

## Rare land snails from the Faroe Islands (Denmark): first records for the archipelago or single islands

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**Abstract.** The Faroe Islands, an isolated North Atlantic archipelago, are characterized by a grassland vegetation, which is shaped by strong winds and, since human settlement, also by intensive sheep grazing. This study, conducted in August 2023, investigated terrestrial gastropod fauna across 46 sites on six islands: Vagár, Streymoy, Eysturoy, Kunoy, Borðoy, and Viðoy. We found 26 gastropod species, including two new species for the archipelago (*Euconulus fulvus* and *Vertigo angustior*). Several rare species were found at new locations, including *Lauria cylindracea*, previously only known from a single site on Suðuoy, now documented at two additional sites on Vagár and Streymoy. Species richness at the sites varied between 1 and 16 species, with an average of five species. The fauna is notably slug-dominated, as on average more slug species were found at a site than snail species. Our results illustrate the effects of overgrazing by sheep, which limits gastropod diversity to refuges such as steep rocky outcrops, tall riparian vegetation in narrow canyons, and less disturbed wetlands. The snail fauna of the Faroes is relatively species-poor (31 species in total) and is dominated by introduced generalists and non-native slugs, while micro-snails, which are common in other insular areas with similar climates, are notably absent.

**Key words.** Mollusca, Gastropoda, survey, snails, slugs, distribution

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### INTRODUCTION

The Faroe Islands, an isolated archipelago in the North Atlantic between Iceland and Scotland, consist of 18 rugged volcanic islands characterized by steep cliffs and fjords. The islands are exposed remnants of the extensive Palaeogene basalt lava flows (Millett *et al.* 2017), with modern soils that generally have low base saturation due to intensive leaching (Veihe & Thers 2007). The islands are of a predominantly maritime climate, experiencing cool summers (12–15 °C on average) and mild winters (3–5 °C) with frequent rainfall (1,270 mm annually). The natural growth of trees is prevented in particular by the persistently strong winds. As a result, the landscape on most of the islands is dominated by grassland and rare shrubs; only a few trees are planted. The Norse settlers arrived in the 9th century and introduced sheep, efficient grazers that changed the landscape considerably (Jóhansen 1985; Mysterud & Thórhallsdóttir 2016). Today, the number of sheep is greater than the human population. Their grazing pressure reduces plant diversity and

biomass, especially of tall herbs and shrubs, and it also contributes to erosion (McGovern *et al.* 2005; Lawson *et al.* 2008; Verbrugge *et al.* 2022). Nowadays, most of the area resembles a well-maintained golf course, albeit with sheep droppings scattered across the landscape.

To date, 29 species of land snails and slugs have been reported from the archipelago (Fog 1971; Solhøy 1981), of which at least eight have been recently introduced by humans (McMillan 1972; Jensen *et al.* 2014). In the past, two large field surveys have been conducted on all islands, documenting 22 species mainly between 1925–1926 (Fog 1971) and 20 species (Solhøy 1981). While most species (*c.* 75%) are distributed throughout the archipelago, five occur only in a few localities, with *Lauria cylindracea* known only from a single locality on Suðuoy (Fog 1971). Although the fauna appears to be well recorded in terms of native elements, no systematic inventory of non-anthropogenic habitats has been published in the last 45 years.

Here we report the results of our research in 2023 on six islands that are accessible by car, with an aim to capture the

highest possible diversity of natural habitats suitable for the occurrence of terrestrial gastropods.

## MATERIAL AND METHODS

In August 2023, we surveyed the terrestrial gastropod fauna at 46 sites on six of the islands: Vagár, Streymoy, Eysturoy, Kunoy, Borðoy, and Viðoy. Snails and slugs were collected by hand, litter sieving or wet sieving in spring fens and other wetlands (Horsák 2003). Samples were air-dried at room temperature, identified, and counted. They are deposited in the collection of M. Horsák in Brno, Czech Republic. Images of voucher individuals were taken using an Olympus szx 7 microscope with Olympus C-7070 wide zoom camera and QuickPHOTO MICRO software at c. 20×. Between five and ten images were taken with the focus from the bot-

tom to the top of the shell and merged into a single focussed image using Combine ZM (<https://combinezm.en.lo4d.com/windows>). Boxplots were created using the 'ggplot2' package in R (Wickham 2016).

## RESULTS AND DISCUSSION

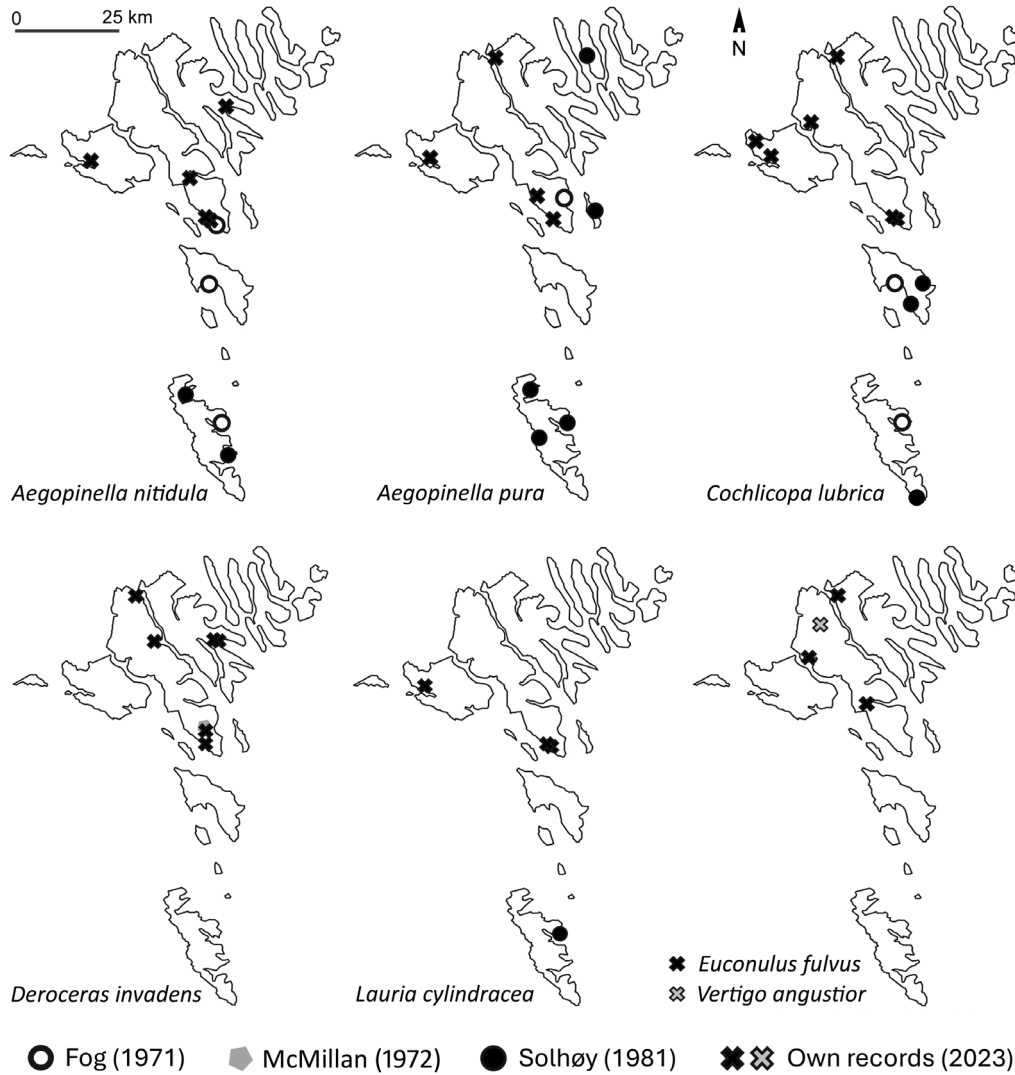
During our field study, 26 terrestrial gastropod species were recorded (Table 1), including *Euconulus fulvus* and *Vertigo angustior*, which are new to the archipelago (Table 2; Figs 1, 2). We also extended the known distribution of the other five rare species. *Lauria cylindracea* was originally reported from a single site on the island of Suðuoy; however, we found it at two new sites on the islands of Vagár and Streymoy (Table 2). Abundant colonies were found at natural habitats with a species-rich (by Faroese standards) snail fauna. The spe-

**Table 1.** All recorded land snail and slug species across 46 sites sampled on six road-connected islands of the Faroe archipelago. Frequency, number of sites with the species occurrence; No. islands, the number of islands where the species was found during our survey; No. total, the combined total number of islands where the species was recorded in previous surveys (Fog 1971; McMillan 1972; Solhøy 1981; Jensen *et al.* 2014) and our survey. There are 18 islands in the archipelago, but no data exist from Lítla Dímun, the smallest island.

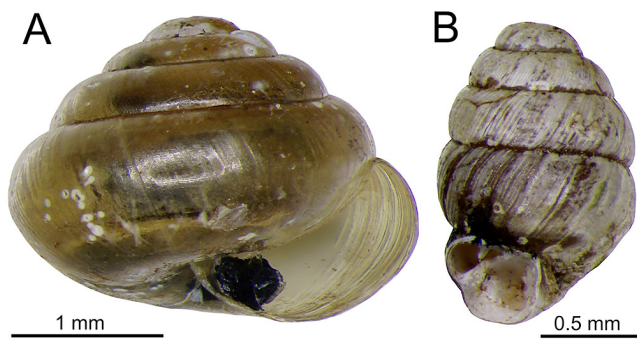
| Species  | Frequency | No. islands | No. total |
|--|-----------|-------------|-----------|
| <i>Arion distinctus</i> Mabile, 1868                 | 22        | 5           | 13        |
| <i>Vitrea contracta</i> (Westerlund, 1871)           | 19        | 3           | 14        |
| <i>Oxychilus alliarius</i> (J. S. Miller, 1822)      | 19        | 3           | 17        |
| <i>Arion fuscus</i> (O.F. Müller, 1774)              | 18        | 3           | 16        |
| <i>Perpolita hammonis</i> (Strøm, 1765)              | 18        | 4           | 9         |
| <i>Arion silvaticus</i> Lohmander, 1937              | 16        | 4           | 15        |
| <i>Arion vulgaris</i> Moquin-Tandon, 1855            | 14        | 2           | 3         |
| <i>Columella aspera</i> Waldén, 1966                 | 12        | 4           | 12        |
| <i>Lehmannia marginata</i> (O.F. Müller, 1774)       | 11        | 3           | 17        |
| <i>Deroceras laeve</i> (O.F. Müller, 1774)           | 10        | 4           | 9         |
| <i>Arion ater</i> (Linnaeus, 1758)                   | 9         | 3           | 16        |
| <i>Deroceras agreste</i> (Linnaeus, 1758)            | 8         | 3           | 16        |
| <i>Vitrea pellucida</i> (O.F. Müller, 1774)          | 7         | 3           | 17        |
| <i>Arion intermedius</i> Normand, 1852               | 6         | 2           | 17        |
| <i>Cochlicopa lubrica</i> (O.F. Müller, 1774)        | 6         | 3           | 5         |
| <i>Deroceras invadens</i> Reise <i>et al.</i> , 2011 | 6         | 2           | 2         |
| <i>Aegopinella nitidula</i> (Draparnaud, 1805)       | 5         | 3           | 5         |
| <i>Deroceras reticulatum</i> (O.F. Müller, 1774)     | 5         | 2           | 17        |
| <i>Aegopinella pura</i> (Alder, 1830)                | 4         | 3           | 6         |
| <i>Euconulus fulvus</i> (O.F. Müller, 1774)          | 3         | 2           | 2         |
| <i>Lauria cylindracea</i> (Da Costa, 1778)           | 3         | 2           | 3         |
| <i>Arianta arbustorum</i> (Linnaeus, 1758)           | 2         | 1           | 4         |
| <i>Arion fasciatus</i> (Nilsson, 1823)               | 2         | 1           | 1         |
| <i>Oxychilus cellarius</i> (O.F. Müller, 1774)       | 2         | 1           | 3         |
| <i>Punctum pygmaeum</i> (Draparnaud, 1801)           | 2         | 2           | 15        |
| <i>Vertigo angustior</i> Jeffreys, 1830              | 1         | 1           | 1         |

**Table 2.** List of new records with location information. Live, number of live individuals; shell, number of empty shells found. Collector for all: Horsák and Horsáková.

| Site ID  | Species                     | Live | Shell | Island   | Lat (°N) | Lon (°W) | Settlement  | Habitat                          | Date       |
|----------|-----------------------------|------|-------|----------|----------|----------|-------------|----------------------------------|------------|
| FAE41/23 | <i>Aegopinella nitidula</i> | 0    | 2     | Streymoy | 61.9486  | 006.7797 | Kirkjubøur  | Mesic-dry rocks, rich vegetation | 13.08.2023 |
| FAE12/23 | <i>Aegopinella nitidula</i> | 7    | 6     | Streymoy | 61.9505  | 006.7840 | Kirkjubøur  | Wet rocks with rich vegetation   | 06.08.2023 |
| FAE14/23 | <i>Aegopinella nitidula</i> | 1    | 0     | Streymoy | 62.0558  | 006.9224 | Norðradalur | Spring fen along a brook         | 06.08.2023 |
| FAE36/23 | <i>Aegopinella nitidula</i> | 4    | 3     | Vágar    | 62.0850  | 007.3628 | Bøur        | Mesic-dry rocks, rich vegetation | 11.08.2023 |
| FAE24/23 | <i>Aegopinella nitidula</i> | 2    | 4     | Eysturoy | 62.1908  | 006.7493 | Gøtugjógv   | Tall-herb vegetation in a canyon | 08.08.2023 |
| FAE12/23 | <i>Aegopinella pura</i>     | 1    | 0     | Streymoy | 61.9505  | 006.7840 | Kirkjubøur  | Wet rocks with rich vegetation   | 06.08.2023 |
| FAE13/23 | <i>Aegopinella pura</i>     | 6    | 0     | Streymoy | 62.0163  | 006.9075 | Syðradalur  | Wet rocks with rich vegetation   | 06.08.2023 |
| FAE36/23 | <i>Aegopinella pura</i>     | 1    | 0     | Vágar    | 62.0850  | 007.3628 | Bøur        | Mesic-dry rocks, rich vegetation | 11.08.2023 |
| FAE32/23 | <i>Aegopinella pura</i>     | 9    | 2     | Eysturoy | 62.2912  | 007.0784 | Eiði        | Herb vegetation in a canyon      | 10.08.2023 |
| FAE41/23 | <i>Cochlicopa lubrica</i>   | 2    | 2     | Streymoy | 61.9486  | 006.7797 | Kirkjubøur  | Mesic-dry rocks, rich vegetation | 13.08.2023 |
| FAE12/23 | <i>Cochlicopa lubrica</i>   | 7    | 5     | Streymoy | 61.9505  | 006.7840 | Kirkjubøur  | Wet rocks with rich vegetation   | 06.08.2023 |
| FAE37/23 | <i>Cochlicopa lubrica</i>   | 1    | 0     | Vágar    | 62.1184  | 007.4265 | Gásadalur   | Productive spring fen            | 12.08.2023 |
| FAE15/23 | <i>Cochlicopa lubrica</i>   | 7    | 1     | Streymoy | 62.1450  | 007.1770 | Vestmanna   | Mesic-dry rocks, rich vegetation | 07.08.2023 |
| FAE32/23 | <i>Cochlicopa lubrica</i>   | 19   | 1     | Eysturoy | 62.2912  | 007.0784 | Eiði        | Herb vegetation in a canyon      | 10.08.2023 |
| FAE11/23 | <i>Deroceras invadens</i>   | 6    | 0     | Streymoy | 61.9665  | 006.8194 | Velbastaður | Wet pasture with shrubs          | 06.08.2023 |
| FAE42/23 | <i>Deroceras invadens</i>   | 20   | 0     | Streymoy | 61.9994  | 006.8237 | Tórshavn    | Artificial willow growth         | 13.08.2023 |
| FAE22/23 | <i>Deroceras invadens</i>   | 2    | 0     | Eysturoy | 62.1878  | 006.7596 | Syðrugøta   | Artificial willow growth         | 08.08.2023 |
| FAE09/23 | <i>Deroceras invadens</i>   | 2    | 0     | Streymoy | 62.1880  | 007.0354 | Hvalvík     | Artificial wetland forest        | 05.08.2023 |
| FAE23/23 | <i>Deroceras invadens</i>   | 1    | 0     | Eysturoy | 62.1921  | 006.7517 | Gøtugjógv   | Artificial maple growth          | 08.08.2023 |
| FAE28/23 | <i>Deroceras invadens</i>   | 4    | 0     | Streymoy | 62.2850  | 007.1016 | Haldórsvík  | Wet rocks with rich vegetation   | 09.08.2023 |
| FAE14/23 | <i>Euconulus fulvus</i>     | 5    | 0     | Streymoy | 62.0558  | 006.9224 | Norðradalur | Spring fen along a brook         | 06.08.2023 |
| FAE15/23 | <i>Euconulus fulvus</i>     | 3    | 1     | Streymoy | 62.1449  | 007.1770 | Vestmanna   | Mesic-dry rocks, rich vegetation | 07.08.2023 |
| FAE32/23 | <i>Euconulus fulvus</i>     | 25   | 3     | Eysturoy | 62.2912  | 007.0784 | Eiði        | Herb vegetation in a canyon      | 10.08.2023 |
| FAE41/23 | <i>Lauria cylindracea</i>   | 8    | 3     | Streymoy | 61.9486  | 006.7797 | Kirkjubøur  | Mesic-dry rocks, rich vegetation | 13.08.2023 |
| FAE12/23 | <i>Lauria cylindracea</i>   | 32   | 19    | Streymoy | 61.9505  | 006.7840 | Kirkjubøur  | Wet rocks with rich vegetation   | 06.08.2023 |
| FAE36/23 | <i>Lauria cylindracea</i>   | 26   | 19    | Vágar    | 62.0850  | 007.3628 | Bøur        | Mesic-dry rocks, rich vegetation | 11.08.2023 |
| FAE08/23 | <i>Vertigo angustior</i>    | 0    | 1     | Streymoy | 62.2358  | 007.1437 | Saksun      | Alkaline spring fen              | 05.08.2023 |

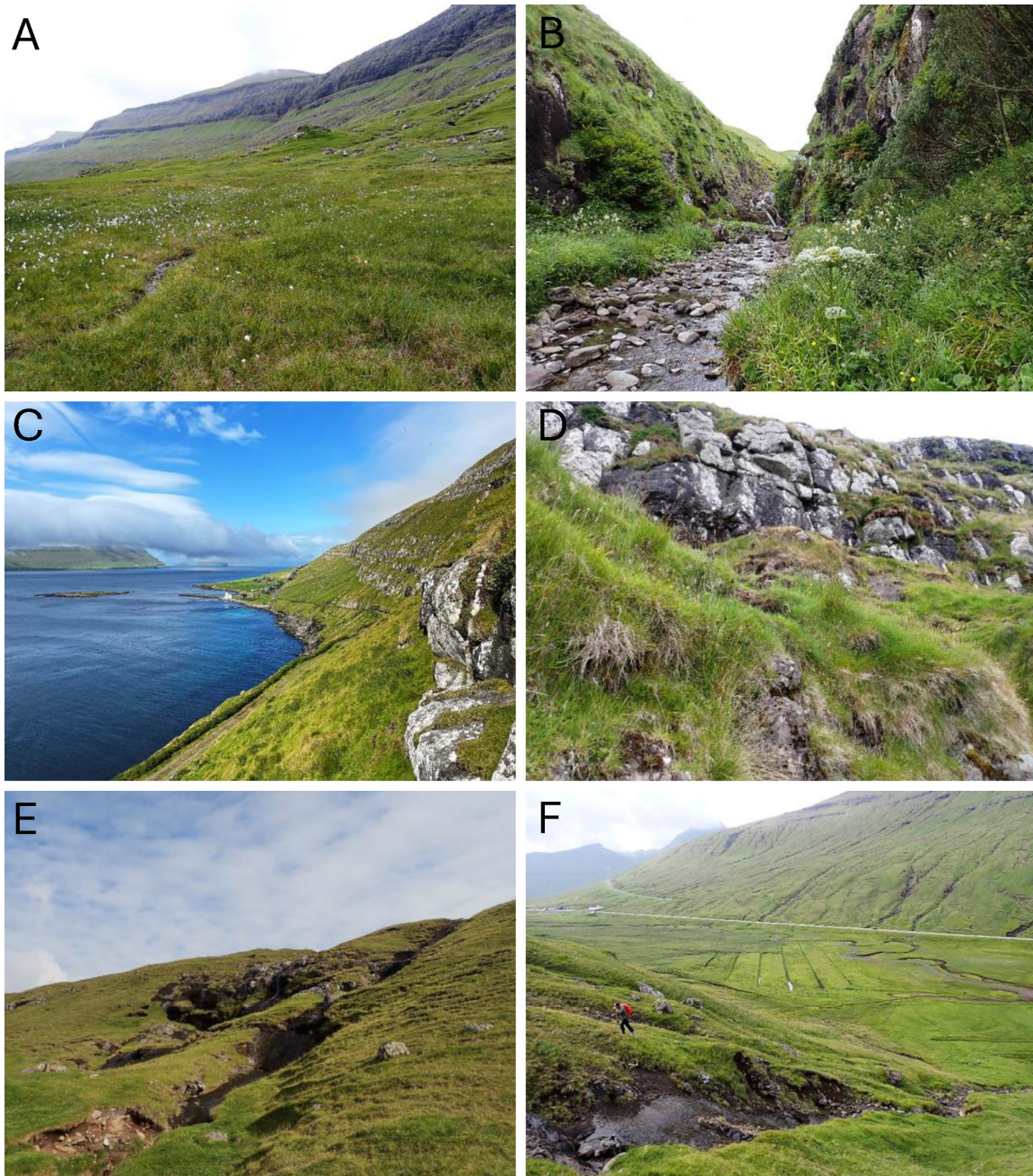


**Figure 1.** Location of new sites for seven rare terrestrial gastropod species on the Faroe Islands, including old records from previous publications (Fog 1971; McMillan 1972; Solhøy 1981). Map adopted from <https://www.vectorstock.com>.



**Figure 2.** Images of voucher specimens of the two newly reported micro-land snails from the Faroe Islands: **A**, *Euconulus fulvus*, #FAE32/23, Eysturoy, Eiði (Breiðá), rich herb vegetation in a river canyon; **B**, *Vertigo angustior*, #FAE08/23, Streymoy, Oyranar (Dalá), a small rich fen. Photos: M. Horsák.

cies was restricted to the dense and preserved vegetation of rocky outcrops on very steep slopes that cannot be grazed by sheep. After learning the correct vegetation architecture (Fig. 3C, D), we discovered the second locality at Vagár by searching with binoculars in the same type of cliff-edge vegetation. Therefore, it is likely that the species is more common but restricted to hard-to-reach places that require specialised climbing equipment and a lot of effort to reach. However, it is likely that only sites enriched with calcium through intense weathering or base-rich seepages can support a richer malacofauna, including also more demanding snail species. The homogeneous volcanic bedrock, which is usually overlain by acidic soils due to intensive leaching (Veihe & Thers 2007), is probably also an additional pre-



**Figure 3.** Images of sampled sites. **A**, a larger complex of alkaline seepages and small spring fens with *Eriophorum angustifolium* and brown mosses in the valley of the Dalá River in Streymoy, site #FAE08/23 with *Vertigo angustior*. **B**, dense tall-herb riparian vegetation and shrubs in the narrow canyon near Gøtugjógv in Eysturoy, site #FAE24/23 with *Aegopinella nitidula*. **C**, **D**, layers of steep base-rich outcrops forming ledges with rich vegetation of rock shelves along the coast near Kirkjubøur in Streymoy, site #FAE12/23 with *Lauria cylindracea*, *Cochlicopa lubrica*, *A. nitidula*, and *A. pura* (the richest natural site with 15 terrestrial gastropod species). **E**, **F**, heavily overgrazed landscape supports mostly only slug populations. Photos: V. Horsáková.

dicator of land-snail distribution and local species richness, which is generally favoured by alkaline conditions (e.g. Horsák 2006).

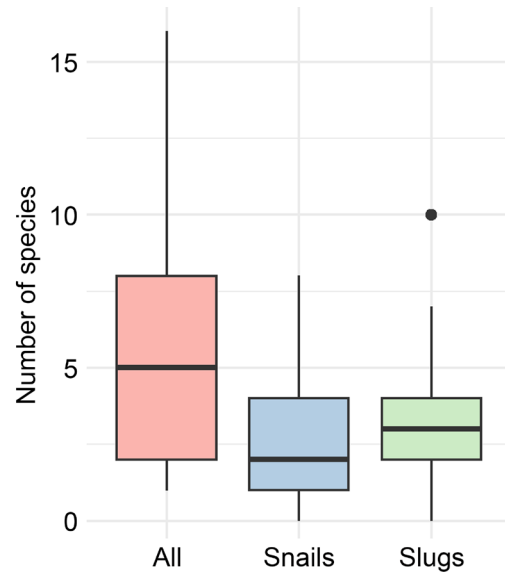
We also investigated several fen habitats, which mostly developed on alkaline seepages on gentle slopes or along

small streams. We focussed on less overgrazed, more productive vegetation, as the heavily overgrazed vegetation typically only favoured the occurrence of slugs, hiding in old sheep stone shelters or under stones in general (Fig. 3E, F). We found three populations of *E. fulvus* (Fig. 2A)

on the islands of Streymoy (two sites) and Eysturoy (one site) in such habitats (Fig. 3B). In an extensive seepage area with many small alkaline fen pockets in the northern part of Streymoy (Fig. 3A), a single shell of *V. angustior* (Fig. 2B) was found in a quantitative 12-L wet sieve sample. Further research is required to determine the population of this species, which may be a victim of sheep grazing. This is the first record of a *Vertigo* species in the archipelago. The absence of other, otherwise common micro-snails in such habitats of the European Atlantic coast or the Shetland Islands is surprising. These common components of the maritime grassland snail fauna are completely absent (e.g. *Vallonia* spp.) and many of the species present, otherwise common generalists, are conspicuously rare, such as *E. fulvus*, *Vitrina pellucida*, and *Cochlicopa lubrica* (all common throughout Iceland; M. Horsák and V. Horsáková pers. observ.) The latter species has only been reported from five sites on the islands of Suðuoy and Sandoy (Solhøy 1981), but was also found on Vagár, Streymoy and Eysturoy (5 sites in total) during our sampling.

Interestingly, all 26 species recorded also occurred on Streymoy, the largest of all the islands, which lies in the centre of the archipelago. The species richness of the sites varied between 1 and 16 species, with an average of five species (Fig. 4). The most species-rich site, Viðarlundin í Hvalvík on Streymoy, was an artificial swamp forest with old willow and alder trees, fallen wood, and sedge vegetation along the streams. The second most species-rich site, Kirkjubøur on Streymoy (Fig. 3C, D), was a natural cliff face with vegetated ledges and base-rich seepages that harboured 15 species, including *A. nitidula*, *A. pura*, *C. lubrica*, and *L. cylindracea*.

The Faroese snail fauna is very sluggish, even in non-anthropogenic habitats. We documented 15 shelled snail species, including all previously reported species from the wild, and 11 slug species. The proportion of slug species in the gastropod assemblages was very high and varied between 20 and 100%, with an average of 60%. On average, there were more slug species than shelled snail species at one site (Fig. 4). In addition to nine slug species recorded by Solhøy (1981) between 1977 and 1979, *Deroceras invadens* was reported by McMillan (1972) to be common west of the capital Tórshavn. Two other non-native slug species, *Limax maximus* and *Arion vulgaris*, were recently reported by Jensen *et al.* (2014). While Solhøy (1981) and Jensen *et al.* (2014) did not list *D. invadens*, we found it at four sites on Streymoy (it was common near Tórshavn) and at two sites on Eysturoy. Although it was mostly found in man-made or heavily modified habitats such as artificially planted growths of willows and conifers, two sites were only slightly dis-



**Figure 4.** Variation of site species richness observed at 44 sampled sites; two sites with no land-snail species recorded were excluded.

turbed natural areas (Table 2). Solhøy (1981) also did not list *Arion fasciatus*, whereas it was mentioned by Fog (1971).

There are more sheep than people on the Faroe Islands, on average 50 ewes per km<sup>2</sup> (Thorsteinsson 2020). However, the density varies from area to area and ranges from 13 to 546 per km<sup>2</sup> (Verbrugge *et al.* 2022). Overgrazing by sheep has had a severe impact on ecosystems, in particular it has removed all native shrubs and dwarf willows from the landscape. The only places where these survive are inaccessible cliffs (Pálsson 1993). As a result, the occurrence of forest and shrub snail species is limited to a few refugia, again on rocky outcrops or in deep rocky ravines (Fig. 3B). These were the habitats of two *Aegopinella* species known from the Faroe Islands. *Aegopinella pura* was found at six sites on Suðuoy, Streymoy, Nólsoy, and Kunoy. We found another colony on Streymoy and two new sites on Vagár and Eysturoy. Likewise, *A. nitidula* was known from five sites on Suðuoy, Sandoy, and Streymoy (Solhøy 1981). We re-sampled a rich population at the southern tip of Streymoy (Fig. 3C) and also recorded a new site on Vagár and also on Eysturoy (Fig. 3B).

The fauna of the Faroe Islands is relatively species-poor—based on all surveys combined, 31 terrestrial gastropod species were recorded, of which at least eight were recently introduced by humans (Jensen *et al.* 2014). It is very likely that the majority of the remaining fauna has also been introduced by humans. Therefore, the fauna consists mainly of generalist and non-native temperate species, with only a few species whose colonisation could have been naturally medi-

ated by migratory birds (e.g. Simonová *et al.* 2016). There are several reasons for this, such as isolation (the Shetland Islands, 300 km away, are the closest land mass), the relatively small total area and the homogeneous geology and vegetation. In comparison, 43 species of land snails (including 13 slugs) are known from the Shetland, although these are only about 5% larger, have a milder climate and are less isolated. With the exception of *V. angustior*, the terrestrial gastropods of the Faroe Islands are a complete subset of the species found on Shetland. The lack of natural, more productive shrub and forest vegetation on the Faroes probably excludes many of the gastropod species found on Shetland. Following human colonisation, heavy overgrazing by sheep and soil erosion may have led to the extinction of some species and restricted many species to a few small and preserved sites as found also for *Pupilla alpicola* on Iceland (Horsák *et al.* 2022). This could explain the very scattered occurrence of some species that are common habitat generalists in European regions with similar climates (e.g. *C. lubrica*, *E. fulvus*, *V. pellucida*). This has also led to the establishment of a gastropod fauna that favours slug species, many of which, probably almost all, have been introduced by humans.

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