

Coccidia of the genus *Eimeria* in sheep in Iceland

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SUMMARY

Coccidia (*Eimeria* spp.) are common in sheep in Iceland but little has been known about which species of *Eimeria* occur, their prevalence or intensity.

In November 1993 faecal samples were collected from six (7 months old) lambs and in early June 1994 from two (one month old) lambs on the same locality.

Altogether 9 or 10 species of *Eimeria* were found. Those were *Eimeria ahsata*, *E. bakuensis*, *E. crandallis*, *E. faurei*, *E. intricata*, *E. ovinoidalis*, *E. pallida*, *E. parva*, *E. weybridgensis* and possibly *E. granulosa*. It is notable that so many species were found in this limited study since only about 15 species of *Eimeria* in sheep have been described world-wide and only 12 of those are generally accepted as valid.

The information gathered in this study on the occurrence of the *Eimeria* species indicates that there are seasonal and/or host-age related differences in the prevalence and/or intensity of several of the species.

Key words: Coccidia, *Eimeria*, Iceland, sheep.

YFIRLIT

Hnísildýr (Eimeria-tegundir) í sauðfé á Íslandi

Hnísildýr af ættkvíslinni *Eimeria* eru einfrumungar (gróðýr) sem fjölga sér í þarmafrumum í meltingarvegi ýmissa dýra. Að því loknu mynda einfrumungarnir um sig þolhjúp, kallast þá hníslar og berast út með saur hýsla sinna. Á því stigi geta þeir lifað í marga mánuði, jafnvel ár, í umhverfinu, þar til þeir berast ofan í næsta hýsil. Fjöldi hnísla í grammi saurs er oft notaður sem mælikvarði á sýkingu. Hnísildýrategundirnar eru bundnar við eina hýsiltegund, eru misskæðar og ná auk þess líklega hámarki á mismunandi árstímum og í mismunandi gömlu fé. Í lömbum geta sumar tegundanna valdið niðurgangi, dregið verulega úr þroska lambanna og jafnvel dregið þau í stöku tilfellum til dauða. Fullorðið fé hefur aftur á móti myndað verulegt ónæmi og veikist ekki.

Hnísildýr af ættkvíslinni *Eimeria* eru algeng í sauðfé á Íslandi. Heildarfjöldi *Eimeria*-hnísla (hníslar allra tegundanna lagðir saman) í saur er mestur í 2–4 vikna gömlum lömbum í byrjun sumars þegar beitt er þröngt í nágrenni bæjanna. Fjöldi hnísla í grammi saurs getur þá náð milljónum og oft verður vart við skitu. Yfir sumarið eru lömbin aftur á móti á mun rýmra beutilandi og heildarfjöldi hnísla í saur minnkar verulega. Á haustin er fénu yfirleitt safnað saman á sömu beutilöndin í nágrenni bæjanna og næstu 1–2 mánuði fjölga hníslunum, í g lambasaurs, oft upp í hundruð þúsunda og stundum verður hníslasóttar vart. Tilraunaniðurstöður hér á landi hafa ennfremur gefið greinilega vísbendingu um að hníslasýking geti dregið verulega úr þrifum lamba á þröngri haustbeit þar sem sauðfé hefur verið beitt um sumarið og það náð að hníslamenga landið. Yfir veturinn minnkar heildarhníslafjöldinn í lömbunum. Í fullorðnu fé er fjöldi hnísla í g saurs oftast lítill, aðeins nokkur hundruð, en hækkar örlítið í byrjun sumars og seint á haustin, samtímis hækkunum í lömbunum.

Mjög lítið hefur verið kannað hvaða tegundir *Eimeria* finnast í sauðfé á Íslandi og ekki hefur verið rannsakað hver tíðni einstakra tegunda er í misgömlu fé og á mismunandi árstímum.

Í nóvember 1993 voru tekin saursýni úr sex (7 mánaða gömlum) lömbum og í byrjun júní 1994 úr tveimur (mánaðar gömlum) lömbum á sama staðnum í nágrenni Reykjavíkur. Heildarfjöldi hnísla í g saurs í hverju lambi var talinn og hníslum safnað úr sýnunum, bæði fyrir og eftir svonefnda grómyndun. Hníslarnir voru mældir, önnur greiningaratriði skoðuð og eintök af hverri tegund ljósmynduð. Hlutfall einstakra tegunda var metið (nóvember) eða talið (júní).

Alls fundust 9 eða 10 tegundir hnísla. Þær voru *Eimeria ahsata*, *E. bakuensis*, *E. crandallis*, *E. faurei*, *E. intricata*, *E. ovinoidalis*, *E. pallida*, *E. parva*, *E. weybridgensis* og hugsanlega *E. granulosa*.

Einstaklingafjöldi margra tegundanna í saur lambanna var mjög misjafn eftir árstímum. Bendir það til að árstíðabundinn munur, og/eða munur tengdur aldri hýsilsins, sé á tíðni þeirra í sauðfé hér á landi.

Í sauðfé hefur um 15 tegundum hnísildýra verið lýst í heiminum en þar af eru aðeins 12 almennt viðurkenndar. Með tilliti til þess hve fá lömb voru rannsökuð, öll frá sama stað og sýni aðeins tekin tvisvar, þá er það athyglivert að 9 eða 10 tegundanna fundust í þessari rannsókn.

INTRODUCTION

The Icelandic sheep is a special race which belongs to the Northern European short-tailed group of sheep. It was brought to Iceland during the settlement of the country which took place during the years 874–930 and originates from Norway and the British Isles. In the last centuries and up to 1933, sheep of other races have been imported several times to the country for interbreeding but they have probably only had limited influence on the breed. The imported sheep have come from Denmark, Scotland and Germany but in several cases the country of origin is not known (Aðalsteinsson, 1980; Eylands *et al.*, 1947).

Coccidia (*Eimeria* spp.) have been shown to be common in sheep in Iceland (Richter, 1974, 1976, 1977, 1979; Richter *et al.*, 1981, 1983; Richter og Eydal, 1985). The highest total oocyst numbers per gram of faeces (opg) are observed in lambs, 2–4 weeks old, during early summer (May/June), when they are grazing at high stocking rates near the farms. The opg counts per individual can reach hundreds of thousands, or even millions, and diarrhoea is often observed at that time. During the summer the sheep are grazed at much lower stocking densities, either on lowland pastures of large areas or highland pastures of vast areas and as a consequence the total opg in lambs then decreases. In the autumn (September) the sheep are herded back to the same pastures as in early summer and during the

next 1–2 months a considerable rise in total opg in lambs is seen, often to hundreds of thousands, and coccidiosis is sometimes observed. Furthermore, experimental results in Iceland have clearly indicated that coccidiosis can reduce the growth rate of lambs which are intensively grazed in the autumn on pastures where sheep have grazed during the summer and contaminated the pastures with coccidia (Richter *et al.*, 1983). During the winter the sheep are housed and the total opg number in the lambs decreases. In adult sheep the opg is usually low, only a few hundreds, but rises slightly during early summer and in late autumn coinciding with the rise in the lambs.

Little however has been known about which species of *Eimeria* occur in sheep in Iceland, their prevalence or intensity. In 1984 a limited study was performed on what species could be found in lambs grazing on highland summer pastures (Auðkúluheiði) in Iceland. Faecal samples from 3 lambs, 2–3 months of age were collected on one occasion and the following species were identified: *E. ahsata*, *E. crandallis* and/or *weybridgensis*, *E. faurei*, *E. intricata*, *E. ovina* (= *bakuensis*), *E. parva* and probably *E. ovinoidales* (Matthías Eydal, personal communication).

MATERIALS AND METHODS

On the 10th of November 1993 faecal samples were collected from 6 apparently healthy

lambs, seven months old, and on the 11th of June 1994 samples were collected from 2 apparently healthy lambs, one month old, at the same locality (Fjárborgir) near Reykjavík.

Preparation of samples

Each sample was divided into three parts (a, b and c) and prepared as follows:

- a) Counting of oocysts: A modified McMaster salt-flotation technique and McMaster counting chambers were used for counting the number of oocysts per g faeces (opg) (Helle, 1971).
- b) Isolation of unsporulated oocysts: A formaldehyde ethyl acetate sedimentation technique was used in order to isolate and sediment the oocysts (Allen and Ridley, 1970; Young *et al.*, 1979). A concentrated NaCl suspension was then added to the sediment in a 15 ml centrifugal tube and the tube filled up to the rim so that a convex surface reached above the rim of the tube. A coverslip was then placed over the opening and the tube was left standing for 5–10 minutes while the oocysts were ascending. The coverslip was then lifted carefully so that the surface of the fluid followed as a drop. The coverslip was then put on a microscope slide and the drop studied under a microscope.
- c) Isolation of sporulated oocysts: The sample was put on a petri dish, cut into small pieces and covered with 4% potassium dichromate ($K_2Cr_2O_7$) solution in order to prevent the growth of fungi and bacteria. The lid was then put on the petri dish to prevent drying out. The sample was kept at approx. 20°C for 9 days. Then the oocysts were isolated in the same manner as described under b).

Identification of species

The oocysts were searched for at 125× magnification but species identification was performed at 500–1250× magnification.

The species were identified by measuring the length and breadth of the oocysts and the

sporozoites; by studying their shape and by the presence or absence of a micropyle on the oocysts. The size and shape of the sporocyst residuum in the sporozoites was also noted. Other distinctive features were also taken into consideration such as colour, texture, size of large refractile globule in the sporozoites, the orientation of sporozoites and the presence or absence of a polar granule in the oocyst.

The dimensions and other features of the oocysts were then compared with identification keys for species identification (Shah, 1963; Joyner *et al.*, 1966; Anonymous, 1986; Gregory *et al.*, 1987; O'Callaghan *et al.*, 1987; Barutzki and Gothe, 1988; Rommel, 1992). The nomenclature of the species is based on Rommel (1992).

Photography

The oocysts were photographed with a Leitz Orthoplan light-microscope, using a 100× oil-immersion lens and a green filter. The film used was a black and white 100 iso Kodak Tmax.

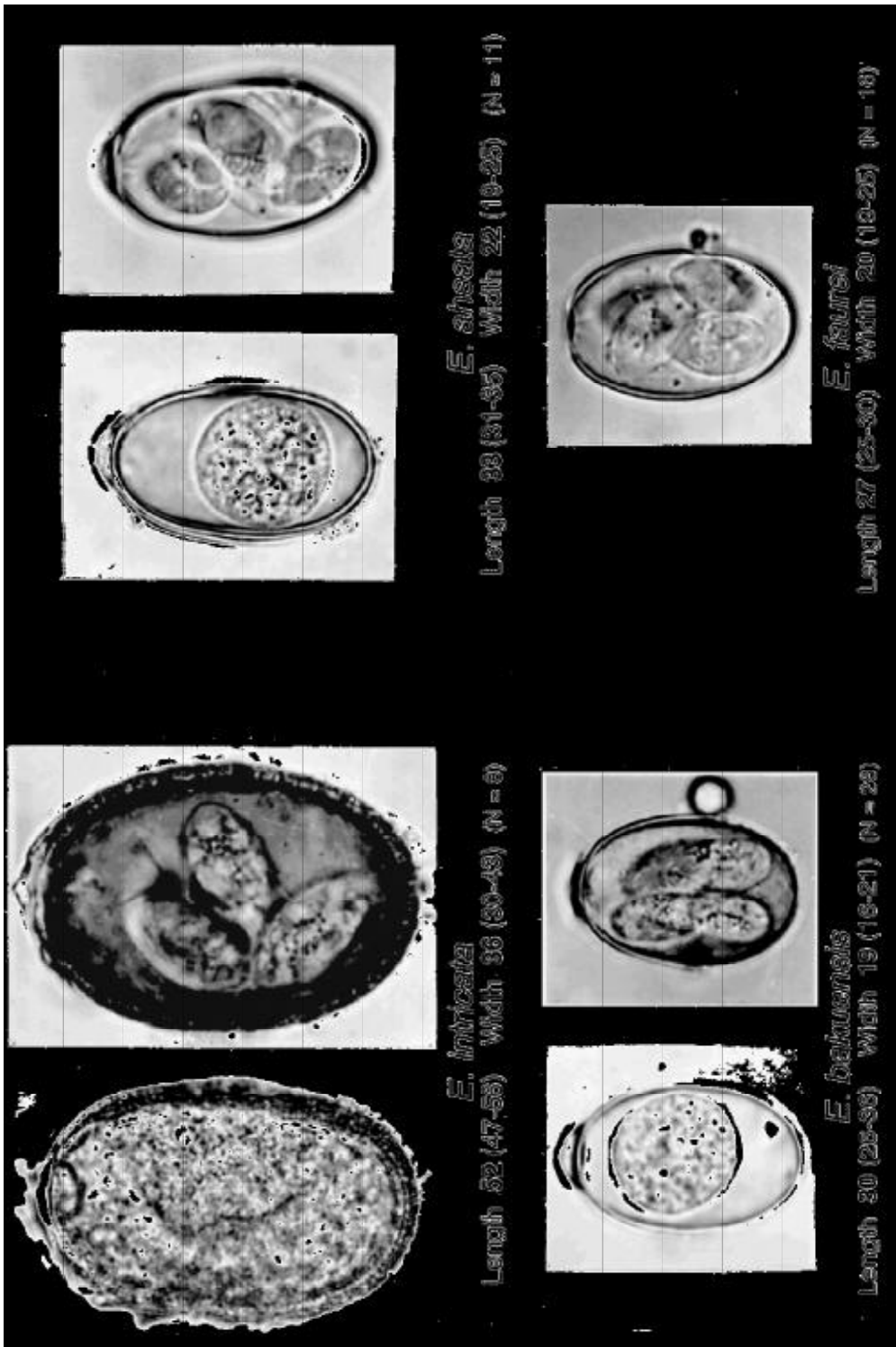
RESULTS AND DISCUSSION

The species

Altogether 9 or 10 species of *Eimeria* were found. Those were *Eimeria ahsata* Honess, 1942; *E. bakuensis* Musaev, 1970; *E. crandallis* Honess, 1942; *E. faurei* Moussu and Marotel, 1902; *E. intricata* Spiegl, 1925; *E. ovinoideal* McDougald, 1978; *E. pallida* Christensen, 1938; *E. parva* Kotlan, Moscy and Vajda, 1929; *E. weybridgeensis* Norton, Joyner and Catchpole, 1974 and possibly *E. granulosa* Christensen, 1938. Photographs and other information on the species found are shown in Figure 1. It should be noted that the identification of *E. granulosa* is only based on a single oocyst (Figure 1).

In sheep, 15 species of *Eimeria* have been described world-wide but only 12 of those are generally accepted as valid (Barutzki and Gothe, 1988).

The 10 species found in this study have all been found widely distributed around the



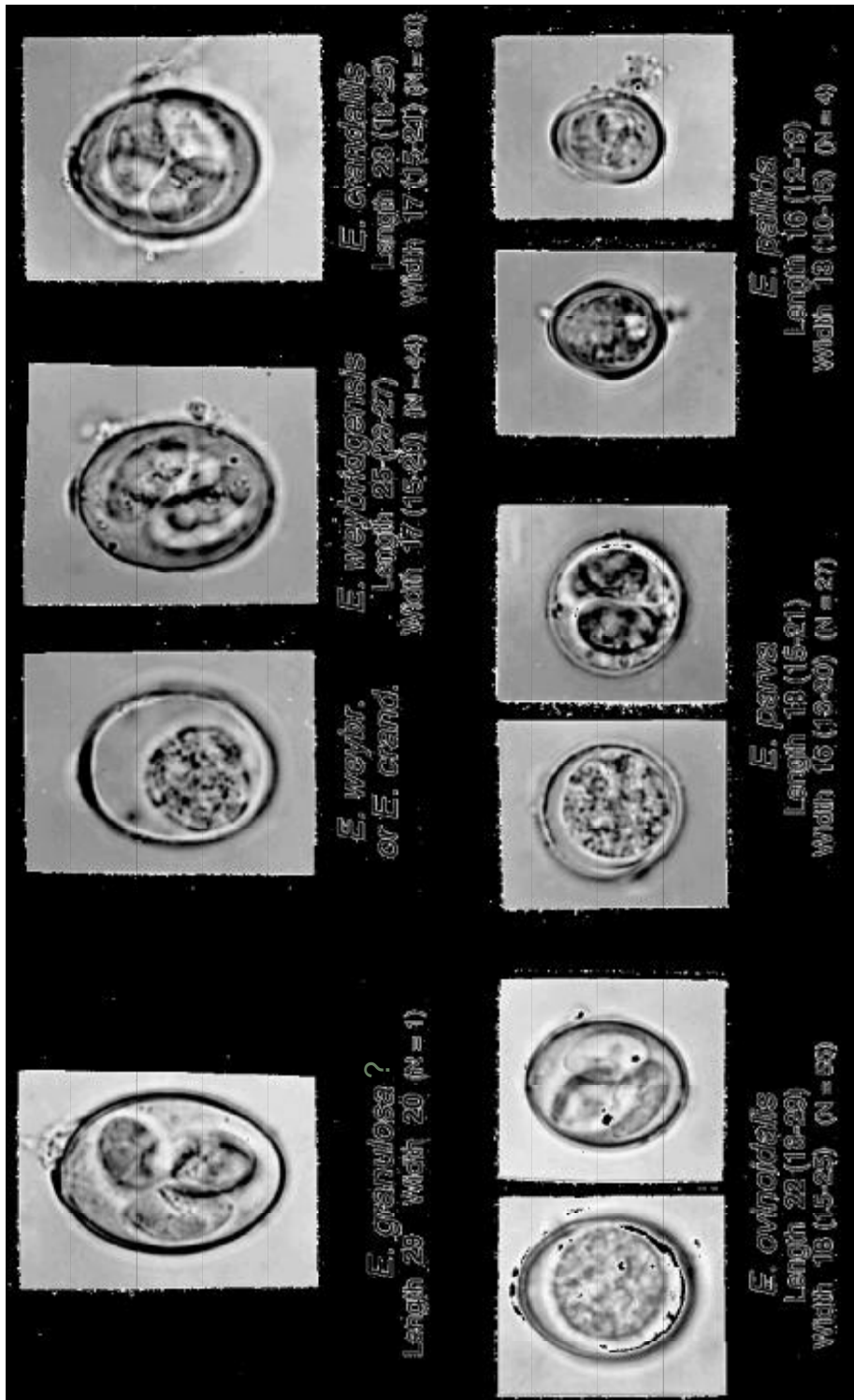


Figure 1 . *Eimeria* spp. found in Icelandic sheep. Unsporulated and sporulated cysts. (All pictures on the same scale. Measurements in microns. Range in parenthesis. N=number measured).
 I. mynd. Eimeria-tegundir fundnar í íslensku sauðfé. Hnúslar fyrir og eftir grómyndun. (Allar myndir stækkaðar jafnt. Stærðir í mikronum. Dreifingarsvið í sviga. N=íöldi mældur)

world and have possibly a global distribution. Among the countries from where it is known that sheep have been imported to Iceland, it can be mentioned that in Norway nine of these 10 species have been found, *E. granulosa* being the only one lacking (Helle and Hilali, 1973; Bjørn Gjerde, personal communication) and all ten species have been found on the British Isles (Norton *et al.*, 1974) and in Germany (Barutzki *et al.*, 1989).

The remaining two species, generally accepted as valid, seem to have more limited distribution. *E. marsica* Restani, 1971, has been found in Norway (Bjørn Gjerde, personal communication) on the British Isles and in Italy, Spain and Hungary (Barutzki *et al.*, 1989). *E. punctata* Landers, 1955, has been found in Czechoslovakia, Spain, Egypt, Canada, USA, Australia and New Zealand (Barutzki *et al.*, 1989).

Considering the limited number of lambs studied, all being from the same locality and the samples were collected on only two occasions, it is noteworthy that 9 or 10 of the 12 species generally accepted as valid were found in this study.

Oocyst counts

Total oocyst counts and countings or esti-

mates of the proportional numbers of individual species are shown in Table 1.

The total oocyst counts in the faeces of the lambs is in fairly good accordance with the hypothesis on total oocyst numbers in the faeces of Icelandic sheep shown in Figure 2.

The total oocyst numbers were approximately 100× higher in the one month old lambs in the early summer than in the seven months old lambs in the early winter.

This means that at least for some of the *Eimeria* species there are clearly great differences in abundance between early summer and early winter, their numbers being much higher in the one month old lambs in the early summer than in the seven months old lambs in the early winter (e.g. *E. crandallii*, *E. ovinoidales*, *E. parva*, *E. weybridgeensis*). On the other hand only eight species were found in the early summer, compared to ten in early winter (the additional species in early winter being *E. granulosa* and *E. intricata*).

The proportional abundance of *Eimeria* species in the one month old lambs in the early summer was also considerably different from the seven months old lambs in the early winter.

The limited information gathered in this

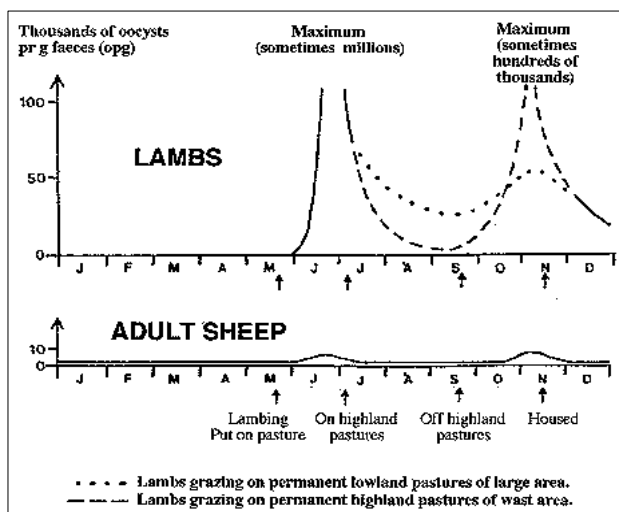


Figure 2. A hypothesis on the variation of the total number of *Eimeria* spp. oocysts in the faeces of sheep in Iceland. (Adapted from Richter and Eydal, 1985).

2. mynd. Tilgáta um sveiflur í heildarfjölda *Eimeria*-hnísla í saur sauðfjár á Íslandi.

Table 1. The *Eimeria* species which were found in the faeces of the lambs and their proportional abundance.*I. tafla. Þær Eimeria-tegundir sem fundust í saur lambanna og hlutfallsleg tíðni þeirra.*

	June 1994 Two lambs (one month of age)		November 1993 Six lambs (seven months of age)
	Lamb 1	Lamb 2	
	Total opg number	2 458 000	3 427 000
<i>E. ahsata</i>	1	0	++
<i>E. bakuensis</i>	6	5	+++
<i>E. crandallis</i>	49	27	+
<i>E. faurei</i>	2	9	+
<i>E. granulosa</i> ?	0	0	+
<i>E. intricata</i>	0	0	++
<i>E. ovinooidales</i>	12	30	++
<i>E. pallida</i>	0	2	+
<i>E. parva</i>	9	13	+
<i>E. weybridgei</i>	21	14	++
Total	100	100	

+ Rare—*Sjaldgæf*.++ Common—*Algeng*.+++ Very common—*Mjög algeng*.

study on the abundance of the *Eimeria* species indicates that there are seasonal and/or host-age related differences in the prevalence and/or intensity of several of the species.

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