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The migration of *Danaus plexippus* (Linnaeus, 1758) during October 1995 in the UK (Lepidoptera : Nymphalidae, Danainae)

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Summary

Sightings of *Danaus plexippus* (Linnaeus, 1758) are reported from the UK, Ireland, Holland, Belgium and France in October 1995. We strongly suggest that these migrated across the Atlantic Ocean, just as most likely has been the case with past migrations. Evidence for this theory is supported by coinciding reports of another North American butterfly in England, *Vanessa virginiensis* (Drury, [1773]) and many North American birds. The meteorological conditions during September and October 1995 don't exclude transatlantic migration.

Résumé

Des observations de *Danaus plexippus* (Linnaeus, 1758) sont rapportées en provenance du Royaume-Uni, d'Irlande, des Pays-Bas, de Belgique et de France en octobre 1995. Il est suggéré, arguments à l'appui, que ces exemplaires sont des migrateurs originaires de l'autre côté de l'océan Atlantique, comme il en a été plus que probablement pour les migrations antérieures. Cette théorie est corroborée par les mentions simultanées d'un autre papillon nord-américain en Angleterre, *Vanessa virginiensis* (Drury, [1773]) et de nombreux oiseaux nord-américains. Les conditions météorologiques pendant les mois de septembre et d'octobre 1995 n'excluent pas une migration transatlantique.

Introduction

Danaus plexippus (Linnaeus, 1758), the Monarch butterfly, has since long been suspected to cross the Atlantic Ocean. Most likely trans-atlantic migration was the way it established colonies on the Azores, Madeira and the Canary Islands. From the UK about 450 records of *Danaus plexippus* were known between the first British observation on 6th September 1876 (Walker, 1914) and 1988 (Bretherton, 1989). Some large and sharply defined immigrations during September and

October were observed in the past : an invasion of 38 butterflies in 1933 was described by Williams *et al.* (1942). In 1968 the main invasion started on 30th October with 63 reported butterflies, in 1981 the invasion started on 24th September and 135 butterflies were reported (Bretherton & Chalmers-Hunt, 1982). In 1983 still a dozen specimens were reported (Bretherton, 1984). The largest immigration ever noticed in the UK was between 29th September and 22nd October 1995 ; more than 150 butterflies were reported. They were mainly observed at the south coast, just as was the case with previous immigrations (Bretherton, 1989). Again, coinciding reports of many American birds during the same period strongly suggest an American origin. Contacts via Internet with entomological, ornithological and meteorological scientists have lead to an acceptable hypothesis about this migration.

UK-sightings of Monarchs in 1995

The first sighting of a Monarch butterfly in England in 1995 was on 6th August with further singletons on 10th and 23rd August. A probable explanation for these singletons in August could be found in the escape of about 30 Monarchs during July from the greenhouse of Dr. M. Rothschild in Ashton, Northants (P. Batty, pers. comm.). Indeed, the first sighting was at Winchester (Hants), about 120 km from Ashton. On 29 th September a Monarch was reported at Liverpool, about 50 km from Ashton. The presumed early October immigration however, large and sharply defined, cannot be explained by these escapees. Almost all observations were done at the south coast of the UK, in the counties of Cornwall, Devon and Dorset.

A map with all sightings of Monarchs during this period in the UK was compiled together with Simon Coombes (pers.e-mail) (Fig. 1). If we superpose the local weather information we can give a fairly good explanation for the histogram (Fig. 4).

"From 28th September to 1st October strong westerly winds blew, having culminated in a west-southwest gale on 30th Sept. The westerly winds were followed from 2nd to 5th October by four days of south-westerly winds, after which continuous southerly winds blew until 14th October. Unsettled weather, with up to 95% cloud cover persisted from 24th September to 3rd October. This almost certainly prevented recording and reduced flight-time of the Monarchs. On 4th and 5th October 75% cloud cover was reported followed by two days of total cloud cover, immediately followed by Sunday 8th October, with 100% sunshine and 20°C. This day was also 'International Birdwatch

Fig. 1

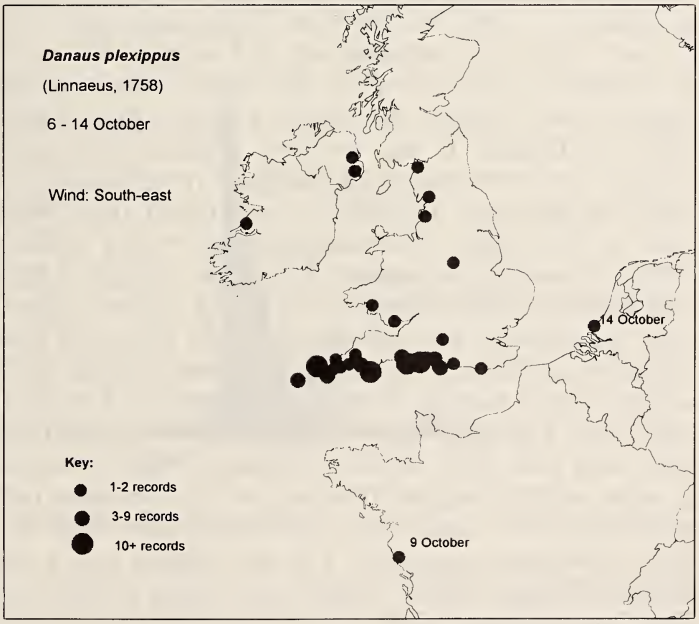

Fig. 2

Fig. 1. Sightings of *Danaus plexippus* (Linnaeus, 1758) in the UK (July - 5th October 1995).
Fig. 2. Sightings of *Danaus plexippus* (Linnaeus, 1758) in the UK, Ireland, Holland and France (6th - 14th October 1995).

Day' and "many birders were out and about to record the Monarchs" (R. Lane, pers. comm.).

As discussed later we presume that the main arrival of the Monarchs in the UK should have been around 3rd October. During the following days 14 Monarchs were reported until 7th October despite the very poor weather conditions. This proves that they were already present before 8th October, the day on which most of the Monarchs were **seen** (Fig. 2).

The numbers reported immediately declined and 7 days later, on the 14th, most of them seemed to have disappeared ; many 'Monarch-seekers' were successful during the morning of the 14th and reported Monarchs being restless and flying strongly until midday. But many were frustrated after midday, with no afternoon sightings anywhere in Britain. Also the next day, 15th October, was a bright sunny Sunday but again almost no sightings anymore. The only positive evidence of change was a 90 degree shift in wind direction from south-east on 14th October to south-west on 15th October. This was the first change back to south-westerlies since 5th October. It seems that they dispersed in different directions. Remarkably coinciding with the disappearing of the butterflies at the south coast of England, one was reported in Ireland on 12th October from Belfast and one in Co. Clare and the only one from Cockermouth in Cumbria, UK on 13th October. In Holland at Oostvoorne in the Meuse valley on 14th October a singleton was reported as well as a record from Downpatrick, Co. Down in Ireland. It was the first Monarch-sighting since 1969 in Holland. On 15th October the last report from Ireland was in co. Down and from the same day was the only report from Belgium near the coast at Raversijde, Oostende (province West-Flanders) (Vanholder, 1996). It was first seen by R. Dejaegher through a binocular, flying high but afterwards coming down out of the sea. After 14th October only 12 specimens were reported from the UK at the south coast. The Monarchs in Holland and Belgium probably ended up there with the westerly winds blowing until 14th October. In France (Dept. Vendée and Dept. Finistère) only 4 sightings were reported and 3 of them were seen after 20th October (Dubois, 1996). Although this sample is rather small, it suggests that some of the Monarchs might have been migrating south, exactly like they should have done in the USA on their southbound migration. The last sighting was a butterfly at Les Sables d'Olonne (Dept. Vendée) seen flying strongly southwards on 29th October (Figs. 3 & 4).

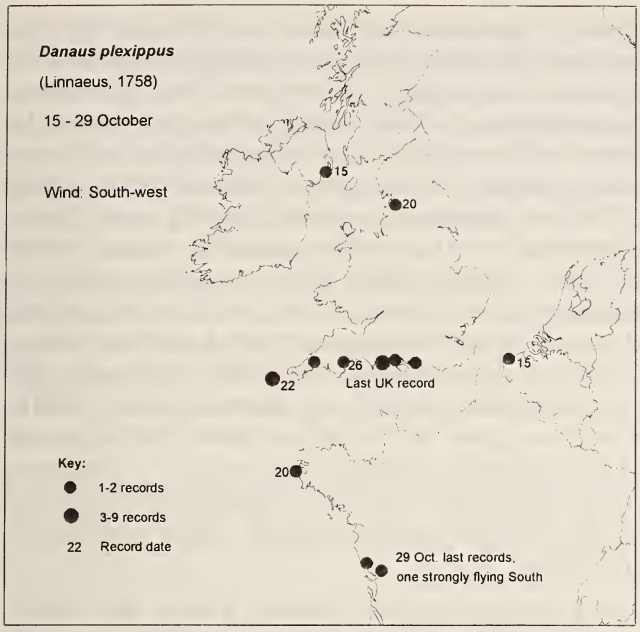

Fig. 3

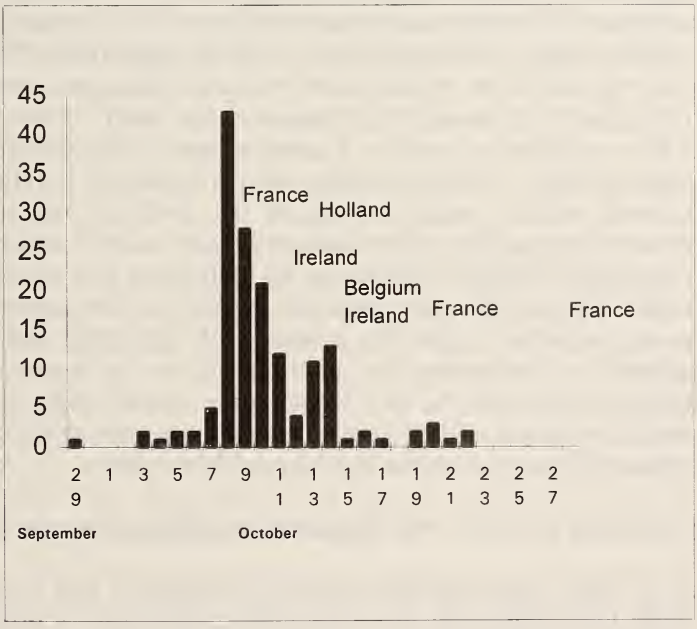

Fig. 4

Fig. 3. Sightings of *Danaus plexippus* (Linnaeus, 1758) in the UK, Belgium, Holland, Ireland and France (15th - 29th October 1995).
Fig. 4. Histogram of sightings of *Danaus plexippus* (Linnaeus, 1758) in the autumn of 1995. Histogram compiled from 162 records.

Exactly analogous with the previous migrations in 1968 and 1981 to the UK, very few were seen after about ten days of arrival. One female, caught in Darwish, Devon, laid eggs in November 1995. The caterpillars were reared successfully by Nigel South in his greenhouse. It is a pity that the female was not kept as a voucher specimen. By so-called cardenolide-fingerprinting the origin of the specimen could have been detected. Only an abdomen, fore- and hind-leg would have been sufficient. Cardenolides are the cardiac glycosids present in the adult Monarchs and these are responsible for their unpalatability to birds. These cardenolides are concentrated in the caterpillars by feeding on *Asclepias* sp. and depending on the foodplant used, a different cardenolide fingerprint is found. It is possible to predict accurately the foodplant used by the caterpillar in this way (Brower, 1984 ; 1995). This knowledge could have given an indication about the origin of the Monarch : e.g. if it had been an *Asclepias syriaca*-type — the main foodplant used by the southbound migrant Monarchs in the USA (Brower, 1995) — or an *Asclepias curassavica*-type, which is the foodplant on the Canary Islands.

The fact of capturing a fertile female at Darwish cannot give much additional information about its origin. In Minnesota, USA the first non-reproductive Monarchs occurred from 15th August. In the more southern states like Kansas even on 18th September 1995 Monarchs were reported to be reproductive, because mating pairs were reported. In the south, however, the situation is less clear, normally the front of the remigration reaches Kansas around 10th September. In the extreme South, like Texas, eggs were still found on 15th November. It seems safe to conclude that in the northern and middle states Monarchs seen after 10th September are usually non-reproductive. Nevertheless, fertility cannot be an indication for the origin of the female. Migrant females need only 6 days for the conversion of the non-reproductive stage into initiation of egg-laying and this can be induced by increasing the photoperiod to 14 hours and raising temperatures to 25 °C (C. Taylor, pers. e-mail). This is most likely what happened in Nigel Souths' greenhouse, thus explaining why the female laid eggs during the first days of November.

Hypothesis about the way Monarchs travelled across the Atlantic

In the past wind-assisted transatlantic migration was suggested many times. Felt (1928) indicated *Danaus plexippus* to be a prime candidate for crossing the Atlantic on its own power. In Britain most of all past observations were done at the south Coast. Lempke (1972) interpreted

sightings at the coast as an indication that the Monarchs travelled across the Atlantic by ship. Probably ship-assistance occurs from time to time, when singletons are reported in Europe. But this would mean that in the case of a large migration like the present one, high numbers should have been travelling together on the same ship. Indeed, to have reports of at least 150 Monarchs in the UK, several thousands should have been on the wing. On some occasions (Brewer, 1967 ; Varey *in* Urquhart, 1987) swarms of *Danaus plexippus* were seen flying along ships and sometimes landing on ships in the Atlantic, suggesting migration. The colonization of the Bermuda Islands more than 1000 miles offshore proves that Monarchs fly across the Atlantic. Observations of butterflies flying over the Atlantic were in many cases reported during hurricanes or stormy weather conditions (Scudder, 1876 ; Varey *in* Urquhart, 1987 ; Brewer, 1967).

For this reason one hypothesis suggested that Monarchs in 1995 could have been ejected in the lower jet-stream by September tropical hurricanes in the USA and in this way have crossed the Atlantic Ocean. During September 1995 two tropical storms, Luis and Marilyn, were tracked on the USA east coasts, the supposed area of origin of the migrating Monarchs. Luis was tracked from 1st Sept. to 14th Sept., when a breakaway low from its remnants was located 300 nautical miles from W. Belfast (Ireland). Mike Campbell (pers. e-mail) analysed the jet to be between 200 and 250 mb (millibar) with average temperatures of -44°C. These temperatures are almost 100% lethal for the butterflies. The jet was characterized by a velocity of 125 kts. This means the distance from the American East Coast to Ireland would have been travelled in 24 hours. These data don't seem to fit with our sightings in the UK. A theoretical possibility for Monarchs to travel across the Atlantic with hurricane Luis could only have been as follows : an instability existed for about 200 nautical miles radius from Luis's center. Monarchs could not have been incorporated into the flow of Luis and ejected in the jet stream unless there were low level jet streams or thunderstorms near the United States' coast wich could have ingested the Monarchs and fed them to Luis beyond its 200 nm radius. A second tropical September storm, Marilyn, was tracked from 21st September to 26th September. The dates seem to fit with the sightings in the UK but... Marilyn did never come close to any land.

A reasonable explanation however for the migration can be found in the existence of a very unusual zonal flow. On 29th September there was a low pressure centre over St. Anthony, Newfoundland (Canada). It intensified to a rather deep 961 mb low by 30th September and

deepened further to 951 mb to lie about 62 degrees North 33 degrees West. At the same time a high pressure centre of 1033 mb was located 200 nautical miles South of Cape Race. The high was moving along a ridge wich extended from Nova Scotia to the Azores. On this day westerly surfaces with a velocity of 30-35 kts were reported by stations in Newfoundland and ships across the Atlantic to Ireland. Such a wind pattern is considered a zonal flow, a condition whereby the winds are nearly parallel to the lines of latitude. Winds generally follow isobars and in this zonal flow around 1st October the isobars were stretching from North America to Europe. These lows of such depth are considered an abnormal situation at that time of the year (they are more common during January through March). Also the position of the ridge of high pressure was unusual. This made the zonal flow across the Atlantic indeed very unusual. On 2nd October the zonal flow was breaking down. In the zonal flow the air temperatures would have been much warmer and hospitable to the Monarchs. Indeed the temperatures between 1500 and 600m level were between 10 and 15 degrees Celsius. As the air moved across the ocean, it was being warmed by the Gulf Stream. This caused the airmass to become increasingly stable, hence non-turbulent. This layer was likely to be warmer by several degrees at the time it reached Europe. Concluding from this we can argue that if a bunch of Monarchs were to take flight above 950 mb — wich represents about 600 m height- around 29 th September (when the zonal flow was to be established), they could have been conceivably carried across the Atlantic at speeds around 30 kts and have ended up in Europe on 3rd October. Indeed, in the past, Monarchs have been reported (by pilots) on height levels of about 1500 m. The 'weak' point remains the question where they have been at night. During the yearly southerly remigration of Monarchs from Canada to Mexico, Monarchs normally don't migrate during the night, but roost together in trees. However, Williams (1958) and Ross (1993) suggested that under certain conditions Monarchs are also able to fly at night, especially during warm nights when temperatures do not urge the butterfly to become inactive. Brower (1995) suggests that migration across large water masses like oceans is merely possible thanks to wind-assistance and hitch-hiking on ships, e.g. during the non-active periods. Although several occasions are described when Monarchs have been seen landing on the water-surface and after a while taking off again, Brower (1995) states that resting on the watersurface for longer than a few minutes would be lethal to the butterfly and is probably not the explanation for what Monarchs do at night when crossing oceans.

Previous to the period of suspected migration across the Atlantic the following observations at the East Coast of the USA were obtained from Dick Walton (pers.e-mail). At Cape May, New Jersey, his research includes 3 daily Pollard-type transects of approximately 5 miles each. The seasonal average for Monarchs per hour of censusing in 1995 was about 26. Daily averages during the suspected migration period were (*Danaus plexippus* per hour) :

Sept. 26 - 15.79
Sept. 27 - 26.00
Sept. 28 - 69.31
Sept. 29 - 32.54
Sept. 30 - 36.21

From these observations it can be concluded that there was indeed a build-up of Monarchs along the East Coast during the time period at which we suggest that migration should have started. Although 28th September was not the 'biggest day of the year', it was significantly above average for the season and may indicate a source for the transatlantic move of the Monarchs.

We may conclude that at least the potential concentrations of Monarchs on the East Coast of the USA were present at the time at which the suitable weather conditions for migration across the Atlantic were establishing.

Coinciding American bird observations

Together with the Monarchs in the UK, many American bird species were reported. This strongly supports the American origin of the Monarchs. October 1995 is likely to be remembered as the best month ever for N. American warblers (fam. Parulidae) in Britain (Millington, 1995). American warblers are such small, delicate birds, hardly larger than Monarchs ! They normally migrate across the Gulf of Mexico. The fact that some of them were seen in Britain is as remarkable as Monarchs to cross the Atlantic. Some of these have only occurred once or twice in the UK. Different species of N. American warblers were reported between 1st and 29th October : *Dendroica coronata, D. petechia, D. castanea, D. pensylvanica, D. striata, Parula americana* (Millington, 1995). All of these are extremely rare migrants, with *D. coronata* being the most regular. Just like the Monarchs they were noticed mostly on Scilly Islands and in Cornwall. Blackpoll warblers (*D. striata*) were noticed for the first time in the UK coinciding with a previous Monarch migration in 1968 (Burton & French, 1969). In

1995 again 2 specimens of the same bird species, wich is extremely rare in the UK, were noticed in localities where also Monarchs were found (Cornwall and Isles of Scilly).

Immigration of American passerine birds, small to medium land birds, was observed during the same period in the UK ; *Zonotrichia leucophrys* (fam. Emberizidae), *Catharus ustulatus, C. guttatus, C. fuscescens* (fam. Turdidae), *Dolichonyx oryzivorus* (fam. Icteridae) and *Pheucticus ludovicianus* (fam Cardinalidae). Other northern American birds were *Charadrius vociferus, Pluvialis dominica* (fam. Charadriidae), *Limnodromus griseus, L. scolopaceus*, (fam. Scolopacidae), *Coccyzus americanus* (fam. Cuculidae), *Anas discors* (fam. Anatidae), *Petrochelidon pyrrhonota* (fam. Hirudinidae). Only the members of the Scolopacidae and *Anas discors* are more or less yearly visitors in the UK, but never common. All others belong to the 'extremely rare' category (i.e. far less than annual occurrence). *Coccyzus americanus*, the yellow-billed Cuckoo, has turned up only a dozen times, mostly on the Isles of Scilly (P. Doyle, pers. e-mail). The observation of 22 specimens of the red-eyed vireo (*Vireo olivaceus*) was remarkable, although this is an annual immigrant, esp. on Scilly Isles. Both birds and Monarchs were apparently displaced by hurricane conditions and both could have been at the mercy of strong westerly winds wich persisted across the Atlantic thereafter.

Coinciding North American Lepidoptera

Another sighting that supports the American origin of the Monarchs is that of the North American *Vanessa virginiensis* (Drury, [1773]) (Lepidoptera, Nymphalidae) on 13th October at Prawle Point, Devon, seen together with a Monarch on the same day. I would strongly recommend to examine the genitalia of all *Nomophila* Hübner, [1825] (Lepidoptera : Pyralidae) caught during the same period at the south coast. It seems almost predictable that the N. American *Nomophila nearctica* (Munroe, 1973) was also present as a migrant species. In the past at least one *Nomophila nearctica* was found on the British Isles on 22nd August 1919 (Pelham-Clinton, 1984).

Conclusion

In the past (1968), simultaneous migrations of *D. plexippus* and *V. virginiensis* have occurred, but for both species the Canary Islands (Spain) could have been a source of migration. It has always been a matter of dispute whether the migration did start in the Canary

Islands or in N. America. The present paper strongly supports evidence for a Northern American origin of all involved migrating species of Lepidoptera and birds in 1995, correlated with suitable meteorological conditions. If the Monarchs did **not** come from America, the timing is a surprising coincidence, as it then has also been in several other years (1968, 1981), given the potential displacement by the meteorological conditions.

Acknowledgements

First of all I wish to underline that without the facilities of Internet, collecting so much information would have been impossible in such a short time. I have to agree that Internet, the way by which information can be shared so fast, is fantastic and opens very promising possibilities. It was really fascinating to receive so much valuable information from 'specialists ' all over the world. Information cannot travel any faster ! I'd like to thank especially Roger Lane, UK for his very valuable suggestions, his very detailed local weather reports from Cornwall and for sending me a list with all the sightings of Monarchs and birds in the UK ; Nick Bowles, UK for compiling this list of sightings ; Simon Coombes <simon@captain.zynet.co.uk> for plotting, scanning and e-mailing of distribution maps of the Monarchs and mailing me the reference about the migration of Monarchs in 1968 in the UK ; Dick Walton, NJ, USA <rwaltonxxx@aol.com> for the kind communication of local reports of Monarch censusing and for his useful thoughts on fertility in Monarchs during migration ; Mike Campbell, Newfoundland, Canada <campbellm@aesbed.am.doe.ca> for the meteorological analysis of the American weather conditions. Further I'd like to thank Mark Dixon, UK <gc77@dial.pipex.com> for the communication of the escapees of Monarchs in the UK ; Willem Pier Vellinga, Holland <w.p.vellinga@phys.rug.nl> for mailing me the observation of a Monarch in Holland ; Dirk Maes, Brussels <instnat@isl.vub.ac.be> for mailing me the observation in Belgium ; Dr. J. Dubois, France, for the kind communication of 4 sightings in France ; Paul Batty, UK for the facilities to publish requests about Monarch sightings in the ELG-list (Entomological Lifestock Group, UK) ; Patrick Doyle, UK <P.Doyle@aberdeen.ac.uk> for suggestions concerning bird migration to the UK. Last but not least I'd like to thank S. Coombes for plotting the very nice maps added to this paper. Especially thanks to A. Olivier for his revision and for supplying me more Monarch references than I could ever dream of.

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