117	0		
118	0		
123	0		
132	0		
149	5	50x30	5 Unknown (*Inocybe* ?), (sp. 10x4 µm, light brown, ellipsoid- cyl., smooth-walled), on tissue
171	1		1 *Psilocybe* sp. ? (sp. 12x6 µm, brown, ellipsoid, smooth-walled)

Table 11. Mushrooms collected from the experimental plot in Stóra-Ármót in 1995 and 1996.

number of mushrooms	species, or a brief description of the mushroom and its spores
01.08.1995	
7	*Stropharia semiglobata* (collected on horse dung)
06.09.1995	
29	*Stropharia semiglobata*
1	*Russula* sp.
1	*Entoloma* sp., spores angular, 1 central oil drop, 7.5-8x 7 µm short pedicel, tapering to the end
1	*Inocybe* sp. 1; spores with big warts, asterospores and a central oil droplet, shapes different, 8-10x6-6.5 µm
1	spores pale brown, ellyptical-(fusiform), 12x6.5 µm
01.08.1996	
98	*Stropharia semiglobata*
1	spores light brown, smooth-walled, irregular ellipsoid-cyl, 10-12x5-6 µm
06.09.1996	
29	*Stropharia semiglobata*
3	*Inocybe* sp. 2, spores brown, smooth-walled, ellipsoid-cyl., longer in a ripe specimen, 8-14x6 µm. The younger has shorter spores but gradient between the two
1	*Laccaria laccata*
2	*Stropharia alpina*
1	*Mycena* sp., grey with yellowish stem, spores hyaline, dacry-long, granular content, 10-12.5x5-6 µm
1	*Collybia dryophila*?, cap white, stem light brown, white below and broader, in moss, gills decurrent, spores white, dacry- ellipsoid, 6x4 µm.
1	small mushroom, brown, spores strong brown, wall smooth but relatively thick, oval, rear end is wider, 8-10x6 µm.
1	pointed cap, light brown, spores brown, relatively thick-walled, ellipsoid, apical germ pore; 11-12x6-8 µm.
1	spores brown, smooth-walled, apical germ pore, ellipsoid; 12-13x6.5-7 µm.
3	cap thin, spores brown, smooth-walled, apical germ pore; 12-14x6.5-7 µm. On dung.
1	dark brown spores, apical germ pore, long-ellipsoid, smooth-walled, 19-22x10 µm.
2	rather tall, cap white with grey in the middle, spores white, subglobose, filled with oil, smooth-walled; 11-12x10 µm.
1	pale colored mushroom, medium size, gills decurrent, spores hyaline, smooth-walled, oval or dacry- the front end wider; 6x4 µm.
1	young, thick, stem short, whitish mushroom without spores.