A contribution to the knowledge of the Iceland noctuid fauna (coll. Lindroth, Lepidoptera, Noctuidae) with new aspects on passive dispersal by ice-rafting

CLAES ELIASSON

Eliasson, C.: A contribution to the knowledge of the Iceland noctuid fauna (coll. Lindroth, Lepidoptera, Noctuidae) with new aspects on passive dispersal by ice-rafting. [Bidrag till kännedom om Islands nattflyfauna (coll. Lindroth, Lepidoptera, Noctuidae) med nya synpunkter på passiv spridning med istransport.] - Ent. Tidskr. 113 (4): XXXXX Uppsala, Sweden 1992. ISSN 0013-886X.

The first records of *Standfussiana lucernea* (L.) and *Photedes stigmatica* (Ev.) in Iceland were made by C. H. Lindroth in 1926 and 1929 respectively. The specimens have hitherto rested unrecognized in his collection in the Museum of Natural History, Göteborg. Ice-rafting with origin in Siberia is suggested as a dispersal mechanism to explain the very disjunct distribution of *Photedes stigmatica* and *Euxoa ochrogaster*. An explanation to how biota can be protected from the destructable impact of saltwater is given and repeated hibernations in ballast considered. The North Atlantic and Arctic currents, the speed of the icecap and the speed of iceberg movements are discussed. The impact of man on the Icelandic Lepidoptera fauna in relation to aerial dispersal is discussed. A hypothesis of passive dispersal of biota with migratory birds caught and gathered by predatory species is also presented.

Claes Eliasson, Bäcktorpet, Torphyttan 16, S-711 91 Lindesberg, Sweden.

Introduction

I had long been familiar with the fine and well preserved collections of the Göteborg Museum of Natural History, but it was first in the late eighties that I learned to know its archives of separate collections. To my surprise I found the collections from C. H. Lindroth's 1926 and 1929 Iceland expeditions (Fig. 1). I was amazed by his large and fine lepidopterous material. Thanks to the kindness of N. Wolff, who gave me a copy of his just published Iceland fauna in 1971, I was well acquainted with the scanty fauna of Icelandic Lepidoptera.

It was therefore apparent to me that, despite its poor condition, an unset, small and very slender moth probably mistaken as the very common *Cerapteryx graminis* (L.), was rather a male specimen of *Photedes stigmatica* (Ev.) - a species still unknown in Europe and Iceland in 1929. My identification was later confirmed by genital preparation kindly made by J. Jonasson, Göteborg. This preparation matches the photograph of the one by Wolff (1971) very well. The identification of a female specimen of *Standfussiana lucernea* (L.) was less difficult. It was worn, but set. This is also the first record in Iceland.

Wolff had not seen this collection with the exception of a few specimens borrowed with the help of H. Lohmander (Wolff 1971, p. 11, 32). It seems that Lindroth made the identifications himself, though I have not investigated this thoroughly. It is quite evident that he had little opportunity to revise the material when he later held the professorship of Entomology at the University of Lund. I believe he would have been very pleased with these two good records.

I have been searching for a satisfactory explanation to the very disjunct distribution of *P. stigmatica*. A hypothesis is presented here, which is a somewhat different approach to passive dispersal by ice-rafting, and from origins omitted by entomologists studying the Icelandic fauna earlier (Lindroth 1928, 1929, 1957, 1960, 1963, Wolff 1971 p. 177, Coope 1969, Buckland 1988 p. 19).

Occurrence and habitats

Each specimen in the Lindroth collection has a number referring to his notes. *Standfussiana lucernea* (L.), number 73, "22-24.VIII.1926 Hornafjordur Djúpivogur. *Agrotis rava* on the mountain just north of it. Barren gravelled ground on the 23.VIII". (Only one Lepidoptera species

Fig. 1. Carl H. Lindroth in Iceland 1929. Photograph from the archives of the University in Lund. Reproduction by Arne Pettersson.

Carl H. Lindroth på Island 1929. Arkivbild från Lunds Universitet.

mentioned among several Coleoptera species.)

According to E. Olafsson (pers. comm.) the names refer to two different places on the southeast coast of Iceland, but the description of "one" particular mountain points at the latter. The species was not rediscovered in Iceland until 10.IX.1963 by Halfdán Björnsson and later by him a few specimens on 02.IX and 12.IX.1964. Later it was found in numbers on 15.VIII.1970, 25.VII and on 03.VIII.1971, visiting flowers of *Thymus arcticus* at Kvisker and Breidamerkurfjall near Vatnajökull, 64° N, on localities with cliffs and rocky gorges (Wolff 1971, Olafsson, pers. comm.) (Fig. 2). *S. lucernea* has a remarkably long period of flight from early June to early September without interruption, but is rather a summer diapause- than a two generation-species.

In Scandinavia *S. lucernea* occurs in two separate habitats. Firstly, south-facing and wet rocky places with a lush vegetation of for example *Angelica archangelica* and *Valeriana sambucifolia*, on whose flowers the imago often can be found. Such habitats can be found in areas just below the tree line in the mountains or in rocky parts inland, near the mid-coast of the Gulf of Bothnia. They represent habitats similar to those of central Europe. Secondly, it is locally frequent on small islands in the archipelago of the Baltic sea and on the coasts of south Norway and western Sweden. It is always found in habitats with rocks, stones and gravel, often where heaps of seaweed or the shellcracking of gulls give a nutritious soil. Again we find the above mentioned plants in a lush vegetation. The larvae can be found all through the winter among wood jetsam. It feeds on a great variety of plants. *S. lucernea* also appear in less typical habitats, visiting flowers of Calluna vulgaris. The distribution reaches 68° N (Douwes et al 1969) or even to 70° N (a specimen from Alta in Norway in the Zoological museum of Oslo, but without detailed information (Aarvik, pers. comm.)). *S. lucernea* is also found on the Faroe Islands where steep birdcliffs are supposed to be the favourite habitat (Kaaber, pers. comm.). It has a scattered distribution throughout most of Europe (Skou 1991, Fibiger 1990).

Photedes stigmatica Ev. (Fig. 3), number 149, "20.VII.1929 Medalland Skardsmyri open sparsely vegetated peatbog on sandy ground, shallow pools here and there. Vegetation of *Carex, Juncus* etc.. On barren sand dunes with tufts of *Elymus* (=*Leymus*, authors note). All noctuids found in curtains of air exposed roots".

Other known records in Iceland are, Kopasker 02.IX.1937, leg. A. Nörvang, first recognised by N. Wolff (Wolff 1970, -71). The late date is probably the result of occasionally cold summers in northern Iceland and not a second generation (Olafsson, pers. comm.), subsequent records being approximately 150-200 specimens from Skeidarársandur south of Vatnajökull on 26.VI, 01.VII and on 04.VII.1976, most of them resting on *Juncus arcticus* and on the sandy ground between *Leymus* tufts. The habitat at Skeidarársandur is barren sand and gravel with scattered vegetation between the numerous riverbeds from the glacier (Olafsson & Björnsson 1976). The preferred habitat is not far from the sea where sand dunes with *Leymus arenarius* are more frequent (Palmqvist, pers. comm.) (Fig. 4). Besides the dominating *Juncus* and *Leymus* stands, scattered groups of plant opportunists grow, such as: *Salix herbacea, S. phylicifolia, S. lanata, Empetrum nig-*

rum, Sedum villosum, Thymus arcticus, Lychnis alpina, Silene maritima, Cerastium alpinum, Euphrasia sp., Parnassia palustris, Cardaminopsis petraea, Rumex acetosella, Armeria maritima, Epilobium latifolium, Agrostis stolonifera, Poa glauca, Carex viridula and *C. bicolor* (Palmqvist, pers. comm.). In later years *P. stigmatica* has been found in several new localities (Fig. 5). The flight period in south Iceland is from 10.VI- 30.VII with most records in late June and early July (Olafsson, pers. comm.). It flies more actively after midnight (Kaaber, pers. comm.).

Larvae supposed to be *P. stigmatica* were found in Skeidarársandur (Olafsson & Björnsson 1976), but proved to be *Euxoa ochrogaster* (Guenée) ssp. *islandica* (Stgr.) (Olafsson, pers. comm.). Larvae of *P. stigmatica* were, however, found in the Faroe Islands, Sandöy. They were caught in groundbeetle-traps in sand dunes (Bengtson, pers. comm.). This was confirmed by imago findings by S. Kaaber, Aarhus, in 1991. He suggests *Leymus arenarius* to be the foodplant of the larvae in the Faroe Islands (pers. comm.). No further records are known from Europe.

In Asia it appears in the southern parts of the humid forest-taiga zone, which contains scattered grassy patches. It is widespread in the Transbaicalian area, in Dauria, North Mongolia, the lower parts of Russian and Mongolian Altai and the Sayan mountains. More sporadically it is found in the northern Far East and in Western Siberia to the North Ural (Dubatolov and Ronkay, pers. comm., Skou 1991) (Fig. 6). Although the foodplant of *P. stigmatica* in Asia is not known (Dubatolov, pers. comm.), the findings there indicate that among different grassland habitats in the forest steppes, it is often found near rivers with wide flood areas like the Tola in Mongolia and Lena in Siberia (Dubatolov and Ronkay, pers. comm.). In the Far East *P. stigmatica* was collected by light trap just on the shore in front of the slope of a terrace within 20-30 m from the mouth of the river Khindzha, at Cape Ploskiy on Koni peninsula in the Magadan region. This is a flat place in a wide river valley with very limited treevegetation (Dwarf pine *Pinus pumila*) and no cliffs. The plants of the marine meadow are *Fritillaria kamtchatcensis, Iris setosa, Luzula multiflora, Cochlearia officinalis, Polygonum viviparum, Geranium erianthum, Polymonium sp., Rubus arcticus, Rhodiola stephanii, Lathyrus japonicus, Pedicularis resupinatum, Saussuraea oxyodonta*, and on the shore, *Leymus molle, Senecio pseudoarnica, Honckenia oblongifolia* and *Mertensia maritima*. Many *Juncus* species are known from here (Kosterin, pers. comm.). Six specimens of *P. stigmatica* in the collections of The Zoological Museum in Helsinki were collected in Irkutsk and Dauria in Siberia on 15.VI, 5.VII, 6-7.VII, 11.VII, 25.VII and on 1-3.VIII (Kullberg, pers. comm.).

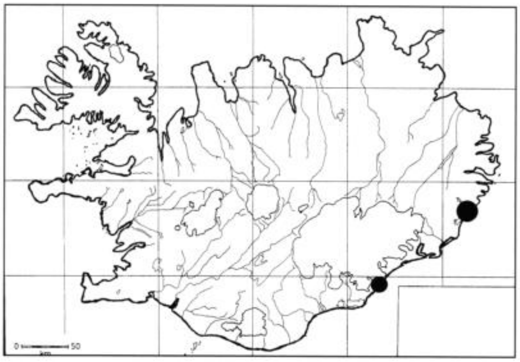

*Fig. 2. Distribution of **Standfussiana lucernea** (L.) in Iceland. The larger dot shows the record of 1926 at Djupivogur made by Lindroth.*

*Utbredningen av **Standfussiana lucernea** (L.) på Island. Den större pricken visar fyndet från 1926 vid Djupivogur av Lindroth.*

Dispersal mechanisms

It is remarkable that only one "true" nearctic Macrolepidoptera species belongs to the Icelandic fauna, and this is *Rhyacia ledereri* (Ersch.) ssp. *quadrangula* (Zett.), with its easternmost occurence in south-west Greenland (Wolff 1971). Although it has been found conspecific to the Palaearctic *R. ledereri*, there is a considerable difference in colour (Mikkola et al 1991). The Icelandic specimens correspond to those in Greenland. Almost all other species are holarctic (Mikkola et al 1991) or they occur commonly in Britain and/or Norway. Exceptions are *Photedes stigmatica* (Ev.), a truly Asian species, and *Euxoa ochrogaster* (Guenée), which is distributed from the Ural mountains to eastern Canada but not in Greenland (Lafontaine 1987). The latter is known as an extremely rare migrant in Western Russia, Estonia, Latvia, Finland and Sweden (Kaisila 1962, Eliasson 1971, Bruun 1990).

There are lots of places with habitats that seem suitable for *P. stigmatica* in northern Scandinavia, especially in Finnmark, Norway. According to Erling Olafsson's personal experience from East Varanger these are equivalent to those he knows

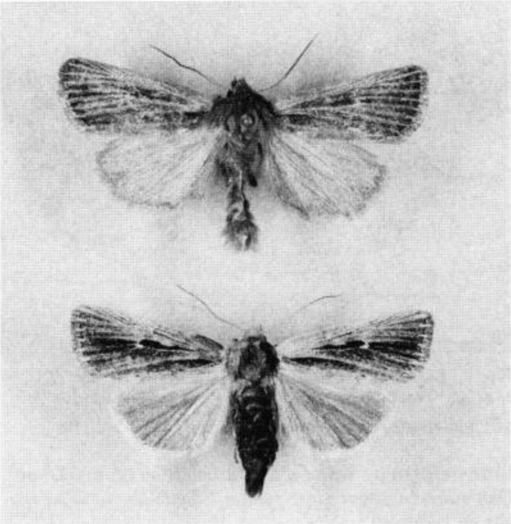

Fig. 3. ***Photedes stigmatica*** *(Ev.) ssp.* ***dispersa*** *(Wolff) from Iceland, Öraefi, Skeidarársandur on 15.VII.1983 (above) and on 3.VII.1988 (below), both males. Wingspan 31 and 29 mm. Leg. Halfdán Björnsson. Photograph by Göran Palmqvist.*

Isländska stråflyet ***Photedes stigmatica*** *(Ev.) ssp.* ***dispersa*** *(Wolff) från Island, Öraefi, Skeidarársandur 15.VII.1983 (ovan), 3.VII.1988 (under), båda hannar. Vingbredd 31 och 29 mm. Insamlade av Halfdán Björnsson.*

from Iceland (Olafsson, pers.comm.). Finnmark and Petsamo (formerly a part of Finland) are well investigated and very few Macrolepidoptera species new to the fauna of northern Fennoscandia have been recorded in this century. Barren sand dunes with *Leymus arenarius* can also be found in the mountains of central Norway. I have searched for *P. stigmatica* in Sör-Tröndelag, Röros, in early July and early August, but without result. Most probably, the species is not native to Fennoscandia.

Is it possible that a Siberian noctuid species could have reached Iceland without ever having occurred in Europe? In the past, entomologists like Lindroth were very unwilling to accept aerial long distance dispersal of all but the toughest insects, e.g. Sphingidae. He preferred to explain the appearence of some well-known migratory Lepidoptera species (eg. *Vanessa cardui*) in Iceland as being introduced in pupal stage (Wolff 1971, p. 179). Today we know he was wrong (Olafsson & Björnsson 1976), and there has been a general change in the attitude to long distance dispersal (Mikkola 1967, 1968, Wolff 1971). The hypothesis of species surviving the Last Glaciation on refuges and the hypothesis of a landbridge connection from Britain to Iceland (Lindroth 1957, 1957, 1960, 1963) has gradually become redundant. The Icelandic Lepidoptera fauna includes no Arctic species (Wolff 1971).

For flightless Coleoptera species in particular, a dispersal hypothesis suggests that ice-rafting in ballast (soil and vegetation) on ice-floes was the most important way of faunal colonisation (Fridriksson 1962, Buckland 1988). Buckland suggests the British Isles as origin and that dispersal took place during a very limited time span (100 years) during the early deglaciation. This transportation time is supposed to take no longer than one hibernation period. One hibernation period seems to be the acceptable limit according to Buckland, and this has forced him to omit other possible origins of dispersal by ice-rafting. In accordance with the present sea currents (Fig. 7) this is a most useful hypothesis to explain the close relationship between the faunas of Britain and Norway (Coope 1969).

Circumpolar ice-rafting

I will here plea for the possibility of passive dispersal of *Photedes stigmatica* and *Euxoa ochrogaster* by ice-rafting on icebergs. If the amount of ballast in one go is big enough for these species to come in several individuals and preferably in the early stage of development (egg/first instars), I see no hindrance to survival also through repeated hibernations. In such a case, one successful landing could be enough to establish a population. During the early period of deglaciation there were probably fewer parasites and predatory species to be met with on isolated islands. The main problem for the earliest arriving species was probably to find foodplants.

The Inuit people in Greenland have always been dependant on driftwood. According to Frithiof Nansen this driftwood (*Larix sibirica, Picea abies ssp. obovata, Abies sibirica, Pinus cembra, Populus tremula* and *Salix vitellina*) must come from the rivers of Siberia (Nansen 1897). The large amount of timber that can be found in unpopulated areas, can be seen on photographs from Jan Mayen (Börde 1983). The people of Iceland formerly made several expeditions to Jan Mayen in times of timber shortage on their own shores (Rosenblad 1990).

Nansen was a pioneer in understanding how the entire icecap of the Eastern Arctic is moving towards the west. The incident that led him to this conclusion was the findings of wreckage and written matters from the lost ship of the American De Long expedition. This ship was crushed in the ice west of Wrangel Island, north of Jeanette Island in 1881, and parts of it were found in south-west Greenland (Julianehaab) 1100 days later. The survivers could identify these items (with names of crew members) as theirs. With this in mind, Nansen constructed his uncrushable ship Fram in which he hoped to reach the Northpole. They travelled passively inside the icecap (with a thickness of 2,5 m in a single layer, and up to 10 m in several layers), passed north of Svalbard to 86° N, and were finally released from the ice by the impact of the North Atlantic current ("the Gulfstream") between Svalbard and Greenland as planned (Nansen 1897, Bartholomew 1976). If their drifting had continued, they would have been caught by the East Greenland Stream and may have ended up in Iceland (Fig. 7).

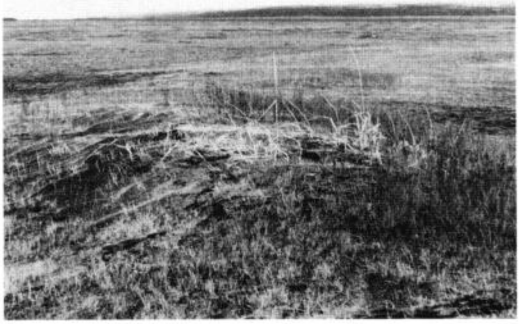

*Fig. 4. Habitat of **Photedes stigmatica** (Ev.) ssp. **dispersa** (Wolff) and **Euxoa ochrogaster** (Guenée) ssp. **islandica** (Stgr.) in Iceland, Skeidarársandur, in August 1992. Photograph by Göran Palmqvist.*

*Biotop för isländska stråflyet **Photedes stigmatica** (Ev.) ssp. **dispersa** (Wolff) och ryska jordflyet **Euxoa ochrogaster** (Guenée) ssp. **islandica** (Stgr.) på Island, Skeidarársandur, i augusti 1992.*

From river-ice to icebergs

The damage of ice-floes on vegetation at the rivers of northern Palaearctic culminates in springtime. Sometimes ice-floes block the water, causing tremendous damage when the ice-blockage breaks. This is the time when riverbanks get swept clear causing the typical barren banks of sand and gravel with only a temporary vegetation. There are many possible ways in which heaps of soil and vegetation (ballast) can be gathered on river-ice without getting submerged. Ice can work like a bulldozer. Land slips in riverbends with steep banks before the river-ice breaks. The river-ice of Siberia is probably the thickest in the world, as winters here are colder than elsewhere in the northern hemisphere. In the permafrost area the river-banks can be steep ice-walls with overhanging soil interwoven by roots.

The major problem for the survival of terrestrial biota on ice-floes is the destructable impact of saltwater (Buckland 1988). This can probably only be solved by the packing of river-ice, sea-ice and glacier-ice (icebergs). When the icebergs are newly released from a glacier they often split or simply change their centre of gravity. This is often the result of warmer saltwater (higher density) from the North Atlantic stream that sinks, when cooled off, beneath the non-salt, but colder water of melted sea-ice and rivers (Torkildsen 1984). I suggest this to have occurred more frequently, also during winter time, in a rather limited contact zone of Atlantic and Arctic currents between Svalbard and Nova Zemlja. When icebergs turn over, ballast may change means of transport, and be given a safe journey on a large iceberg lifted high above the saltwater. The cold East Greenland stream is -1 - -1,5°C in all levels (Nansen 1897) indicating a limited melting effect on the submerged ice.

The summers of the Arctic are warm enough to create large freshwater pools on the continuous icecap near the North Pole. The relatively high temperature (average 0°C, maximum +6°C) is a consequence of the never setting sun (Nansen 1897). But summers are very short. Many Arctic, Subarctic and Boreal Lepidoptera species have evolved a regular two year cycle, eg. species of *Erebia, Oeneis, Lasiocampa, Dasychira* and *Xestia* (Mikkola 1976), as an adaptation to short seasons. Three to five year cycles are known in *Gynaephora groenlandica* (Wocke) and *Euphydryas* species (Wolff 1964, Scott 1986, Eliasson 1991). Other species have adapted to occasionally unfavourable climate by having a high percentage of pupae that hibernate twice or more. Larvae of the temperate geometrid *Idaea aversata* (L.) are able to feed and moult at constant temperatures of +7°C and above (Ryrholm 1989). Thus they will be able to sustain a continuous growth during relatively cold conditions. In Subarctic regions summer ground temperatures will reach above this level during periods of sunshine due to the

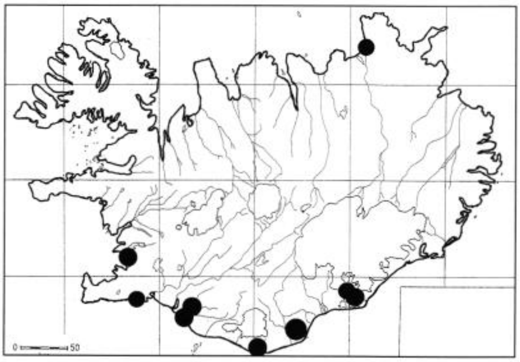

Fig. 5. Distribution of ***Photedes stigmatica*** *(Ev.) ssp.* ***dispersa*** *(Wolff) in Iceland. The larger dot shows the record of 1929 at Medalland Skardsmyri made by Lindroth.*

Utbredningen av ***Photedes stigmatica*** *(Ev.) ssp.* ***dispersa*** *(Wolff) på Island. Den större pricken visar fyndet från 1929 vid Medalland Skardsmyri av Lindroth.*

insolation. Even layers of soil on top of an icesheet will reach approximately the same temperatures. Therefore one can assume that semi Arctic/Boreal species, with low temperature demands, will be able to grow within the microclimate produced by Subarctic solar radiation despite low/insufficient air temperatures (Ryrholm, pers. comm.).

It is difficult to calculate the fastest route from Siberia to Iceland for this suggested iceberg. I can only speculate with a few facts.

1) Areas with numerous icebergs are the seas surrounding islands from Nova Zemlja to Svalbard, and the seas surrounding Greenland.

2) The direction of the cold Arctic stream, when confronted with the North Atlantic stream ("the Gulfstream") (Fig. 7). Icebergs hardly ever reach the Norwegian coast of Finnmark, but occasionally reach the Faroe Islands (Nansen 1897). Investigations of vulcanic ash in sea sediments around Iceland prove that the warm Atlantic and cold Arctic streams have been unchanged since Last Glaciation (Buckland 1988).

3) The fastest measured movement of an iceberg in open water west of Svalbard is 80 km in 24 hours (Torkildsen 1984). At this pace the distance from Jenisejs rivermouth to Iceland, on a route north of Svalbard (approximately 5000 km), could be covered within two months.

It seems possible for ice-rafting biota to cross the open waters south of the continuous icecap in less than half the time made by Nansen (1893-96). An iceberg is mainly controlled by the current due to its underwater size, while the movement of the icecap is highly influenced by wind from any direction (Nansen 1897). The period of deglaciation offered various climates, of which our knowledge is quite limited from Arctic regions. At times it was warmer than today (Buckland 1988) and possibly the area with open water south of the icecap was wider and stayed open a longer period in the autumn. According to Hoel (1966) the waters east of Novaja Semlja were ice-covered in August during the period 1898-1922, but open 1929-1938 as far north as Franz Josefs Land. Seacurrents north of Siberia were possibly faster during the time of deglaciation than today, icebergs more frequent, and the salinity lower (Buckland 1988). The shallow waters north of Siberia and the vast areas beneath 100 m above sealevel indicate great changes of the shore line during the deglaciation.

Conclusions

A total number of 98 Lepidoptera species are recorded in Iceland (Olafsson 1991). The composition of the domestic Icelandic Lepidoptera fauna (approximately 50 species found in numbers above 10 including 8 indoor species (Wolff 1971)) holds few surprises. Apart from the less investigated Microlepidoptera, nearly all species belong to the fauna of all north European Atlantic coasts and islands. It consists of an extract of the most abundant species. According to Wolff (1971 p. 184) most of them could have arrived by aerial dispersal, either as imago or in the first instar, lifted by its thread as *Orgyia antiqua* (L.). Should there be any doubt that all of them arrived in this way?

My belief is that Iceland has the potential of hosting far more Lepidoptera species. Aerial dispersal has disadvantages to species that show no strong tendency to long distance migration. Only a larger number within a restricted area is likely to overcome the risk of rapid extinction due to stochastic factors and/or inbreeding. Today we know that weather conditions favourable for migration have very little to do with the prevailing direction of wind, as suggested by Lindroth (Lindroth 1931 p. 518-528, Wolff 1971). It is more often the heat from the continental climate zone that brings large amounts of migratory Lepidoptera to north-western Europe, and Iceland is no exception (Olafsson 1989).

We know the limited number of large scale migrating species far better today. Probably most of this migration is a result of overpopulation and

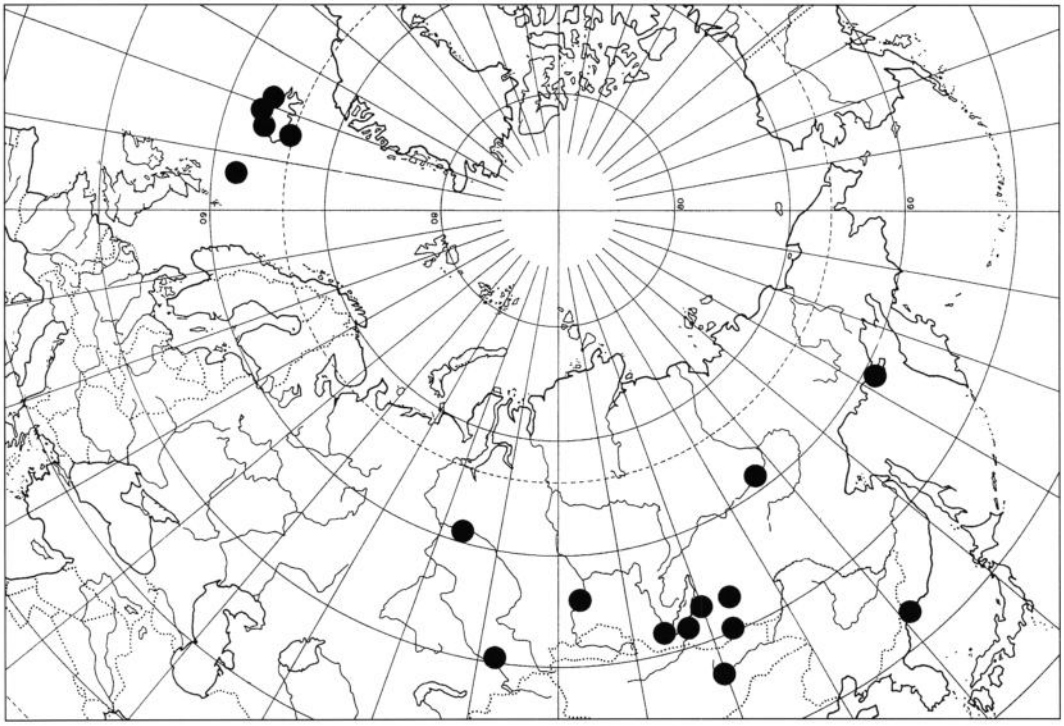

Fig. 6. World distribution of ***Photedes stigmatica*** *(Ev.) From records in the collections of the Biological Institute in Novosibirsk, given by V. V. Dubatolov, and information from L. Ronkay. Records from Iceland and the Faroe Islands given by S.-A. Bengtson, S. Kaaber, and E. Olafsson.*

Världsutbredningen av ***Photedes stigmatica*** *(Ev.) Efter fynd i samlingarna vid Biologiska Institutet i Novosibirsk, sammanställda av V. V. Dubatolov, och information från L. Ronkay. Fynd från Island och Färöarna meddelade av S.-A. Bengtson, S. Kaaber, och E. Olafsson.*

drought causing lack of nectar resources. This combination of causes are less likely to appear in the humid climate zone. The expanding species *Photedes brevilinea* (Fenn.) and *P. extrema* (Hübner) are advancing at a very slow pace in the Nordic countries. *Standfussiana lucernea* is only recorded once in Denmark although it is abundant in the Swedish west-coast. My experiance is that the larvae of *S. lucernea* are resistant to a limited salinity. Its habitat is often submerged during stormy periods. I suggest that *S. lucernea* could have reached Iceland and the Faroe Islands by ice-rafting in larval stage as *P. stigmatica*, or as imago in summer diapause hidden on Viking ships. Also *Rhyacia ledereri* can be expected to be a summer diapause species as its close relative *R. simulans* (Hufn.). The latter is regularly attracted to wooden buildings. The distribution of *R. ledereri* in West Greenland coincides with the Viking settlements (duration of 500 years) (Wolff 1964). None of the robust Noctuids of Nearctic origin distributed in East Greenland have made it to Iceland (Wolff 1964).

The introduction of foreign trees and domesticated animals to Iceland offered many opportunities of dispersal. Bushes and hay were probably used not only as a food resource, but for the comfort and protection from hoofs and dung. The habits of mead and beer drinking among Vikings and the transports of sugary sticky barrels could have offered ideal conditions of dispersal. Noctuids attracted by the smell would have been little disturbed by human activities on a crowded ship, once affected by the alcohol. This could limit the number of species supposed to have reached Iceland by air considerably. It is remarkable that none of the exclusively Palaearctic Macrolepidoptera species in Iceland (approximately 20) also made it to East Greenland (Wolff 1964, Mikkola et al 1991).

The two species *Photedes stigmatica* (Ev.) and *Euxoa ochrogaster* (Guenée) do both belong to the same habitat of dry grassland, similar to the sparsely vegetated land uncovered by withdrawing glaciers (Fig. 4). This offers the opportunity of an early colonisation when the number of parasites could have been limited. They are probably less dependent on sunshine, as their larvae are nocturnal. The former probably dwells hidden inside the tuft of its foodplant as other *Photedes* species feeding on *Leymus*, *Calamagrostis* etc (Skou 1991). To me these seem to be the perfect conditions for successful colonisation by ice-rafting in ballast.

I suggest that ice-rafting larvae/egg of both species departing from rivers in spring/early summer, during a warmer period of the deglaciation, would face similar climatological conditions through a summer in Arctic seas as during an occasionally unfavorable season in their original habitat. They would adapt to a two year development and spend most of their journey in hibernation. Icebergs finally caught by the rather swift and cold East Greenland stream would move southwards during the second spring to Iceland and the Faroe Islands. In a large ballast the larvae could continue to feed, as summer returns, and preferably leave the stranded iceberg as imago. The distribution of the North Atlantic and the Arctic streams offers a possible explanation to the absence of *P. stigmatica* on the Norwegian coast, and in the northernmost islands of Great Britain (Fig. 7). The wide belt of ice-floes close to the East Greenland coast has probably been an effective barrier.

The Icelandic *P. stigmatica* specimens are quite different from the Sibirian ones. The former are darker and often striped (ribbed) in dark brown and yellowish white (Fig. 3) (Skou 1991), and the latter more uniformly coloured in yellowish white and light brown. Wolff suggested it to be a subspecies with only one specimen at hand, and named it *dispersa* (Wolff) (Wolff 1970, 1971). Today this seems to have been justified. Specimens of *E. ochrogaster* ssp. *islandica* are also quite different from Siberian and Canadian specimens, and very different from the specimens migrating to Fennoscandia. This indicates that both species are old members of the Icelandic fauna.

Fig. 7. Sea-currents in April in the North Atlantic. The areas dominated by the North Atlantic and the Arctic currents (the East Greenland Stream) are within the continuous lines. Revised from H. Mosby in Börde (1983) and information from Nansen (1897).

Havsströmmar i april i norra Atlanten. Områden dominerade av Nordatlantiska strömmen och arktiska havsströmmar (Öst-Grönlandsströmmen) är markerade med heldragen linje. Omarbetad efter H. Mosby i Börde (1983) och information från Nansen (1897).

Dispersal of biota by birds

One more possible dispersal mechanism that has been totally omitted by botanists as well as entomologists (Lindroth 1957, 1960, 1963, Löve & Löve 1979, Buckland 1988) is passive dispersal by migratory birds. The fact that almost all the terrestrial birds (including Goose *Anser* species) in Iceland and East Greenland migrate towards Europe has not influenced their opinions. The principal floristic barrier in the North Atlantic is Davis Strait, west of Greenland (Lindroth 1960).

I suggest that southfacing birdcliffs with predatory birds provide both nutritious soil, optimal period of vegetation, and possibly gather a good genetical diversity of seeds from prey, such as Snowbuntings *Plectrophenax nivalis* departing from the Norwegian coast. At Lofoten these birds spend some time building up their energy supply. The East Greenland population winters in Central Asia and the Scandinavian population winters in Western Europe (Staav & Fransson 1987). They will probably migrate with seeds in their crop as well as in their stomach. Quite a number of seeds are known to survive digestion (Lofterud 1992). I suggest that insects and seeds also can be transported hidden in their plumage. This hypothesis could be applied on the occurrence of the moth *Coleophora algidella* (Zell.) (Coleophoridae) which is found in Iceland and in Norway (one record in Narvik (Wolff 1971)). The larva of Coleophoridae fastens its portable case firmly to plants (and plumage of birds at night rest?) several times through its life. *C. algidella* feeds on seeds of *Juncus*, *Luzula* and *Cerastium* (Wolff 1971). Perhaps migratory birds will reveal the origin of this "endemic" but frequent Icelandic species.

The plant *Lappula deflexa* occurs only in this habitat of southfacing cliffs in Scandinavia. It is thought to be a relict in many isolated habitats (Andersson & Birger 1912). I believe that its hooked seeds can be widely dispersed especially by means of the plumage of young predatory birds in search of optimal breeding spots.

Acknowledgements
I am most grateful to Dr. V. V. Dubatolov and Dr. O. Kosterin, Novosibirsk, and to Dr. Laszlo Ronkay, Budapest, for encouragement and detailed information on the occurence of *P. stigmatica* in Asia. To Dr. Svend Kaaber, Aarhus, Mr. Göran Palmqvist, Stockholm, and to Dr. Erling Olafsson, Reykjavik, for encouragement and detailed information from Iceland and the Faroe Islands. To Mr. Leif Aarvik, Oslo, Dr. Gudmundur Björvingsson, Lindesberg, Dr. Sven-Axel Bengtson, Lund, Dr. Roy Danielsson, Lund, Mr. Jaakko Kullberg, Helsinki, Dr. Jan Jonasson and to Dr. Ted von Proschwitz, Göteborg, for their kind help. To Mr. Sven-Åke Berglind, Karlstad, and Dr. Torkel Hagström, Göteborg, for valuable comments on the manuscript. To Mr. Nick and Mrs. Åsa Furderer, Lindesberg, and Mr. Ivan Kruys, Borghamn, for linguistic guidance. To Mr. Arne Petterson, Lindesberg, and Mr. Göran Palmquist, Stockholm, for the fine photographic material. And finally to Dr. Nils Ryrholm, Uppsala, and Dr. Peter Streith, Lindesberg, for all their support.

References

Andersson, G. & Birger, S. 1912. Den norrländska florans geografiska fördelning och invandringshistoria med särskild hänsyn till dess sydskandinaviska arter. Almqvist & Wiksell, Uppsala.

Bartholomew, J. C. 1976. The Times concise atlas of the world. Times books, London.

Bruun, H. 1990. Euxoa ochrogaster (Guenée) ssp. rossica (Staud.) fångad med sexualferomon i Houtskär i SW-Finlands skärgård. - Baptria 15(3): 119-122.

Buckland, P. 1988. North Atlantic faunal connections introduction or endemics? - Ent. Scand. suppl. 32: 7-29.

Börde, H. 1983. Svalbard och havsområdene. Gyldendals forlag, Oslo.

Coope, G. R. 1969. The contribution that the Coleoptera of glacial Britain could have made to the subsequent colonisation of Scandinavia. - Opusc. Ent. 34: 95-108.

Douwes, P., Nordström, F., Kaaber, S., Opheim, M. & Sotavalta, O. 1969. De fennoskandiska och danska nattflynas utbredning. CWK Gleerups, Lund.

Eliasson, C. 1971. Euxoa islandica rossica (Stgr.) i Sverige. - Ent. Tidskr. 92(3-4): 283-284.

Eliasson, C. 1991. Studier av boknätfjärilens, Euphydryas maturna (L.) förekomst och biologi i Västmanland. - Ent. Tidskr. 112: 113-124.

Fibiger, M. 1990 Noctuidae Europaeae vol. 1, Noctuinae Entomological Press, Köbenhavn.

Fridriksson, S. 1962. Um adflutning islenzku florunnar. Náttúrufraedingurinn 32: 175-189.

Hoel, A. 1966. Svalbard. S. Kildahls, Oslo.

Kaisila, J. 1962. Immigration und Expansion der Lepidopteren in Finnland in den Jahren 1869-1960. - Acta Ent. Fennica 18: 1-452.

Lafontaine, J. D. 1987. The Moths of America and North Mexico. - The Wedge Entomological research foundation 27: 2, Washington.

Lindroth, C. H. 1928. Zur Land-Evertebratenfauna Islands 1.Göteborgs K. Vetenskap & Vitterh. Samh. Handl. Femte följd. serie B, 1(4), Göteborg.

Lindroth, C. H. 1929. Zur Land-Evertebratenfauna Islands 2,Göteborgs K. Vetenskap & Vitterh. Samh. Handl. Femte följd. serie B, 1(6), Göteborg.

Lindroth, C. H. 1957. The faunal connections between Europe and North America. Almqvist & Wiksell, Stockholm

Lindroth, C. H. 1960. Is Davies Strait - between Greenland and Baffin Island - a floristic barrier? - Bot. Not. 113: 129-140.

Lindroth, C. H. 1963. The problem of late land connections in the North Atlantic area - North Atlantic biota and their history.Pergamon press, New York.

Lofterud, C. 1992. Växternas sätt att sprida frön: oräkneliga originella, otroliga. - Forskning och framsteg 92(6): 21-24

Löve, Å. & Löve, D., 1979. The history and geobotanical position of the Icelandic flora. - Phytocoenologia 6: 94-105.

Mikkola, K. 1967. Immigrations of Lepidoptera, recorded in Finland in the years 1946-1966, in relation to aircurrents. - Ann. Ent. Fenn. 33: 65-101.

Mikkola, K. 1968. Hemianax ephippiger (Burm.)(Odonata) carried to Iceland from Eastern Mediterranean by an aircurrent? - Opusc. Ent. 33: 111-113.

Mikkola, K. 1976. Alternate-year flight of northern Xestia species (Lep., Noctuidae) and its adaptive significance. - Ann. Ent. Fenn. 42(4): 191-199

Mikkola, K., Lafontaine, J. D., Kononenko, V. S. 1991. Zoogeography of the Holarctic species of Noctuidae (Lepidoptera): importance of Beringian refuge. - Ent. Fenn. 2: 157-173.

Nansen, F. 1897. Fram öfver polarhafvet, den norska polarfärden 1893-96. A. Bonniers förlag, Stockholm.

Olafsson, E. & Björnsson, H. 1976. Sandygla Photedes stigmatica (Ev.) endurfundin á Islandi. - Natturufraedingurinn 46(3): 118-120.

Olafsson, E. & Björnsson, H. 1976. Three migratory moths breed successfully in Iceland. - Natturufrae-

dingurinn 46(4): 200-208.
Olafsson, E. 1989. Luperina zollikoferi (Freyer) found in Iceland (Lep. Noct.). - Ent. Meddr. 57(3): 121-122.
Olafsson, E. 1991. Islenskt skordyratal. Náttúrufrædistofnun Islands, Reykjavik.
Rosenblad, E. 1990. Island i saga och nutid. Norstedts förlag,Stockholm.
Ryrholm, N. 1989. The influence of the climatic energy balance on living conditions and distribution patterns of Idaea spp. (Lepidoptera: Geometridae), an expansion of the species energytheory. Ph.D.-thesis, Dept. of Zoology, Akademitryck, Uppsala.
Scott, J. A. 1986. The Butterflies of North America. StanfordUniversity press, Stanford.
Skou, P. 1991. Nordens ugler. Apollo Books, Stenstrup.
Staav, R. & Fransson, T. 1987. Nordens fåglar. Norstedts förlag, Stockholm.
Torkildsen, T. 1984. Svalbard, vårt nordlige Norge. Det Norske Svalbardselskap, Forlaget Det Beste, Oslo.
Wolff, N. L. 1964. The Lepidoptera of Greenland. - Meddr. Grönland 159 (11).
Wolff, N. L. 1970. Hypocoena dispersa n. sp. (Lep. Noct.) from Iceland. - Ent. Meddr. 38: 215-221.
Wolff, N. L. 1971. The Zoology of Iceland, vol. 3, part 45, Lep. E. Munksgaard forlag, Köbenhavn & Reykjavik.

Sammanfattning

Vid en inspektion av C. H. Lindroths Islandssamling från åren 1926 och 1929 på Naturhistoriska museet i Göteborg upptäckte jag två nattflyn som väckte mitt intresse. Ett preparerat men slitet fly kunde utan större svårighet artbestämmas till en hona av ljusjordfly *Standfussiana lucernea* (L.), funnen vid Djupivogur på östra Island 24.VIII.1926. Ett opreparerat exemplar av ett mycket slitet fly, som troligtvis förväxlats med det på Island mycket vanliga allmänna gräsflyet *Cerapteryx graminis* (L.), visade sig vara en hane av stråflyet *Photedes stigmatica* (Ev.), funnen vid Medalland Skardsmyri på södra Island 20.VII.1929. Den senare har genitalpreparerats av Jan Jonasson, Göteborg. Som svenskt namn föreslås härmed isländskt stråfly.

Dessa fynd är de första från Island. Ljusjordflyet återfanns först 10.IX.1963 av Halfdán Björnsson vid Kvisker och senare i antal på samma lokal (Wolff 1971). Det isländska stråflyet fångades 02.IX.1937 av A. Nörvang (Wolff 1970,1971), men hittades ej på nytt förrän 26.VI.1976 av H. Björnsson och Erling Olafsson - nu i hundratal på sandområden söder om Vatnajökull. De flesta vilande på fjälltåg *Juncus arcticus* bland spridda sanddyner med strandråg *Leymus arenarius*, som är den troliga värdväxten.

Den isländska fjärilsfaunan är Europas i särklass artfattigaste med endast ett femtiotal bofasta arter (Wolff 1971). Trots närheten till Grönland förekommer endast en art som kan förmodas ha nått Island därifrån. De allra flesta arterna är utanför Island vitt utbredda i Storbritannien, Skandinavien och på Färöarna, med ett par högst iögonfallande undantag. Dessa är det isländska stråflyet och det ryska jordflyet *Euxoa ochrogaster* (Guenée) (ssp. *islandica* (Stgr.)), som ej finns i övriga Europa, men väl i Sibirien (ssp. *rossica* (Stgr.)). Den senare är dock funnen som sällsynt immigrant (femtio år mellan fynden) i Finland och Sverige.

Olika hypoteser om hur insekterna på Island har kommit dit existerar idag. För de vinglösa skalbaggarnas del var Lindroth övertygad om att de överlevt istiden på refugier vid isländska kusten och nått dit på en idag ej längre existerande landbrygga från Storbritannien (Lindroth 1963). Idag förkastar man denna hypotes pga nya geologiska fakta och på grund av Islands avsaknad av rent arktiska arter (Wolff 1971, Buckland 1988).

En intressant hypotes framförs av Buckland (1988), som hävdar att det i ett tidigt avsmältningsskede av inlandsisen borde varit möjligt för insekter att passivt forslas med barlast (jord och växter) på isflak från Storbritannien till Island. Denna hypotes kommer väl till pass i mitt försök att förklara det isländska stråflyets märkliga utbredning. Biotopen för arten på Island är sandbankar mellan de otaliga småflödena från Vatnajökull, och flygsandfält eller sandstränder. Liknande miljöer finner man ofta vid flodstränder i Europa och Asien. Det förefaller sannolikt att larver av stråflyet lever likt mer välkända medlemmar av sitt släkte av rötter och skott av olika gräsarter och därmed ganska skyddat.

Den stora mängden drivved från Sibirien på stränder i hela Nordatlanten indikerar möjligheten att olika levande organismer förs ut till havet av de nordriktade floderna i Sibirien. Man har dock ej räknat med att något kunde överleva saltvattnets skadliga inverkan. Ett intressant faktum är att isberg i de nordliga haven smälter underifrån och ofta kantrar. Vid sådana tillfällen kunde en i jord och rötter dold insekt som stråflyets larv i en mängd barlast bli överflyttad från flodernas isflak till ett högre isberg. Den tid det tar för isberg att förflytta sig är avsevärt kortare än väntat. Maximal hastighet vid kort distans är 80 km/24 tim (Torkildsen 1984). Sträckan Jenisejs mynning till Island (ca 5000 km) skulle med denna hastighet ej överstiga två månader. I farvattnen norr om Sibirien rör sig havsströmmarna

idag relativt långsamt, men förhållandena kan ha varit annorlunda vid inlandsisens avsmältning. För havsisdrift på lång distans från norr om floden Lena till Grönlands sydspets är den kortast kända tiden ca 3 år (Nansen 1897).

Hotade vedinsekter i lövbrännor i Hälsingland

Wikars, L.-O. & Ås, S. 1991. *Hotade vedinsekter i fem lövbrännor i norra Hälsingland.* Länsstyrelsen i Gävleborgs län, rapport 1991: 7. 31 sid. Kan rekvireras från Länsstyrelsen i Gävleborgs län, Miljövårds- och fiskeenheten, 80170 Gävle. Pris: gratis!

Skogsbrändernas positiva betydelse för fauna och flora uppmärksammas nu allt mer. Ett viktigt bidrag till dokumentationen av den speciella insektsfauna som koloniserar s k lövbrännor, d v s huvudsakligen lövdominerade skogar som växt upp efter brand, lämnas i denna rapport från länsstyrelsen i Gävleborgs län. Författarna är båda forskare vid Zoologiska institutionen vid Uppsala universitet. Lars-Ove Wikars arbetar nu på en doktorsavhandling om brandberoende insekter (se artikel i detta nr av ET!).

Författarna har under 1986–89 studerat fem stycken 7–109 ha stora fragment av lövbrännor i Ramsjö socken i Ljusdals kommun i norra Hälsingland, som föryngrats efter brand år 1888. Dessa brännor har jämförts med fem provrutor i intilliggande rationellt brukade skogsområden. Totalt har 256 vedlevande insektsarter identifierats, huvuddelen skalbaggar, varav många räknas som hotade i Sverige eller utomlands. Jämfört med den rationellt brukade skogen konstaterades lövbrännorna hysa en avvikande fauna med arter som med stor sannolikhet är beroende av stora bestånd och höga tätheter av döda lövträd som asp och björk. Men även omgivande hyggen visade sig innehålla en intressant och hotad fauna med arter som tidigare haft sin huvudutbredning på nyuppkomna brandfält. Författarna påpekar dock att de hyggen som undersökts var exceptionellt rika på kvarlämnad död ved och att hyggena var upptagna i skog som innan slutavverkning var ren naturskog med stort lövinslag. Kalhyggen som tas upp i framtida lövfattiga skogar med få redan döda träd kommer knappast att erbjuda samma utvecklingsmöjligheter.

Rapporten innehåller mycket av intresse för flera olika kategorier av insektsintresserade. Tjänstemän vid skogsvårdsstyrelser och länsstyrelsernas naturvårdsenheter torde finna en hel del smått och gott i inledningen, där en allmän presentation ges av vedlevande insekter och skogsbränder, samt i skötselförslagen. Den trevande insektsentusiasten som vill lära sig mera om denna fauna, torde bli inspirerad av den smakfulla presentation som ges av ett 40-tal hotade arter, med kärnfulla texter och svartvita avbildningar. Vidare tillgodoses specialistens lystmäte med kompletta artlistor. En utmärkt rapport som varmt rekommenderas!

Sven-Åke Berglind