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The Link Between Cereal Thrips and Thunderstorms

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Across much of northern Europe, there is a traditional link between thunderstorms and the mass appearance of thrips migrating from cereal crops. The link is reflected in the common names for thrips in seven countries. This association could be a coincidence because cereal thrips migrate in warm weather in summer when thunderstorms are common, but personal observations and an earlier study indicate that a causative link is likely. The possibility that electric fields from thunderstorms affect the behaviour of cereal thrips is discussed.

Keywords: Cereal thrips, *Limothrips cerealium,* swarm, thunderstorm, electric field.

Cereals are grown intensively across much of eastern England. In these areas, vast numbers of cereal thrips migrate from cereal crops in July and August (Lewis, 1959). The phenomenal size of these migrations is indicated by their population density in cereal fields, which can reach about 16×10^6 ha^{-1} (Lewis, 1973). In East Anglia, wheat and barley are grown on about 695,000 ha (Anonymous, 2003), which gives a rough regional estimate of 10^{13} migrating cereal thrips (over 300 tonnes).

Migrating thrips regularly become a nuisance to the public because large numbers of them land on exposed skin and produce an unpleasant itching sensation. They also get in the eyes, nose and mouth, and even find their way into picture frames and set off smoke detectors (Cuthbertson, 1989). In England, the biggest nuisance from migrating cereal thrips is traditionally linked with the occurrence of thunderstorms, so thrips are popularly known as thunderbugs or thunderflies. Similar mass migrations occur regularly across much of northern Europe (Körting, 1930). This paper reviews the evidence for the link between cereal thrips and thunderstorms.

Common Names of Thrips

In England, catches of migrating cereal thrips are predominantly *Limothrips cerealium* Haliday, but also include *Limothrips denticornis* Haliday, *Chirothrips manicatus* Haliday and *Stenothrips graminum* (Uzel) (Lewis, 1965). In northern Germany, 95–100% of individuals in mass migrations are *L. cerealium* (Körting, 1930). Mass flights of species other than grass thrips occur, for example *Frankliniella intonsa* (Trybom) (Jenser, 1973), *Taeniothrips inconsequens* (Uzel) (Foster and Jones, 1915), *Thrips imaginis* Bagnall (Evans, 1932) and *Thrips* spp. (Lewis, 1964), but these either occur rarely or are not usually obvious to the general public over a wide area. In Australia, *Pseudanaphothrips araucariae* Mound and Palmer has recently occurred locally in such numbers that it has become a public nuisance (Mound et al., 2002).

Migrating cereal thrips were a nuisance as long ago as the nineteenth century (Bold, 1869). In the twentieth century, they caused suffering among harvest workers and even drove bathers away from a beach resort in northern Germany (Körting, 1930). None of these outbreaks were reported to be connected with thunderstorms, but the popular association of thrips with thunderstorms is widespread. An informal survey of thrips researchers showed that seven countries have common names for thrips that make reference to thunderstorms *(Table 1)*. However, common names could simply reflect a non-causal association. For example, thrips used to be known as cholera flies in Denmark (kolerafluer) and Sweden (koleraflugor), because they were particularly abundant in the warm summer of 1853 when there was also much cholera (Ahlberg, 1926; Maltbæk, 1932). Presumably both the insect and the disease were favoured by the higher temperatures. However, it is remarkable that the link between thrips and thunder is current in the common names used in so many countries and dates back at least 150 years (Simpson and Weiner, 1989).

Table 1

A list of common names of thrips that are in current use and that refer to thunder or thunderstorms

Region	Common name	Reference
Belgium (Flemish)	donderfliegjes (=thunder flies)	A. J. M. Loomans, pers. comm. 2002
	donderbeestjes (=thunder bugs)	A. J. M. Loomans, pers. comm. 2002
Belgium (French)	bêtes d'orage (=thunderstorm bugs)	A. J. M. Loomans, pers. comm. 2002
Denmark	tordenfluer (=thunder flies)	H. F. Brødsgaard, pers. comm. 2002
France	bêtes d'orage (=thunderstorm bugs)	L. Patoor, pers. comm. 2003
Germany	Gewitterfliegen (=thunderstorm flies)	Maltbæk, 1932; Moritz, 1999
Netherlands	onweersvliegjes (=thunderstorm flies)	A. J. M. Loomans, pers. comm. 2002
	onweersbeestjes (=thunderstorm bugs)	A. J. M. Loomans, pers. comm. 2002
Sweden	åskflugor (=thunder flies)	B. Nedstam, pers. comm. 2002
United Kingdom	thunderflies	Kirk, 1996
	thunderbugs	Kirk, 1996

Observations

Trapping experiments show that mass migrations occur frequently in the absence of thunderstorms (Körting, 1930; Hurst, 1964; Lewis, 1964), so thunderstorms are certainly not a normal part of migration. There appears to be only one published description of thrips behaviour at the time of a thunderstorm. In a brief paper, Kittel (1958) described how, as a thunderstorm came near, *L. denticornis* and *C. manicatus* appeared on leaf tips and flower edges and the number in flight increased continually near the ground. Copulation was observed frequently in sweep net catches. The behaviour was described as swarming.

I have once experienced a thunderstorm during the period of cereal thrips migration. On 13th July 1982 I was at Wicken Fen in Cambridgeshire, a nature reserve surrounded by cereal fields. It had been warm all morning and at about 1 pm, we began to notice lots of black thrips landing on us. I could tell by eye that they were in the genus *Limothrips,* and were probably *L. cerealium.* At about 1.30 pm, the numbers landing reached a peak and the thrips were causing considerable irritation to the skin. A group of school children was present and many were scratching themselves. The irritation was greater than I have ever experienced from thrips. I and other people moved indoors to escape the irritation. At about 1.50 pm, we noticed dark clouds nearby and just after this the temperature dropped noticeably and the number of thrips decreased. At 2 pm a thunderstorm started.

A colleague recalls a similar memorable experience (M. S. Whittaker, pers. comm. 2002). "I had been visiting a commercial strawberry glasshouse near Colchester, Essex. It was early afternoon on a warm sunny day in August 2002. I had been standing outside talking to the owner for about 15 minutes, when we noticed cereal thrips landing in large numbers. I guess they came out of the surrounding fields as the area is encircled by scrubby grassland and cereal production. I was brushing about a dozen or so off each forearm every 30 seconds. There were certainly enough to make the experience pretty irritating, maybe even verging on unpleasant. The storm broke approximately 10 minutes later and was severe. The rain was torrential, lasted for hours, and when back at the office I watched lightning repeatedly striking the pylons in the adjacent field."

All three observations are of a marked change in behaviour that starts as a thunderstorm approaches. Kittel (1958) interpreted the behaviour as a mass take-off or swarm close to the ground, whereas the other observers interpreted the behaviour as a mass landing. However, if migrating thrips were to land quickly and then make short flights near the ground to locate suitable shelter, the behaviour could be interpreted both ways.

Lewis (1965) recorded a maximum aerial density of *L. cerealium* during mass flights of 2.1 m^{-3}. If these were to land quickly from a column of air hundreds of metres tall, people in the vicinity would certainly notice it.

Meteorological Correlations

Detailed studies of the mass flights of cereal thrips in Germany and England have shown that flights occur when conditions are sunny and dry with low wind speed, the air temperature is at least 20 °C, and the adiabatic lapse of temperature with altitude is low (Körting, 1930; Hurst, 1964; Lewis, 1964). These are not conditions associated with thunderstorms and the authors accordingly found no evidence that thunderstorms would promote mass flights. However, none of them refer to thunderstorms occurring during their studies. In addition, the aggregated daily catches that were used in the analysis could not have distinguished a sudden mass take-off or landing from a normal extended take-off or landing. The current view appears to be that the traditional association of thrips with thunder simply reflects the seasonal coincidence of summer thunderstorms with ripening cereal crops (Lewis, 1997).

Kittel (1958) recorded catches of *L. cerealium* and *C. manicatus* and the occurrence of near and far thunderstorms in the Harz Mountains of central Germany. He provided little information about how the data were obtained and there was no statistical analysis, but the data can still be analysed easily from the graphs. Days on which the temperature did not exceed 20 °C can be excluded since they were unsuitable for flight. Counts for the remaining days can be divided up according to whether or not a thunderstorm occurred and whether or not a high catch (at least double the normal catch) occurred *(Table 2)*. A chi-square analysis that allows for sparse data shows a significant association between thunderstorms and high catches ($\chi^2_{(1)}$=16.4; exact P=0.002). The same result applies to both species as their high catches occurred on the same days.

Table 2

The association between high catches of *L. cerealium* and *C. manicatus* and the occurrence of thunderstorms for the number of days when the temperature exceeded 20 °C in June and August 1957 from the data of Kittel (1958). $\chi^2_{(1)}$=16.4; exact P=0.002

	High catch	Normal catch
Thunderstorm	3	1
No thunderstorm	0	19

Hypotheses

The above evidence suggests that something about nearby thunderstorms causes a marked behavioural change in cereal thrips. The same effect may occur in other thrips, but the abundance of migrating cereal thrips makes the phenomenon obvious. Kittel (1958) concluded from his data that only the disturbances to the electric field ahead of a thunderstorm could account for the rapid changes in behaviour. It has been suggested that the antennal sense cones of thrips may be able to detect electric fields (Kittel, 1958; Moritz, 1997), but this would be most unusual in insects. Changes in temperature or relative humidity could affect thrips, but these occur daily and are not specific to thunderstorms. The cold gust front ahead of a thunderstorm causes a sudden drop in air temperature, which could cause thrips to land, but in one of the observations described above, thrips landed before the gust front arrived. Changes in air pressure might also be responsible and pressure changes ahead of frontal passages have been suspected of increasing the activity of many insects, perhaps as an adaptation to promote long-range dispersal (Wellington, 1957), but these changes are usually relatively slow, so pressure changes seem unlikely to account for behavioural changes over minutes. Horizontal pressure gradients from fronts are low compared with the vertical pressure gradients to which flying thrips would normally be exposed while ascending and descending.

The normal fair-weather electric field in the atmosphere is only about +0.1 kVm^{-1}. In the vicinity of a thunder cloud, charges within the cloud produce an electric field that decreases with distance. This is typically about –1 kVm^{-1} at a distance of 5 km, becoming negligible at about 20 km (Wormell, 1939). Lightning discharges also produce rapid short-term positive or negative changes in the electric field that decrease with distance. These are about 1–8 kVm^{-1} at 5 km from the discharge and about 0–1 kVm^{-1} at 15 km (Wormell, 1939). Typically, as a storm passes overhead, the field at ground level drops to about –7 kVm^{-1}, with rapid field reversals up to +10 kVm^{-1} caused by lightning. It then reverses to about +10 kVm^{-1} at the end of a storm, reverses again to –5 kVm^{-1}, and then returns to about +0.1 kVm^{-1} (Moore and Vonnegut, 1977). The field may exceed 50 kVm^{-1} immediately after a close lightning discharge (Wormell, 1939). Thus, near thunderstorms there are strong electric fields to which migrating thrips would be exposed.

A possible hypothesis to explain the behaviour of thrips before thunderstorms is that electrostatic effects from strong electric fields near thunderstorms interfere physically with the flight and movement of thrips. As a result, migrating thrips are forced to land quickly and they then perform short flights near the ground looking for somewhere to settle. This would be a physical limitation rather than a behavioural adaptation. When all the migrating thrips in the air are concentrated quickly at ground level, they will become very obvious to people in the area.

Although the effect of strong electrostatic fields on insects has been little studied and has mostly been in relation to high-voltage AC power lines, insects are clearly affected. The walking activity of *Drosophila* flies can be halted completely at 75 kVm^{-1} DC (Watson et al., 1986) and can be reduced temporarily by sudden exposure to a field as low as 1–6 kVm^{-1} (Edwards, 1960), which is similar to the field strength thrips would encounter before a storm. Repeated changes of the field maintained the effect and similar field fluctuations would be produced by lightning. Larger *Calliphora* flies were less affected, so extrapolation to smaller body size suggests that thrips might be more susceptible. The pointed, fringed wings of thrips could be particularly affected by electrostatic effects that might make their use difficult. It is not clear how field strength would affect flight as opposed to walking, but the greater co-ordination needed for flight might mean that flight would be affected more. Orlov (1990) claimed that small insects could not fly in fields greater than 8–10 kVm^{-1}.

In order to investigate this phenomenon, we need detailed observations of thrips behaviour ahead of summer thunderstorms, combined with a range of atmospheric measurements. Laboratory experiments can establish how thrips are affected by the range of strengths of electric fields they are likely to encounter before a thunderstorm.

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