Notes on Two Migrant Moths from the Faroe Islands, *Agrotis segetum* (L.) and *Noctua orbona* (Hfn) (Lepidoptera, Noctuidae)

Fráboðan um tveir ferðanáttfirvaldar, *Agrostis segetum* (L.) og *Noctua orbona* (Hfn) (Lepidoptera. Noctuidae)

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Úrtak

Hin 21. juni 1996 varð eitt *Agrostis segetum* (L.) kalldýr fingið á Oyrarbakka, og hin 7. juli 1997 varð eitt *Noctua orbona* (Hfn.) kvenndýr fingið í Nesvík. Hesi bæði sløgini av náttfirvaldi vóru ikki skrásett í Føroyum frammanundan. Í báðum førum vóru tey á staðnum samstundis, sum aðrir ferðandi náttfirvaldar róku inn higar. Hitin, leiðin og ferðin á luftstreyminum bæði nær sjónum og á 850 nPa (1500 o.sj.), meðan teir ferðaðust, bendu á, at bæði sløgini vórðu borin av luftstreymi, helst upp í 1000 m hædd. Verður leitað aftur til gomul veðurfrøðilig tøl, kemur fram, at *Agrostis segetum* varð flutt úr Vesturevropa um eitt hátrýstøki uppi yvir bretsku oyggjunum, meðan *Noctua orbona* varð flutt eystureftir úr Miðevropa um eitt lágtrýstøki, sum eisini var uppi yvir bretsku oyggjunum.

Abstract

On 21 June 1996, a male *Agrotis segetum* (L.) was caught at Oyrarbakki on northern Eysturoy and, on 7 July 1997, a female *Noctua orbona* (Hfn.) was caught at Nesvík on northern Streymoy. The two moth species had not been recorded previously in the Faroe Islands. In both cases, their presence coincided with influxes of other migratory lepidoptera species to the area. Temperature conditions, the direction and flow rates of the air currents both at sea level (s.l.) and at 850 hPa (1500 m a.s.l.) during the migratory periods of each indicated that both species were transported by air currents, probably at altitudes of 1000 m a.s.l. Reference to meteorological "backtrack" data showed that *Agrotis segetum* was transported from western Europe westward via a high-pressure area over the British Isles, while the *Noctua orbona* was transported eastward from central Europe via a low-pressure area again over the British Isles.

Fróðskaparrit 47. bók 1999: 159-168

Introduction

During the period from 1990 to 1999, a survey was conducted of the lepidoptera fauna of the Faroe Islands by the first author (SK). The aims were to study the species content of the various ecological niches in the islands and to assess the importance of migratory movements on the native fauna. During the study period, 47 lepidoptera species, previously unknown in the Faroe Islands, were encountered together with 52 previously recorded species. This has increased the species content of the fauna from 57 in 1970 to 109 in 1999 (Kaaber, 1997b; 1999). At least 43 of these species are considered to be migratory or vagrant, and most of them have already been recorded in the neighbouring faunas of Iceland and Shetland, where studies of the insect faunas have been conducted far longer and by far more students and resident naturalists than in the Faroes.

At present, the knowledge of the Faroes lepidopterous fauna is so comprehensive, that current additions should be published and commented on due to their general interest. The aim of the present article, therefore, is to publish records of two moth species previously unrecorded in the fauna of the Faroes Islands and to discuss their origin and local status.

Material

Agrotis segetum (L.)

On 21 June 1996 after a calm day, the second author (SA) visited the damp meadows at Oyrabakki on Eysturoy at midnight to watch the flight and courtship of the Ghost moth (*Hepialus humuli*), in Faroese, the *Hulda*. On that occasion, no *H. humuli* were seen, but a number of noctuid moths were feeding on Marsh Marigold (*Caltha palustris*), including several *Autographa gamma*, a regular Faroes migrant moth. Among them was a different-looking moth that was caught for identification. After it was set, it was evident that it did not belong to the usual Faroes midsummer moths, *Mniotype adusta sommeri* (Lef.) or *Apamea crenata* (Hfn.). During the winter, the moth was sent to a Danish lepidopterist, Mr.Uffe Seneca, in Kalundborg, who identified the specimen in question as *Agrotis segetum*, a male, now kept at the Føroya Náttúrugripasavn in Tórshavn, Fig. 1. At a

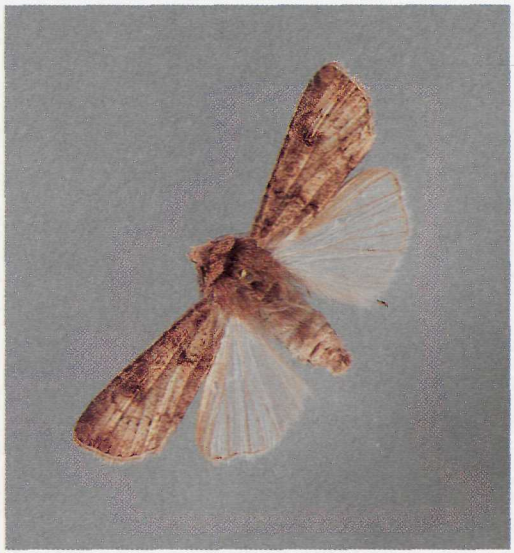

Fig. 1. *Male specimen of* ***Agrotis segetum*** *(L.) from the Faroe Islands. Eysturoy, Oyrarbakki 21.VI.1996. (Photo by Føroya Náttúrugripasavn).*
Mynd 1. Kalldýr av *Agrostus segetum* (L.) úr Føroyum. Eysturoy, Oyrarbakki 21.VI.1996. Føroya Náttúrugripasavn tók myndina

Danish entomological meeting in March 1998, SK was informed about the finding.

Agrotis segetum had not been recorded previously in the Faroe Islands, but is a well-known straggler, recorded both in Iceland and Shetland. Therefore, it could be anticipated to be in the Faroes, especially in a year like 1996, which was a year of strong migrational activity by many migratory European lepidoptera (Kaaber, 1997a). The specimen was recorded during a period in June during which several common migrating lepidoptera, *e.g. Vanessa atalanta* and *Autographa gamma*, and also a few *V. cardui* were observed in the Faroes. In a similar year, in 1995, which also exhibited much migrational activity in the Faroes, the first Iceland specimen was captured in a light trap at Kvisker on 20 August in the southeastern part of the country (Olafsson and Björnsson, 1997).

The two records are the northernmost sightings in Europe. In western and central Europe, the moth occurs quite commonly in England and southeastern Scotland (Bretherton *et al.,* 1983). It is well distributed in Denmark and the southern parts of Scandinavia, while in Norway, it is only resident in the southernmost section of the country (Nordström *et al.,* 1969; Skou, 1991).

North of its residential area in Great Britain, such as the main part of Scotland and the Orkneys, it is recorded irregularly and without any evidence of breeding (Lorimer, 1983). In Shetland, the moth has been recorded singly on eastern Mainland at Eswick, the first time in July and September 1994 and then again in September 1995. In 1996, it was recorded there singly in both June and late August. No records were made in 1997, but one was made in early July 1998 (Pennington, 1996; 1997; Pennington and Rogers, 1999). The many recent records from Shetland seemingly represent only stray specimens from Continental Europe.

In Denmark, *A. segetum* is a moth species of considerable economic importance. The larvae, as cutworms, often damage various agricultural crops. The moth has been surveyed over the last forty years and strong annual fluctuations in its frequency have been noted. During the period, however, no firm evidence of any regular migratory behaviour in Northern Europe has been established, contrary to southwestern Europe where the moth is a regular migrant (P. Esbjerg, personal information). Migrations from the latter area have been traced in southern England as early as early May, where the moth has been recorded together with other Mediterranean moth species (Hale and Hicks, 1999).

The appearance of the moth can be confused with two other related migrant species found in the Faroe Islands, namely *Agrotis ipsilon* (Hfn.) and *Peridroma saucia* (Hb.), which also have pearly hindwings, Fig. 2. Both are usually larger than *A.segetum*. On the forewing, *A. ipsilon* has a black dash extending from the reniform stigma to the outer cross line; in *P. saucia*, this black dash is lacking, but the forewing markings, especially the innermost orbicular stigma, are larger, the forewing is broader and of a more mottled brownish colour,

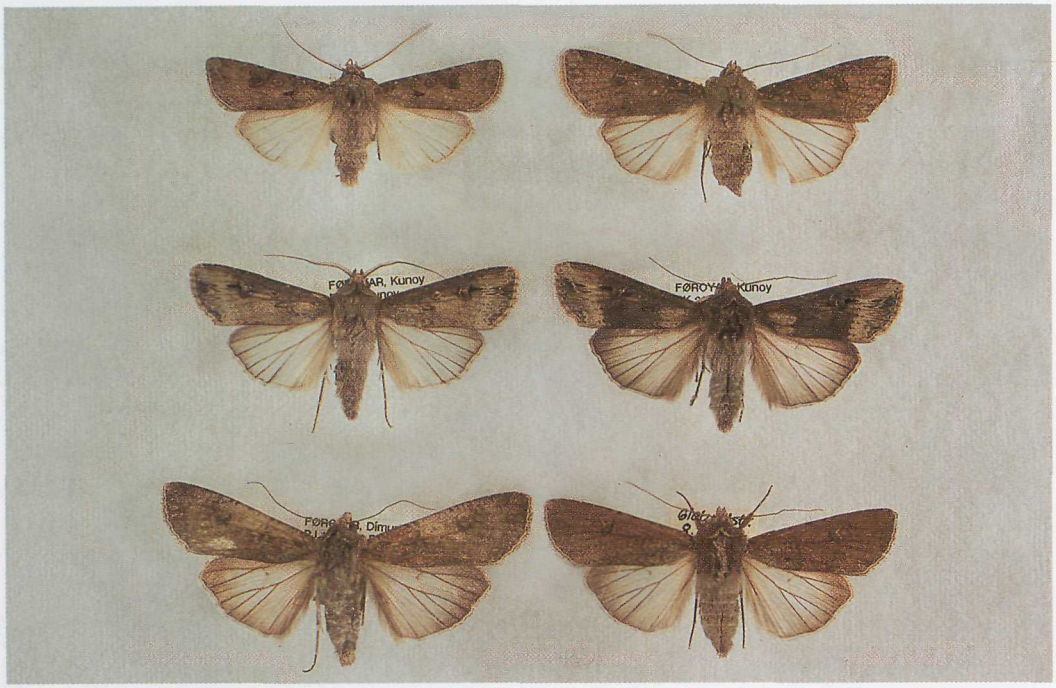

Fig. 2. *The appearance of* Agrotis segetum *(L.) compared with other migrating noctuids recorded from the Faroe Isles.*
Upper row. Agrotis segetum. *Left. Male.* gen. aest. *Denmark. Fyn, Nørresø 14.X.1957. Right. Female.* gen. aest. *Denmark. East Jutland, Horsens 20.X.1959.*
Middle row. Agrotis ipsilon *(Hfn.). Left. Male. Faroe Islands. Kunoy 28.VIII-4.IX.1996. Right. Female. Faroe Islands. Kunoy 4-22.IX.1996.*
Lower row. Peridroma saucia *(Hb.). Left. Male. Faroe Islands. Stóra Dímun. 26.VIII- 3.IX.1994. Right. Female. Denmark. East Jutland, Glatved 8.X.1964.*

Mynd 2. Soleiðis sær *Agrostis segetum* (L.) út borin saman við aðrar ferðanáttfirvaldar, sum eru skrásettir í Føroyum.
Ovasta rað: *Agrostis segetum.* Vinstrumegin. Kalldýr. *gen.aest.* Danmark. Fyn, Nørresø 14.X.1957.
Høgrumegin. Kvenndýr. *gen.aest.* Danmark. Eysturjútland, Horsens 20.X.1959.
Miðrað: *Agrotis ipsilon* (Hfn.). Vinstrumegin. Kalldýr. Føroyar. Kunoy 28.VIII-4.IX.1996.
Høgrumegin. Kvenndýr. Føroyar, Kunoy 4-22.IX.1996.
Niðasta rað: *Peridroma saucia* (Hb.). Vinstrumegin. Kalldýr. Føroyar. Stóra Dímun. 26.VIII-3.IX.1994.
Høgrumegin. Kvenndýr. Danmark. Eysturjútland, Glatved 8.X.1964.

and in the hindwing a discal spot is present.

Noctua orbona (Hfn.)

During another nightly excursion on 7 July 1997 to an outfield area near Nesvík on northern Streymoy, SA caught a moth, which, with its yellow dark-banded hindwings, looked much like a small specimen of the well-known Faroes moth, the *Veingjagúli* (*Noctua pronuba*). Its forewing,

Table 1. *Day to day changes in meteorological factors over the Faroe Islands during periods in 1996 and 1997 with long-range lepidoptera migrations.*
Talva 1. Veðurlagsbroytingar í 1996 og 1997 við nógvum ferðandi náttfirvaldum.

Temperature values, wind direction and wind velocity at sea level are recorded at midnight, 00 UTC, and at 850 hPa (1500 m above sea level) at 12 UTC. Data from Deutsche Wetterdienst, Frankfurt am Main.

		Meteorological Data at Sea Leve	Data at 850 hPa (1500 m a.s.l)				
Year/ date	**Observation of migrants**	**Pressure (hPa)**	**Temp. (°C)**	**Wind direction**	**Velocity (m/sec)**	**Temp. (°C)**	**Wind direction**	**Velocity (m/sec)**
1996:								
12.VI	-	1005	+9	w	15	0 / -3	nw	20
13.VI	-	1025	+7	n	< 5	+1/ -6	w	10
14.VI	+	1030	+10	ssw	10	+3/+1	w	20
15.VI	-	1025	+10	w	5	+9/-14	sw	20
16.VI	+	1025	+9	e	< 5	+5/ -1	sw	30
17.VI	-	1010	+9	nw	10	+1/ 0	nw	30
18.VI	+	1015	+8	ne	20	+3/ -7	nne	25
19.VI	+	1020	+8	n	5	0 / -2	n	15
20.VI	+	1020	+6	ne	< 5	+1/-20	ne	20
21.VI	+	1020	+5	nw	5	+2/-20	n	15
1997:								
28.VI	-	1020	+5	w	5	+7/-27	nw	5
29.VI	-	1015	+5	w	>5	+8/-10	n	5
30.VI	-	1012	+5	ne	5	0/ -7	ne	25
1.VII	-	1015	+7	nw	15	+2/-25	ne	30
2.VII	+	1015	+8	ne	10	+7/+1	e	15
3.VII	+	1010	+8	ne	5	+2/+1	se	20
4.VII	+	1010	+9	s	10	+4/-11	sw	20
5.VII	+	1015	+10	sw	5	+7/+4	w	30

however, was more distinctly marked and had a differentiating light brown ground colour. During the winter, the specimen was handed over for determination to another Faroes lepidopterist, Mrs. Annleyg Patursson in Tórshavn. During a visit in early August 1998, the specimen was shown to SK who identified it as *Noctua orbona* (Hfn.), another unrecorded moth species from the Faroe Islands. At that time, the specimen had lost its abdomen, which complicated to some extent a determination of sex, as the species, contrary to *N. pronuba*, does not demonstrate sexual dimorphism in forewing coloration. The coupling site of the frenulum on the underside of the forewing demonstrated that it was a female, cf. Fig. 39-C in Kristensen (1970). The appearance of *Noctua orbona* compared with *N. pronuba* is shown in Fig. 3.

The occurrence of *N. orbona* in the Faroe Islands was unexpected, as the moth until now had not been regarded as migratory. The record occurred contemporaneously, however, with other regular migrating lepi-

doptera. At the time when the moth was recorded, SK had been collecting specimens in the Faroes. During late June and early July, the prevailing wind direction from the northeast prevented any lepidoptera migrations from Central Europe, cf. Table 1. On 2 July, the weather conditions changed, and on the same day an evident migration of many *Plutella xylostella* and a few *Vanessa atalanta* was observed on the island of Sandoy, and on other islands in the Faroes on the following days. On 5 July, a great number of hill-topping Red Admirals were spotted at 500 m a.s.l. on Kunoy (Mr. Atli Vilhelm, personal information). Most probably, the specimen of *N. orbona* was also transported during the same period, suggesting that it had reached northern Streymoy by 2 or 3 July.

In the neighbouring faunas, two specimens were recorded in 1862 on Shetland (Pennington, 1997). The authenticity of these sightings has been questioned by recent British authors (Bretherton *et al.,* 1983). In Scandinavia and Great Britain, its distribution is comparable to *Agrotis segetum,* and the moth is generally characterised as local, thermophilic, and fluctuating in occurrence (Hoffmeyer, 1962; Nordström *et al.,*1969; Bretherton *et al.,* 1983). During recent decades, its frequency in Denmark has been closely related to periods with warm summers, as 1964-1976, the early 1980s, and most recently from 1994 onwards. In 1997, the species appeared quite commonly in light traps in southern and southeastern Denmark.

This pattern suggests that the local and restricted populations of *Noctua orbona* in northwestern Europe are reinforced during warm summers by migration from the eastern parts of Continental Europe. Due to its status as a generally uncommon moth species in Central and Western Europe, such stray specimens of *N. orbona* have not earlier been recognised as migrants in European literature. Such a pattern of dispersal may not be recognised until stray specimens are recorded far away from their breeding areas.

The early date of the Faroese record is also of interest, as the ordinary period of flight of the moth is in late summer from late July to September, like its close relative in the Faroes, *Noctua pronuba.* The middle of June is the normal time for emergence of both moth species. After a short flight period, both sexes spend the main part of summer aestivating in sheltered places until they are sexually mature in early August (Bretherton *et al.,* 1983). The early date of the Faroese record may suggest that an early migratory potential is present in these aestivating and teneral European noctuid species. Such early migratory movements are well known in other aestivating moth species, such as the cosmopolitan *Agrotis ipsilon* (Hfn.) and the Australian *A. infusa* (Bsd.) (Williams, 1958), or the nearctic *Chorizagrotis auxiliaris* Grote (Pruess and Pruess, 1971).

Meteorological Factors Governing the Transport of the Moths to the Faroes

The record of the two species in 1996 and 1997 was contemporaneous with a number of long-range migrating lepidoptera that regularly are observed in the Faroe Islands.

Thus, in 1996, *Agrotis segetum* occurred at the same time as other migrant species, such as *Vanessa atalanta, V. cardui, Autographa gamma* and *Plutella xylostella.*

According to observations received at Føroya Náttúrugripasavn in Tórshavn, the first two Red Admirals were observed on 14 June, then later on 16 June. From 18 to 21 June, more than twenty specimens were recorded on many of the islands. From 16 to 19 June, a migration of *V. cardui* was recorded on Suðuroy, but apparently not on the other islands (Mr. Ejler Djurhuus, personal communication). In western and northern Europe, a migration, which was dominated by *V. cardui* and other Mediterranean species, occurred at the same time. The migration reached southern England on 3 June (Davey, 1997), entered into southern Scandinavia on 7 June (Hansen, 1997), reached Shetland on 8 – 9 June (Pennington, 1997), and finally crossed the Polar Circle around 20 June (Hansen *l.c.*).

In 1997, the Faroese record of *N. orbona* coincided with a small migration of *V. atalanta* and *Plutella xylostella.* This migration was not observed in Shetland, where it was antedated by a record of an extraordinarily rare vagrant moth, *Ochropleura flammatra* (Den. and Schiff.), which was caught on 29 June at Eswick on eastern Mainland (Rogers and Davey, 1998).

Because of the many verified observations during both years, this article attempts to elucidate the possible meteorological transport mechanisms by which the above-mentioned lepidoptera species are carried across the Atlantic from continental Europe to the Faroes.

Recent research has shown that the frontal waves that accompany low pressure weather systems provide the fastest means of transporting living organisms, both birds and insects either across the European continent (Mikkola, 1967; 1986) or the Atlantic Ocean (Hurst, 1969; Wolff, 1971; Elkins, 1979; Davey, 1999). By using "backtracks", *i.e.* the daily changes in the position of the weather fronts along which air currents occur, it is possible to obtain a relatively accurate indication of the origin of migrating or vagrant insects, as the path of the migration can often be traced back to the centre of the air currents (Mikkola, 1967; Hurst, 1969; Davey, 1997). Further, it has been demonstrated that a number of long-range migrant moth species, such as *Agrotis ipsilon*, use low-level jet streams at an altitude of about 600 m above ground level (Showers *et al.*, 1989).

The conditions for a wind-borne transport of the two moth species were examined both at sea level and at higher altitudes by comparing a number of relevant meteorological parameters prior to and at the time the migrating lepidoptera were observed in the Faroes, Table 1. In June 1996, the weather conditions favoured only a long-range, aerial transportation between 14-16 June. At that time, a high pressure area over the British Isles directed fairly strong southern and southwestern winds clockwise from southwestern France, to west of Ireland, and to the Faroe Islands. The strong and relatively warm, southern air currents both at ground level and at the 850 hPa level continued until 17 June, when the direction of the wind again changed to a

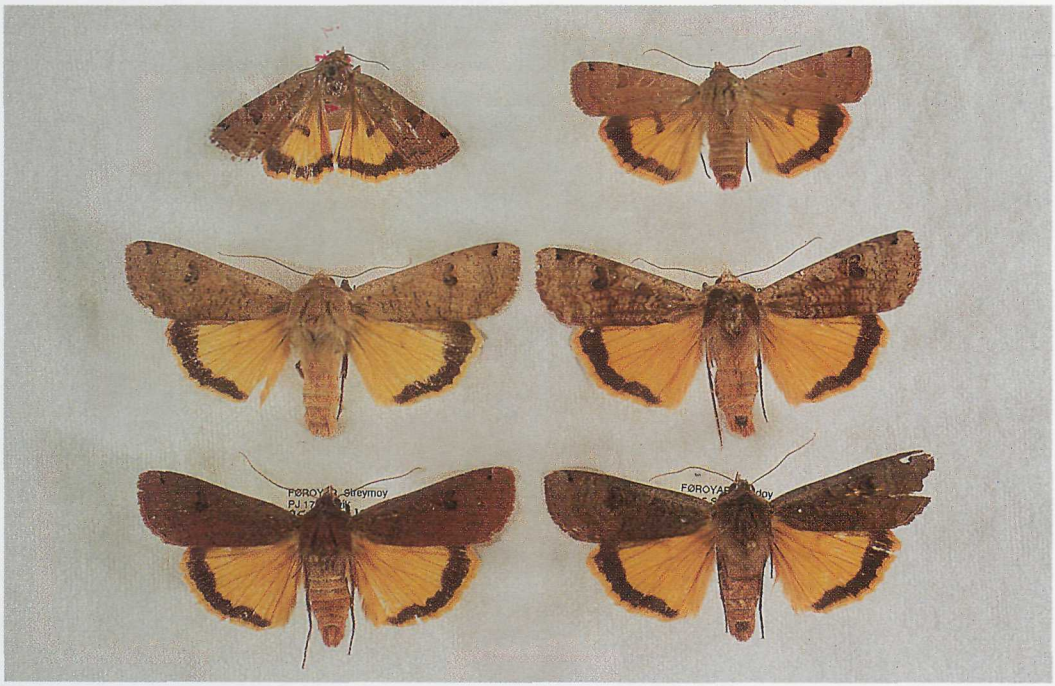

Fig.3. *The appearance of* Noctua orbona *(Hfn.) and* N. pronuba *(L.).*
Upper row: N. orbona. *Left. Female. Faroe Islands. Streymoy, Nesvik 7.VII.1997.*
Right. Male. Denmark. East Jutland, Ramten skov 1.VII.1963.
Middle row. N. pronuba. *Left. Light-coloured female. Faroe Islands. Suduroy, Akraberg 21-28.VIII.1991.*
Right. Typical male. Faroe Islands. Sandoy, Sandur 17-24.VIII.1991.
Lower row. Noctua pronuba. *Left. Red-coloured female. Faroe Islands. Streymoy, Hoyvík 25VIII-3.IX.1993.*
Right. Blackish male. Faroe Islands. Sandoy, Sandur 1-8.IX.1991.

Mynd.3. *Noctua orbona* (Hfn.) og *N.pronuba* (L.).
Ovasta rað: *N.orbona*. Vinstrumegin. Kvenndýr. Føroyar. Streymoy, Nesvík 7.VII.1997.
Høgrumegin. Kalldýr, Danmark. Eysturjútland, Ramten skógur 1.VII.1963.
Miðrað: *N. pronuba*. Vinstrumegin. Ljóslitt kvenndýr. Føroyar. Suðuroy., Akraberg 21-28.VIII.1991.
Høgrumegin. Eyðkent kalldýr. Føroyar. Sandoy, Sandur 17-24.VIII.1991.
Niðasta rað: *Noctua pronuba*. Vinstrumegin. Morreytt kvenndýr. Føroyar. Streymoy, Hoyvík 25.VIII-3.IX.1993.
Høgrumegin. Myrkt kalldýr. Føroyar. Sandoy, Sandur 1-8.IX.1991.

northerly direction. The meteorological data fit well with observations of the first arrival of *V. atalanta* and *V. cardui*. Probably most of the other migrant moths also arrived in the Faroes during this short period, including the *Agrotis segetum*. Its size and appearance in Fig. 1 corresponds closely with British specimens and suggests that its origin was either western France or southern England.

The corresponding data for 1997 in Table 1 show that a relatively warm air cur-

rent at the 850 hPa level passed over the Faroes on 2 – 3 July, which coincided with the sudden occurrence of *Plutella xylostella* and *V. atalanta* in the islands. At ground level, the air current followed the frontal area of a local low pressure system, which had originated in southern France on 29 June. During its northward movement on 30 June, it caused a marked depression in southern Germany with strong, thermal upwinds and local thunderstorms. During its further movement to the northwest, the resultant cold front system directed the air currents over southern Scandinavia. On 2 July at the 850 hPa level, the warm southern air current passed west of Norway with a speed of 72-108 km/h and reached the Faroe Islands on 2 – 3 July, then changed its direction to southwest, Table 1.

The significant occurrence of long-range, migratory lepidoptera species, such as *P. xylostella* and *V. atalanta* in the Faroes during these days suggested that they originated from the Mediterranean site of the depression on 29 June. The *Noctua orbona* might also have entered the air current later on from a site in central or eastern Europe, most likely on 30 June, when strong thermal upwinds occurred over central Germany during the deepening of the low pressure area. In this case, the circumstantial evidence from the data in Table 1 strongly indicates that airborne transport took place at 1000-1500 metres above sea-level, thus enabling a transport of more than 2500 km from southern Europe to the Faroes, without compromising the viability of even a small moth like *Plutella xylostella.*

Furthermore, the present analysis demonstrates that a main, meteorological factor governing the insect transportation to the Faroe Islands is the geographical location of the parent high or low pressure system over the British Isles. In the case of a high pressure area, such as in 1996, the migratory transport is directed clockwise west of Ireland via the Atlantic Ocean. In 1997, with a low pressure located in the same area, the transportation was directed counter-clockwise via southern Scandinavia or the North Sea to the Faroe Islands, cf. the illustrations in Kaaber *et al.* (1994). Interestingly this dispersal mechanism is used not only by regular migrating insects, but apparently also by an ever-increasing number of other lepidoptera species that are recorded more or less regularly in the North Atlantic isles far away from their usual breeding areas.

Acknowledgements

The authors would like to thank Dr. Dorete Bloch, Director of the Føroya Náttúrugripasavn, Tórshavn, for her kind co-operation. Professor Peter Esbjerg, The Royal Veterinary and Agricultural University, Copenhagen, gave valuable information on *Agrotis segetum* in Denmark. The climatologists, Mr. John Cappelen and Mr. Stig Rosenørn, both at The Danish Meteorological Institute, Copenhagen, provided access to the meteorological data used. Their kind support is gratefully acknowledged. The fauna studies in the Faroe Islands by SK in 1996 and 1997 was made possible by financial support and grants from the Schiøtz-Christensens Mindefond, The Museum of Natural History in Aarhus, and The Carlsberg Foundation. During both years, Føroya Náttúrugripasavn and Føroya Banki in Tórshavn provided generous support and excellent working conditions.

Literature

Bretherton, R.F., Goater, B. and Lorimer, R.I. 1983. Noctuidae. *In* Heath, J. and Emmett, A.M. (eds.).

The Moths and Butterflies of Great Britain and Ireland. vol. 9. Colchester.

Davey, P. 1997. The 1996 Insect Immigration. *Atropos* 2:2-13.

Davey, P. 1999. Weather Conditions Leading to the 1998 Green Darner *Anax junius* (Drury) Influx. *Atropos* 6:8-12.

Elkins, N. 1979. Nearctic Landbirds in Britain and Ireland: A Meteorological Analysis. *British Birds* 72:417-433.

Hale, J. and Hicks, M. 1999. Lepidoptera Migrations in Great Britain in 1998: Report from St. Agnes, Isles of Scilly. *Atropos* 6:46-47.

Hansen, M.D.D. 1997. Observations on the Migrations of the Painted Lady (*Vanessa cardui* (L.)) in Denmark in 1996. *Entomologiske Meddelelser* 65:165-173.

Hoffmeyer, S. 1962. (2nd ed). *De danske Ugler*. Aarhus.

Hurst, G.W. 1969. Meteorological Aspects of Insect Migrations. *Endeavour* 28:77-81.

Kaaber, S., Gjelstrup, P., Bloch, D. and Jensen, J.K. 1994. Invasion af Admiralen (*Vanessa atalanta* (L.)) og andre sommerfugle på Færøerne i 1992. *Fróðskaparrit* 41:125-149.

Kaaber, S. 1997a. Iagttagelser under tre sommerfuglетræk over Færøerne i 1996. *Entomologiske Meddelelser* 65:109-118.

Kaaber, S. 1997b. An Annotated List of Lepidoptera Known from the Faroe Islands. *Fróðskaparrit* 45:97-106.

Kaaber, S. 1999. Nogle bemærkninger om otte sommerfuglearter, nye for Færøerne i 1999. *Entomologiske Meddelelser* 67: 1-12.

Kristensen, N.P. 1970. *Systematisk Entomologi*. København.

Lorimer, R.I. 1983. *The Lepidoptera of the Orkney Islands*. Faringdon.

Mikkola, K. 1967. Immigrations of lepidoptera, Recorded in Finland in the Years 1946-1966, in Relation to Air Currents. *Annales Zoologica Fennica* 2:124-139.

Mikkola, K. 1986. Direction of Insect Migration in Relation to the Wind. *In*: Danthanarayana, W. (ed.) *Insect Flight: Dispersal and Migration*. Berlin. 152-171.

Nordström, F., Kaaber, S., Opheim, M. and Sotavalta, O. 1969. *De fennoskandiska och danska nattflynas utbredning*. Lund.

Olafsson, E. and Björnsson, H. 1997. Fidrildi á Islandi 1995. *Fjölrit Náttúrufrædistofnur* 32.

Pennington, M. 1996. Moths and Butterflies in Shetland. Lepidoptera Report for 1996. Shetland Entomological Group. November 1996.

Pennington, M. 1997. Moths and Butterflies in Shetland. Lepidoptera report for 1996. Shetland Entomological Group. June 1997.

Pennington, M. and Rogers, T. 1999. Reports from Coastal Stations - 1998: Shetland. *Atropos* 6:62-63.

Pruess, K.P. and Pruess, N.C. 1971. Telescopic Observation of the Moon as a Means for Observing Migration of the Army Cutworm, *Chorizagotis auxiliaris* (Lepidoptera, Noctuidae). *Ecology* 52:999-1007.

Rogers, T. and Davey, P. 1998. Capture of Black Collar *Ochropleura flammatra* in Shetland. *Atropos* 4:28-29.

Showers, W.B., Smelser, R.B., Keaster, A.J., Whitford, F., Robinson, J.F., Lopez, J.D. and Taylor, S.E. 1989. Recapture of Marked Black Cutworm (Lep., Noctuidae) Males After Long-range Transport. *Environmental Entomology* 18:447-458.

Skou, P. 1991. *Nordens ugler*. Danmarks Dyreliv bd 5. Stenstrup.

Williams, C.B. 1958. *Insect Migration*. London.

Wolff, N.L. 1971. Lepidoptera. *In*: Tuxen, S.L. (ed.) *The Zoology of Iceland*. III, 45. Reykjavik.