

12) Das Excretionssystem zeigt nach v. Kennel einen vom Porus nach vorn verlaufenden Hauptstamm, während der nach hinten ziehende Stamm von geringerer Bedeutung ist. Bei *Tetrahymena* sind jedoch jederseits zwei nach hinten verlaufende Hauptstämme von bedeutender Länge, von denen der laterale sich sogar eine Strecke weit in der Region der Geschlechtsorgane verfolgen lässt. Diese beiden treten nach vorn sich vereinigend in einen hinter den Hirnganglien liegenden, aus mehreren Schleifen gebildeten Knäuel ein, aus welchem sowohl der nahe hinter dem Hirne ausmündende Ausführungsgang hervorgeht, als auch Canäle, welche nach vorn zwischen Hirn und Seitenorgan ziehen. Alle Stämme und Verzweigungen wipern lebhaft, was auch schon MacIntosh beobachtet hatte. Zahlreiche, trübe Zellen umlagern auf dem Querschnitt das Lumen.

Alles dies lässt sich bei günstigen Objecten am lebenden Thiere verfolgen, selbst die Verästelungen; doch war es unmöglich die äußersten Enden der letzteren aufzufinden.

Wien, den 19. Juni 1880.

3. Note on the Geographical Distribution of *Limax agrestis*, *Arion hortensis* and *Fasciola hepatica*.

By Dr. George Rolleston, Professor in Oxford.

(Eingegangen 28. Juni.)

That some not inconsiderable confusion exists as to the question of the existence of *Arion hortensis* and *Limax agrestis* in Greenland will be seen from the following quotations.

The first of these comes from the »Manual of the Natural History, Geology and Physics of Greenland together with Instructions for the use of the Arctic Expedition«, 1875. London. p. 124. »Mollusca Groenlandica.

Classis 1. *Androgyna* Mörch,

Order 1. *Geophila* Fér,

* *Arion Fuscus* Müll. Probably introduced
L. agrestis L. according to Wormskjöld.

The Species marked with an * are doubtful inhabitants of Greenland«.

Prefixed to the list whence the above passage is taken is a note to the effect that the list is the »Prodromus Faunae Molluscorum Groenlandiae (in Rink's Grönlands sc. 1857. p. 75—100) by Dr. O. A. L. Mörch. Revised and augmented by Dr. O. A. L. Mörch, University Museum. Copenhagen, April 1875.«

On referring however to the Prodrômus itself as published in Danish in 1857, I find that the entry which concerns us stands simply thus: »Mollusca Grönlandica

Order 1. *Geophila*,

• Gen. 1. *Limax* L.

* *L. agrestis* L. (ifølge Wormskjold),

* Betegner at Arten's Forekomst paa Grönland ikke er sikker.«

Here we see that the line in the entry given in the Manual of 1875 »*Arion fuscus* Müll. Probably introduced« is altogether something fresh and new, whilst the asterisk denoting that the animal so marked is possibly not indigenous has been removed from the *Limax agrestis* and prefixed to the curious name »*Arion fuscus* Müll.«

It is difficult to understand, how the late Dr. O. A. L. Mörch can have come in 1875 to alter his previous entry in this manner. For the name »*Arion*« was unknown to Müller, the author of the *Historia Vermium*, having been introduced into Malacology by Férussac as he himself tells us *Hist. Nat. des Mollusques*. II. 1820—1851. p. 23 and 54, and as regards the animal itself, on the supposition that Dr. Mörch by his entry »*Arion fuscus* Müll.« intended to have written *Limax fuscus* Müll. and knowing that this *Limax* so called by Müller was really an *Arion hortensis* and not a slug with a posteriorly placed respiratory inlet and a continuous shell, it is still more difficult to see how he could have left standing the words »*Limax agrestis* L.« apparently as a synonym. For in the 13th Edition of the *Systema Naturae* Tom. 1. pars VI. p. 3101—3102 the (true) »*Limax agrestis*« is distinguished from the »*Limax fuscus*« (= *Arion hortensis* hodie) of »Müller hist. verm. II. p. 11, n. 209«. On referring to Dr. O. A. L. Mörch's *Faunula Molluscorum Islandiae*, communicated on the 13th April of 1866 and published in 1868 in the Danish *Vidensk. Medd. fra den naturhist. Forening*, I. Kbn. p. 185—227, I find at p. 196, 3. that »*Limax agrestis* L.« stands with a ? after its name, even though there can be no doubt from references to Olafsen, several of which are in fact given by Mörch, that a grey slug as well as the black slug *Arion ater* exists in Iceland. The words at the end of the entry make me think that Mörch may have intended to hint that this *Limax* was not *Limax agrestis* but *Limax tenellus*. The words are »Et exempl, taget af Hallgrímson er muligvis *Limax tenellus*.«

Perhaps therefore the true explanation of the entry in the Manual of 1875 is as follows: in the interval between 1857 and 1875 a black slug may have been proved to Dr. Mörch's satisfaction to have been found in Greenland, and he may have identified it as the *Arion fuscus* of Moquin Tandon, which is the same as the *Arion hortensis* of Férussac and

as the *Limax fuscus* of Müller and Linnaeus, and he may by a very slight slip have entered it as »*Arion fuscus* Müll.« instead of »*Arion fuscus*« Moquin Tandon or *Arion hortensis* Fér. or *Limax fuscus* Müll. To his addition »Probably introduced« some objection might be taken on the ground that there is no very strong a priori reason, why an *Arion* should not exist in Greenland considering that it exists in Iceland, the land shells of which Mörch himself (see Manual, p. 135) allows are nearly allied to those of Greenland: and that it is not only an acknowledged¹ member of the Circumpolar Fauna, but the most abundant of all slugs whatever throughout Sweden, Finland and Lapland². It is curious to note, and not only curious but in view of the question of the distribution of *Fasciola hepatica* also important to note what follows. In 1875 Dr. Mörch appears, after thus adding *Arion hortensis* to his former list of Greenland Mollusca, to have been content to leave the entry of »*Limax agrestis* L. according to Wormskiöld« untouched; though in smaller type, feeling probably that as the entry of the animal was overtly made only on the authority of Wormskiöld, he was in no way pledged either to holding that it was *Limax agrestis* and not *Limax tenellus* which existed in Greenland, or indeed to holding that any *Limax* whatever existed there. What completes my case is the fact, that in 1877 when preparing a list of the Greenland Mollusca for the English Translation of Dr. Rink's »Grönland« of 1857, Dr. Mörch omits all mention of *Limax agrestis* altogether, and his entry runs simply as follows, p. 436:

Class. 1. *Androgynea*,

Order 1. *Geophila* Fér.

1. *Arion fuscus*, probably introduced.

If we follow Dr. Mörch therefore, we shall strike *Limax agrestis* out of the list of Greenland Mollusca, and hold that *Arion hortensis*,

¹ Middendorff indeed in his *Sibirische Reise*, II. 1851. p. 419 omits the name of this small slug from his list of Circumpolar Freshwater and Land Molluscs, but 5 pages further on l. c. says in a note »Vielleicht ist *Limax* (*Arion*) *subfuscus* Drap. (Drap. Moll. p. 125. Pl. IX, 8. *Limax fasciata*, Nilsson, Hist. Moll. Suec. 1822. p. 3) eine circumpolare Art dieses Geschlechtes« and he proceeds to note its discovery by himself within the polar circle in Finland feeding on Sphagnum as also in Lapland feeding on Fungi up to 69°. N. L. Schrenck, *Reise im Amurland* 1859—1867. II. p. 692, whilst identifying the *Limax subfuscus* of Draparnaud with the *Arion hortensis* of Férussac, and so with the *Limax fuscus* of Müller and Linnaeus, confirms the view as to its circumpolar character and uses it as an argument for its being indigenous in America.

² Of course the fact of its being a circumpolar and boreal form is not incompatible with the suggestion that it may have been introduced by man. Its inconspicuousness and its small size make it easy of transport, and like some other northward ranging animals, it has attached itself in great numbers to human homesteads.

which exceeds it in number in other circumpolar regions has in Greenland displaced or at any rate replaced it altogether.

If, however, *Limax agrestis*, notwithstanding the advantage which its colouration might be supposed to have been likely to give it, is beaten in the struggle for existence in circumpolar districts by *Arion hortensis* of about the same size but of such different colour in other districts, if not in the North³, as not only to have been called *fuscus* and *subfuscus*, but even to have been confounded with the true *Arion ater* from which indeed it is mainly distinguished by its more mesially placed respiratory orifice and its small size, it surpasses *Arion hortensis* (see Schrenk, Amurland, II. 1869. p. 690—693; Middendorff, Sibirische Reise, II. 1851. p. 424.) in more southern latitudes.

Middendorff indeed expressly says l. c. »In Sibirien traf ich diesen *Limax* (*Arion hortensis*) nicht, sondern nur einen einzigen kleinen *Limax* im Stanowoj-Gebirge, welcher dem *Limax agrestis* L. recht ähnlich sah«, but this absence from Siberia, to which F. Schmidt's silence as to its presence bears some testimony, may be paralleled by the similar absence of *Paludina vivipara* (Middendorff, l. c. p. 426) and of Crayfishes from the Siberian River Basins (see Huxley on Crayfishes, p. 305), and when, as in these two cases, compared with the facts of distribution elsewhere does not disprove a circumpolar character.

Gerstfeldt, Mém. Sav. Étrang. II. St. Pétersbourg, 1859. p. 515 refers to some few small, ill preserved specimens »einige wenige kleine und schlecht erhaltene Exemplare« of slugs from Irkutsk and Wilni and from the Amur, and speaks of them under the name *Arion ater*. Their small size may justify us in supposing them to have been *Arion hortensis*, and the bad state of preservation in which they were and which makes Gerstfeldt himself speak doubtfully of his identification p. 535 (31), makes this note of their presence less authoritative than it otherwise would have been and has caused Schrenk to suggest that they were in reality specimens of *Limax agrestis*. An illustration of the paucity and rarity of *Limax agrestis* in circumpolar regions is furnished by the entry made by Friedrich Schmidt in his list of Animals from the region of the Lower Jenisei, Mém. Acad. St. Pétersb. 1872. p. 48 as to this eminently social Mollusc. »In einem faulen Treibholzstamme auf der großen

³ Even in England, where the *Arion hortensis* is often of »a deep blue black« and is I suspect the 'Black Jack' of Agriculturists, it is not rarely »yellowish, sometimes grey or greenish grey«. Lovell Reeves, British Land and Freshwater Molluscs, p. 11. In the Amoorland it is »grau gelblich« with three stripes, one dorsal around two lateral narrower ones; whilst its rival the *Limax agrestis* is described as »hell bräunlich- oder bläulich-grün«. See Schrenck, l. c.

Brjochow-Insel (70° n. Br.) in einem Exemplar gefunden.« But per contra im Amurland Schrenk tells us, l. c., that *Limax agrestis* outnumbered *Arion hortensis*, just as *Arion hortensis* outnumbered *Limax agrestis* in Sweden, Finland and Lapland, and that while *Limax agrestis* spreads into Spain, Portugal, Italy, Algeria and the Southern slopes of the Caucasus, *Arion hortensis* reaches no further than the southern slopes of the Pyrenees and Alps.

In a letter published in the Times of April 14th, 1880 and republished with some omissions in the Zoologischer Anzeiger of May 24th, p. 528—560, I suggested that *Arion ater* may be the »Zwischenwirth« or one »Zwischenwirth« to *Fasciola hepatica*. For calling the small black slug, upon the distribution of which I have, following Schrenk and Middendorff, just been writing, »*Arion ater*« I have the example and authority of Forbes and Stanley and I think that of Gerstfeldt. But now, following Schrenk more closely, I should call it *Arion hortensis* and should wish to be understood to be of opinion that it will, as I hope, by means of experiments now being carried on in my laboratory by Mr. A. P. Thomas, be ultimately shewn that the smaller of our two British Arions really is one at least of the hosts infested by the Sheep fluke *Fasciola hepatica*.

As regards the distribution of the *Fasciola hepatica* in Northern regions we have the authority of Leuckart. »Die menschlichen Parasiten«, I. 1863. p. 531 for saying that it is found in Greenland and North America, and the same excellent authority quotes l. c. II. 1876. p. 870 Krabbe to the effect that it is not found in Iceland. The last statement is confirmed by Johnson in »Deutsche Zeitschrift für Thiermedizin und vergleichende Pathologie, Bd. V. Heft 6. 1879. p. 413 in the words »Leberegel kommen in Island nicht vor«. I wish to add that there is no mention of the disease which *Fasciola hepatica* causes in Olafsen's and Povelsen's two volumes of Travels in Iceland, though the diseases of sheep are repeatedly treated of by those authors (see German Translation published in 1774. I. p. 112, 280. II. p. 46, 198, 199). And a similar remark may be made as to Siberia: neither Middendorff, nor Radde, nor the great Pallas, treating as they do so exhaustively of the Natural History of that region, even within my knowledge make any allusion to the existence there of *Fasciola hepatica* as a cause of Sheep disease.

As regards however the existence of this animal and of the Sheep Rot in Greenland as testified to by Leuckart, I wish to lay alongside of it the following statement from the English translation of Rink's Greenland already referred to and edited by Dr. Robert Brown in 1877. There, p. 97, it is stated that about the year 1855 there were in

the whole of Greenland only from 30—40 Cows, 100 Goats and 20 Sheep and that this handful of Cattle were located at Julianshaab on the West Coast. A statement to the same effect is given by Dr. Brown himself in the Manual of Arctic Instructions 1875. p. 27. Surely if the rot still exists in Greenland and has not shared the fate of so many other forms of life which have finally left its inhospitable shores, we have in Julianshaab a simple case and a circumscribed area where on to prosecute research. If the presence of *Fasciola hepatica* in an isolated locality, that of Julianshaab on the west coast of Greenland, is likely to prove instructive, its absence from Iceland may also throw some light upon the subject. Most or all of the Mollusca which have been or can be supposed to act and suffer as »Zwischenwirthe« for the *Fasciola* are to be found in Iceland viz. *Arion ater*, *Arion hortensis*, *Limnaea trunculata* and *Limnaea peregra* (see Mörch, Faunula Molluscorum Islandiae, 1868. p. 12 and 16), as well as *Planorbis rotundatus*, if not *Planorbis marginatus*. And that abundant opportunities for the introduction of *Fasciola hepatica* into Iceland have been given by the importation of sheep from abroad is learnt from what Olafsen l. c. II. p. 198—199, tells us as to the ascription of another sort of Sheep disease to such importation. I incline to ascribe this immunity from Rot which the sheep enjoy in Iceland to the habit which they in common with the Shetland and Orkney sheep have of feeding between high and low water marks upon the sea weed specified by Olafsen in various passages (l. c. I. p. 233, 279. II. p. 198 and Low, Domestic Animals of Great Britain, p. 59). The *Fasciola hepatica* is a fresh water animal and would not of course be picked up in such a locality as the interval between »Ebbe und Fluth« to which the Sheep resort even in the dark nights of winter. It is possible to speculate as to the virtues of salt as an anthelmintic and to suggest that it may act either by enabling a better gastric juice to be secreted and so giving the sheep a better chance of digesting the larval *Fasciola* when swallowed, or by provoking a more copious flow of bile and so washing the young fluke out of the gall ducts. This perhaps is not the place for such enquiries. But it is a pure natural history fact that localities rich in deposits of salt are favourable to the growth and health of sheep. Pallas in the wonderful II. Fasciculus of his Spicilegium Zoologicum dwells on this in reference to the Steatopygous variety of the domestic sheep at p. 65—67, and with reference to the Argali, the *Ovis fera Siberica*, supposed to be the parent stock of *Ovis aries*, var. *domestica*, he writes thus at p. 12: »Omni vero tempore ubi possunt loca salsagine rorida quibus universa Siberia abundat crebro frequentant, terramque sale foetam cavant quod cervino quoque generi solemne est.«

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Zeitschrift/Journal: [Zoologischer Anzeiger](#)

Jahr/Year: 1880

Band/Volume: [3](#)

Autor(en)/Author(s): Rolleston G.

Artikel/Article: [3. Note on the Geographical Distribution of Limax agretis, Arion hortensis and Fasciola hepatica 400-405](#)