The Current Status of Orthopteroid Insects in Britain and Ireland

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Introduction

This article provides an overview of the changes that have occurred within the orthopteroid fauna of Britain and Ireland since the last distribution atlas was published in 1997 (Haes & Harding, 1997). It provides the current IUCN status of the scarce and threatened species in Britain in accordance with their recent reassessment (Sutton, 2015a) and discusses the future prognosis for this group of insects in Britain and Ireland. It also highlights recent developments of the Orthoptera Recording Scheme with particular reference to the collection of distribution map data using new technologies.

Changes to the orthopteroid fauna of Britain and Ireland have been assessed in the landmark publications by Ragge (1965), Marshall & Haes (1988), Haes & Harding (1997) and more recently, Benton (2012), and have also been comprehensively reviewed by Marshall (1974, 2001, 2010). In addition, a regular and ongoing summary of these changes has been provided by the *Grasshoppers and Relatives* section of *British Wildlife* magazine (Haes, 1990–1995; Widgery 1995–2002; Sutton, 2002–2016), and in the Orthoptera Recording Scheme newsletters (1–22 (Haes, 1979–1995); 23–28 (Widgery, 1996–2002) and 29–33 (Beckmann & Sutton, 2013–2016)).

Field Cricket *Gryllus campestris*. Adult male at a West Sussex reintroduction site, 1 June 2013 (Photo: D. Browne).

The Orthopteroid Fauna

The orthopteroid insects include some of the largest and most spectacular insects to be found in Britain and Ireland, such as the beautiful **Large Marsh Grasshopper** *Stethophyma grossum*. They also include some of our rarest insects, including the iconic **Field Cricket** *Gryllus campestris*, famously described by Gilbert White in *The Natural History of Selbourne*, which by the 1980s was confined to a single site in West Sussex, and **Lesser Mottled Grasshopper** *Stenobothrus stigmaticus*, which is confined to a small area on the coast of the Isle of Man.

The orthopteroid insects were historically divided by taxonomists into two groups: those that jump i.e. the Orthoptera Saltatoria, including grasshoppers, groundhoppers, true crickets and bush-crickets; and those that run i.e. the Orthoptera Cursoria, including cockroaches (Blattodea), praying mantises (Mantodea), earwigs (Dermaptera), and stick-insects (Phasmida). Although now only the former group is included in the order Orthoptera and the others are classified as distinct orders, they are closely related and the recording scheme covers all of them.

A checklist of the orthopteroid insects covered by this review, which includes native and non-native (alien) species that have established populations in Britain and Ireland, is provided by the Orthoptera and Allied Insects Recording Scheme website: www.orthoptera.org.uk and Table 1 summarises some recent species name revisions.

Table 1. Recent name changes for orthopteroid insects*

English name	Old checklist name (Haes & Harding, 1997)	New checklist name (UK Species Inventory)
Greenhouse Camel-cricket	*Tachycines asynamorus* Adelung, 1902	*Diestrammena asynamora* (Adelung, 1902)
Long-winged Cone-head	*Conocephalus discolor* (Thunberg, 1815)	*Conocephalus fuscus* (Fabricius, 1793)
Scaly Cricket (or Northern Scaly Cricket)	*Pseudomogoplistes squamiger* (Fischer, 1853)	*Pseudomogoplistes vicentae* Gorochov, 1996
Jersey Grasshopper	*Euchorthippus pulvinatus* (Fischer de Waldheim, 1825) subspecies *elegantulus* (Zeuner, 1940)	*Euchorthippus elegantulus* Zeuner, 1940 subspecies *elegantulus* (Zeuner, 1940)

*The UK Species Inventory (http://www.nhm.ac.uk/research-curation/scientific-resources/ biodiversity/uk-biodiversity/uk-species/about-the-species-inventory/index.html) aims to provide standard reference names for all species of flora and fauna in the UK, bringing all of the names together in one place. It is likely to follow the Orthoptera Species File, a taxonomic database of the world's Orthoptera (http://orthoptera.speciesfile.org/HomePage/Orthoptera/HomePage.aspx) in changing the genus name of Roesel's Bush-cricket *Metrioptera* Wesmaël, 1838, to *Roeseliana* (Zeuner, 1941), and that of Meadow Grasshopper *Chorthippus* Fieber, 1852, to *Pseudochorthippus* Defaut, 2012, in due course.

The Orthoptera and Allied Insects Recording Scheme of Britain and Ireland

The Orthoptera Recording Scheme was launched in 1968 at the Biological Records Centre (BRC) to establish the distribution of Orthoptera in Britain and Ireland using 10 x 10km square distribution records. This culminated in the publication of the first *Provisional Atlas of Orthoptera* (Skelton, 1974), followed by two further provisional atlases (Skelton, 1978; Haes, 1979).

A major publication by Marshall & Haes (1988), *The Grasshoppers and Allied Insects of Great Britain and Ireland*, provided detailed species accounts and up-to-date 10km distribution maps for all orthopteroid species in Britain and Ireland, including the earwigs, cockroaches and naturalised stick-insects. It also included the threat status of species in accordance with the Red Data Book compiled by Shirt (1987), whose work had been informed via the national recorder, Chris Haes, by data from the Orthoptera Recording Scheme.

Comprehensively updated distribution maps were published in the 1997 *Atlas of Grasshoppers, Crickets and Allied Insects in Britain and Ireland* (Haes & Harding, 1997). This atlas also identified the following species that had received protection in Britain and the Isle of Man on Schedule 5 of the Wildlife and Countryside Act of 1990 (WCA), and the 1991 English Nature Species Recovery Programmes (SRP). Currently there are no Orthoptera protected in Ireland or Northern Ireland.

- Wart-biter *Decticus verrucivorus*: WCA Schedule 5 and 1991 SRP
- Dark Bush-cricket *Pholidoptera griseoaptera*: WCA Schedule 5 (Isle of Man only)
- Speckled Bush-cricket *Leptophyes punctatissima*: WCA Schedule 5 (Isle of Man only)
- Field Cricket *Gryllus campestris*: WCA Schedule 5 and 1991 SRP
- Mole Cricket *Gryllotalpa gryllotalpa*: WCA Schedule 5 and 1991 SRP
- Lesser Mottled Grasshopper *Stenobothrus stigmaticus*: WCA Schedule 5 (Isle of Man only)

In October 1995, John Widgery took over from Chris Haes as the national recorder for the Orthoptera Recording Scheme, continuing his predecessor's meticulous record keeping and regular correspondence with county recorders and other orthopterists. Between 1996 and 2002 he added a further 2,365 hitherto unknown 10km species records to the maps.

The current recording scheme organisers are Peter Sutton, who took over from John Widgery in August 2002, and Björn Beckmann, who joined BRC in 2008 and has been increasingly helping Peter since then.

Accessible identification guides are among the top priorities for successful recording of a species group, and the publication of Evans & Edmondson's excellent *Photographic Guide to the Grasshoppers & Crickets of Britain & Ireland* in 2007 was a very welcome addition to the literature, providing a very clear photographic key and comprehensively illustrating the characteristics of males and females, adults and young, and many different colour forms for each species.

With the help of Jim Bacon, Helen Roy and Biren Rathod at BRC a recording scheme website www.orthoptera.org.uk was created in 2008 to further facilitate identification and recording of this group. Observations submitted via this and other websites feed into BRC's

iRecord system. The website provides useful information, including species descriptions, life histories, photographs, sound recordings, and distribution maps of all British and Irish species, free identification guides of common species for download, news items, and the Recording Scheme newsletters (www.orthoptera.org.uk/newsletters).

To make species identification and record submission even more convenient, a mobile phone app 'iRecord Grasshoppers' was released in August 2015, available free for Android and Apple devices. It comprises a field guide with species accounts, identification tips, photos, labelled illustrations and sound recordings, and allows submission of single- and multi-species sightings to the iRecord system. To aid verification, a photo can be attached to each record. An important update this year allows users to make and attach sound recordings, and adds a bat detector function, making quiet and high-pitched Orthoptera calls easier to hear.

Forthcoming Atlas

The next atlas for the Orthoptera and allied insects of Britain and Ireland will be published in 2018, coinciding with the fiftieth anniversary of the establishment of the recording scheme. All records up to the end of 2017 will be included. To help identify areas of under-recording and target areas for recording effort, an updated list of draft atlas maps will be published in 2017 in the Orthoptera Recording Scheme newsletter.

Range Gains and the Arrival of New Species

In 1988 the authors of *Grasshoppers and Allied Insects of Great Britain and Ireland* explained that just five species of Orthoptera had been added to the British and Irish fauna during the twentieth century, but that "there was no real evidence" to suggest that the number of native breeding species had increased since Orthoptera had become the subject of systematic study over 200 years earlier (Marshall & Haes, 1988).

This statement pays testament to the effectiveness of the English Channel as a barrier to the natural range expansion of a number of European species that could reasonably be expected to do well in Britain and Ireland, since they are found on or near the northern coast of France and occur northwards into Scandinavia, e.g. the Bow-winged Grasshopper *Chorthippus biguttulus* and the Lesser Field Grasshopper *C. mollis*.

After many years of maintaining this status quo, we appear to have entered a period of unprecedented change regarding the natural (and assisted) colonisation of Britain and Ireland by orthopteroid species, whose European ranges are expanding northwards in what is likely to be in many cases a response to climatic warming. Since the beginning of the new millennium there have been several instances of European species colonising the southern counties of England with varying degrees of permanence.

Arguably, the first signs of change were observed as early as the 1930s and 1940s with the discovery of **Long-winged Cone-head** *Conocephalus fuscus* (= *discolor*) in the southern coastal counties of England. While it is always possible that this species may be a previous post-glacial colonist (like the four other native species discovered as breeding residents during the twentieth century: Heath Grasshopper *Chorthippus vagans*, Cepero's Groundhopper *Tetrix ceperoi*, Scaly Cricket *Pseudomogoplistes vicentae* and Lesser Mottled Grasshopper *Stenobothrus stigmaticus*), the appearance of this species in Britain coincides with significant dispersal events noted for other species in Europe at that time, including

Long-winged Cone-head *Conocephalus fuscus* female (brown colour variety) ovipositing in a dried umbellifer stem. Lymington Marshes, Hampshire, 6 September 2014 (Photo: D. Browne).

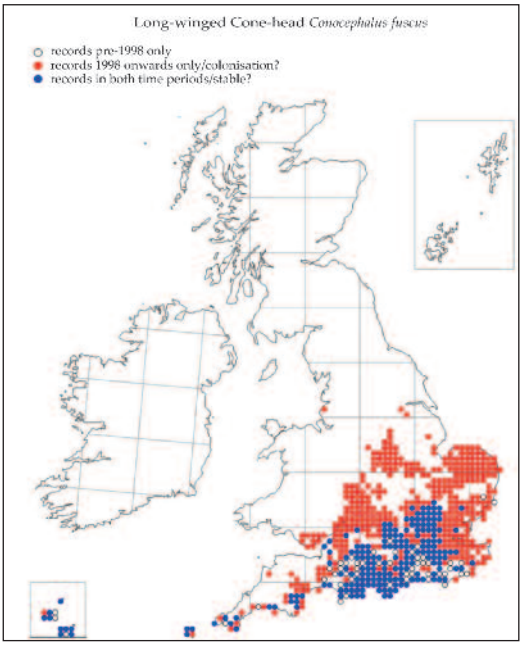


Figure 1. Current distribution map for Long-winged Cone-head *Conocephalus fuscus*, illustrating change since the 1997 atlas.

Red-veined Darter *Sympetrum fonscolombii* and Yellow-winged Darter *S. flaveolum*, and the impressive metallic green beetle, Spanish Fly *Lytta vesicatoria* (Sutton, 2003a, 2003b). It is also possible that Dainty Damselfly *Coenagrion scitulum* was part of this picture of suspected colonisation. This damselfly, which has long been known to have migratory tendencies, was first recorded in the UK during the summer of 1946, which falls between a number of records which established the presence of new colonies of Long-winged Cone-head on the south coast of England between 1945 and 1947.

It has since been speculated (Haes, 2004) that a further wave of colonisation from the Continent occurred in the late 1980s, resulting in the appearance of Long-winged Cone-head in Cornwall and the Scilly Isles,

thus explaining the 'gap' between its known distribution in southern and south-eastern counties, and its unexpected appearance on island and mainland sites in the far west of Britain.

The species quickly went on to colonise other parts of Cornwall, and the remaining Scilly Isles having arrived on St Mary's and St Martin's in 1990 (Haes, *loc. cit.*). Figure 1 illustrates the progressive range expansion of this species since 1998 (ORS data).

Long-winged Cone-head was not the only species on the move. From the 1970s onwards **Roesel's Bush-cricket** *Metrioptera roeselii* also embarked on what would become an equally extensive inland range expansion across southern Britain away from the coastal grasslands that it had been confined to since the first records in

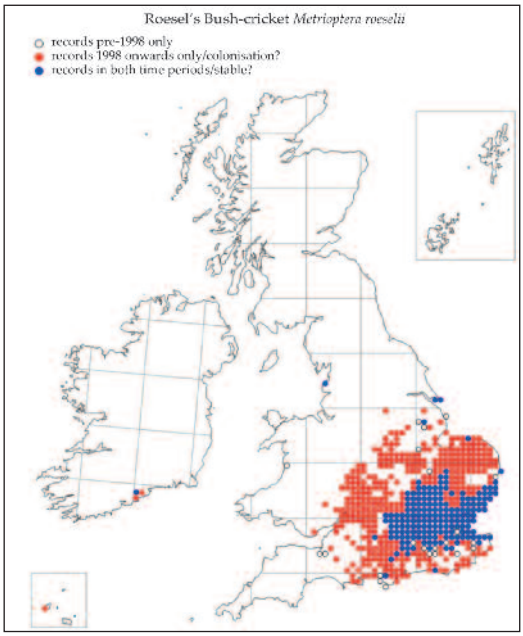


Figure 2. Current distribution map for Roesel's Bush-cricket *Metrioptera roeselii*, illustrating change since the 1997 atlas.

Roesel's Bush-cricket *Metrioptera roeselii*, long-winged dispersive form f. *diluta*. Crawley, West Sussex, 29 July 2012 (Photo: D. Browne).

Short-winged Cone-head *Conocephalus dorsalis*. Lewes, East Sussex, 16 August 2015 (Photo: D. Browne).

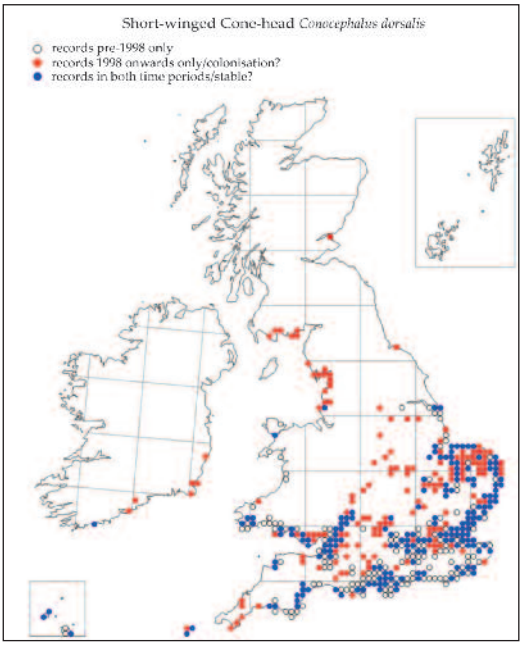


Figure 3. Current distribution map for Short-winged Cone-head *Conocephalus dorsalis*, illustrating change since the 1997 atlas.

the 1830s (see Figure 2). This was an impressive feat for a bush-cricket that had always been considered rare in Britain, and which Lucas (1920) (per Judith Marshall's 1974 review) had described as being "confined to the south-east coast of England, and till a few years ago was almost lost to sight." It was also discovered in Ireland in 1975 (Anderson, 1977), and although this coincides with the period of range expansion observed, it is more likely that this species, like **Lesser Marsh Grasshopper** *Chorthippus albomarginatus*, was discovered as an overlooked resident (assuming it did not arise from an introduction). As evidence for climate change accumulated, entomologists and other naturalists (e.g. Burton, 1991) began to correlate these observations, and several studies published subsequently established

a causal link between climate change and the rapid expansion of these species, with rising temperatures leading to higher population densities and higher numbers of long-winged dispersive individuals (Thomas *et al*., 2001; Simmons & Thomas, 2004; Poniatowski & Fartmann, 2011; Poniatowski *et al*., 2012). At the same time, reductions in management and increases in vegetation height through large-scale set-aside payments and nutrient enrichment also seem to have benefited both species (Gardiner, 2009; Beckmann *et al*., 2015).

By the time the 1997 *Atlas of Grasshoppers, Crickets and Allied insects* was published, a number of other species, including Lesser Marsh Grasshopper *Chorthippus albomarginatus* and Slender Groundhopper *Tetrix subulata*, were either increasing their range or showing signs of doing so. In the years that followed some of these species went on to make extraordinary additions to their known ranges. Of particular note is **Short-winged Cone-head** *Conocephalus dorsalis*, whose former north-western British limit reached Anglesey in Wales. This species subsequently colonised the north-west coast of England from Merseyside and Lancashire (Smith & Newton, 2007) to Cumbria (Sutton 2007b) and had established its first colony (surprisingly, on the east coast) in Scotland by 2010 (Sutton, 2010a) (Figure 3). The first west coast colony in Southern Scotland was found at Rascarrel Bay, Kircudbrightshire, in 2011, and a concerted effort to record this species in 2016 resulted in the discovery of six new sites in five different hectads in Kircudbrightshire (VC73) and Wigtownshire (VC74) (Mearns and Marquiss, 2016).

Brian Eversham recorded Short-winged Cone-head in Co. Cork in Ireland in 1989 (Eversham, 1989) and it has since spread, appearing in several new sites on the south and east coasts. An inland spread has not yet been detected in Ireland, however.

A number of other species are known to have extended their natural range, and

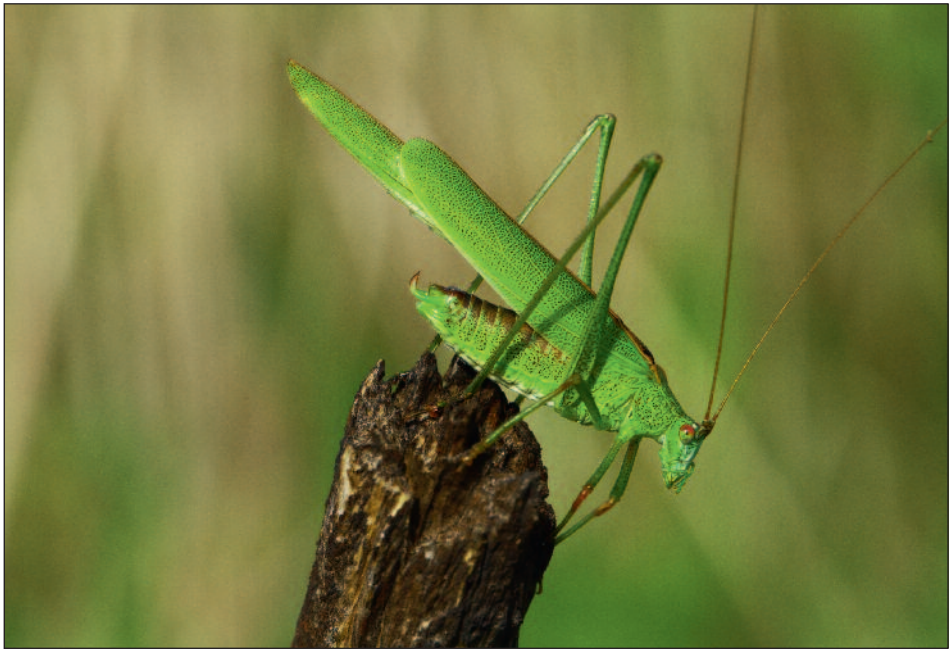
Southern Oak Bush-cricket *Meconema meridionale.* Crawley, West Sussex, September 2014 (Photo: D. Browne).

significant observations include the colonisation of parts of East Anglia by Stripe-winged Grasshopper *Stenobothrus lineatus*, and the apparent north-westward expansion of Oak Bush-cricket *Meconema thalassinum* and Speckled Bush-cricket *Leptophyes punctatissima* in Lancashire and Cumbria.

In mainland Europe a similar pattern of range expansion was being observed for these and additional orthopteran species. In 1999, Peter Sutton, Roger Hawkins and Ralph Hobbs attended a conference hosted by Peter Stallegger and the Normandy Orthoptera recording group. The group heard of the rapid spread of **Southern Oak Bush-cricket** *Meconema meridionale*, and listened with interest to the speakers who had identified automotive transport as a principal mode of dispersal for this flightless species as it progressively colonised areas of northern France. Later in the visit they searched habitats along the north coast of France towards Calais and located, virtually in view of the English coastline, a colony of **Sickle-bearing Bush-cricket** *Phaneroptera falcata*. This, at that time, represented an important record exemplifying the northward range expansion of this species.

Two years later came the exciting news that Southern Oak Bush-cricket had indeed been recorded in Britain (Hawkins, 2002; Widgery, 2002). Soon afterwards, Sickle-bearing Bush-cricket and another species that had steadily been colonising areas of northern Europe—**Large Cone-head** *Ruspolia nitidula*—had appeared, presumably by natural means, at sites along the south coast of England in 2003 (Hathway *et al*., 2003; Sutton, 2003c), 2005 and 2006 (Sutton, 2006).

Southern Oak Bush-cricket is likely to have arrived as either a passenger on vehicles and/or as an unintentional hitchhiker with horticultural imports, and quickly became



Sickle-bearing Bush-cricket *Phaneroptera falcata* (male). Dungeness, Kent, 11 September 2015 (Photo: D. Browne).

firmly established as a breeding species. Within five years of its first discovery at Thames Ditton railway station, Maidenhead and Carshalton in 2001, it had colonised a further ten sites, with one in Chiswick, London, also dating back to 2001 (Roger Hawkins, pers. comm.). It appeared in Wales around Cardiff in 2013 (Sutton, 2013) and the species has also spread to Ireland where it has been seen in Cork (O'Sullivan, 2014) and Dublin (Doyle O'Brien, 2015). Southern Oak Bush-cricket has now colonised a remarkable number of sites across the southern counties of England. In some places, for example Hackney Marshes in West London, it was reported to be one of the most abundant orthopterans present (Sutton, 2007a). This species has now been recorded from sites in the midlands and as far north as Yorkshire.

During the summer of 2003, Large Cone-head, which had previously been reported as a species occasionally brought into the country by the horticultural trade (e.g. Widgery, 2002), appeared simultaneously on different islands in the Scilly Isles, but its presence there proved to be transient. It was again encountered in 2005 and 2006 when single males were recorded for two years running at Canford Cliffs in Dorset, indicating that breeding had occurred (Sutton, 2006; Edwards, 2011).

Sickle-bearing Bush-cricket appeared to have more success, and persisted for a few years after the discovery of a breeding colony containing adults and nymphs on the south coast at Hastings Country Park in East Sussex (Collins *et al*., 2007). The occasional discovery of singletons on the south coast (*e.g.* Pinchen, 2006; Sutton, 2012) provided potential evidence that this species was naturally colonising southern England, and in August 2015 came the news that a small colony of at least four females and one male had been found at Dungeness in Kent (Walker, 2015a & b). In light of the previous discovery of a singleton in the vicinity of this colony in 2009 (Sutton, 2010b), it is quite possible that this species may have persisted on the Dungeness peninsula for several years. In August 2016, David Walker observed over 20 Sickle-bearing Bush-cricket (nymphs and adults) at the Dungeness site near the bird observatory, and on 29 August, Marc Botham observed a single female at the northern end of the Long Pits at Dungeness, almost a mile away from the original site. In addition, on 27 August, another, apparently larger, colony was found by David Brown at The Devil's Kneading Trough, part of the Wye NNR on the Kent Downs, and over the coming days he observed a total of 28 adults (Sutton, 2016; Beckmann & Sutton, 2016). It has become clear that this species may now have gained the foothold that it needs to establish itself as a naturalised resident.

Remarkably and immediately preceding this discovery, a large colony of **Tree Cricket** *Oecanthus pellucens* was also discovered at Dungeness in 2015. With at least 50 singing males and a similar number of females as well as nymphs this population may have a good chance of persisting (Walker, *loc. cit.*). This species had previously been recorded as singletons in Cambridge in 1996 and at Sittingbourne in Kent in 2005 (Beckmann & Sutton, 2015), and in 2010 the first breeding colony was reported from Jersey (David, 2013). In 2016, the Dungeness colony was again observed in August by David Walker, who estimated that over 100 singing males were present at the site (Sutton, 2016; Beckmann & Sutton, 2016).

Dutch literature has been extremely useful in anticipating some of the changes occurring in Britain and Ireland. The extensive 1990–1994 survey of Orthoptera in the Netherlands culminated in an atlas that provided details of species that were in the process of colonising or consolidating their range in that country (Kleukers *et al*., 1997). A more

Tree Cricket *Oecanthus pellucens* (female). Dungeness, Kent, 12 September 2015 (Photo: D. Browne).

recently published Dutch Orthoptera Atlas (Bakker *et al*., 2015) shows that impressive range expansions have continued for species such as Sickle-bearing Bush-cricket, and that future colonisation events previously predicted by Kleukers *et al.* (*loc. cit.*) have indeed occurred, e.g. Tree Cricket. It is therefore likely that if current trends continue, the arrival of other orthopterans in the process of range expansion may be anticipated, including Large Cone-head *Ruspolia nitudula*, Bow-winged Grasshopper *Chorthippus biguttulus*, and perhaps even Blue-winged Locust *Sphingonotus caerulans*, which, not dissimilar to the Southern Oak Bush-cricket's mode of expansion, appears to have colonised areas of Germany and the Netherlands by effectively 'hitch-hiking' along railway networks (Volpers & Vaut, 2011).

Range Losses and the Conservation of Threatened Orthopteroid Species

Despite the expectation that species with a northern/north-western range margin in Britain should have generally benefited from the effects of a warming climate over recent decades, land use changes have simultaneously been extensive, and a number of species have habitat requirements so specific, and a dispersal ability so low, that in the absence of dedicated conservation effort they would almost certainly be lost from our native fauna. This is not without precedent (e.g. Reinhardt *et al*., 2005), and elsewhere in Europe there are many examples of local, regional or national extinctions resulting from habitat deterioration and fragmentation. Wart-biter *Decticus verrucivorus* is now considered to be regionally extinct in Belgium (Kestemont, 2010) and precariously placed elsewhere, e.g. Luxembourg (Proess & Meyer, 2003); northern, Aquitainian and Mediterranean France (Sardet & Defaut, 2004);

Table 2. A comparison of the historical threat status of orthopteroid insects in Britain (Shirt, 1987) and that provided by the current IUCN assessment (Sutton, 2015a).

Scientific name	Shirt (1987)	Haes & Harding (1997)	GB Rarity status (Sutton, 2015a)	IUCN threat status (Sutton, 2015a)
Tettigoniidae				
Wart-biter *Decticus verrucivorus* (Linnaeus, 1758)	RDB2	RDB2	NR	EN
Grey Bush-cricket *Platycleis albopunctata* (Goeze, 1778)	—	Nb	NS	LC
Bog Bush-cricket *Metrioptera brachyptera* (Linnaeus, 1761)	—	Nb	NS	LC
Roesel's Bush-cricket *Metrioptera roeselii* (Hagenbach, 1822)	—	Nb	—	LC
Long-winged Cone-head *Conocephalus fuscus* (Thunberg, 1815)	—	Na	—	LC
Gryllotalpidae				
Mole Cricket *Gryllotalpa gryllotalpa* (Linnaeus, 1758)	RDB1	RDB1	NR	CR
Gryllidae				
Field Cricket *Gryllus campestris* Linnaeus, 1758	RDB1	RDB1	NR	VU
Wood Cricket *Nemobius sylvestris* (Bosc, 1792)	—	—	NS	LC
Northern Scaly Cricket *Pseudomogoplistes vicentae* (Gorochov, 1996)	RDB1	RDB1	NR	VU
Tetrigidae				
Cepero's Groundhopper *Tetrix ceperoi* (Bolivar, 1887)	—	Na	NS	LC
Acrididae				
Large Marsh Grasshopper *Stethophyma grossum* (Linnaeus, 1758)	RDB2	RDB2	NR	NT
Heath Grasshopper *Chorthippus vagans* (Linnaeus, 1758)	RDB3	RDB3	NR	NT
Woodland Grasshopper *Omocestus rufipes* (Zetterstedt, 1821)	—	Nb	—	LC
Rufous Grasshopper *Gomphocerippus rufus* (Linnaeus, 1758)	—	Nb	NS	LC
Blattellidae				
Dusky Cockroach *Ectobius lapponicis* (Linnaeus, 1758)	—	Nb	NS	LC
Tawny Cockroach *Ectobius pallidus* (Olivier, 1789)	—	Nb	NS	LC
Lesser Cockroach *Ectobius panzeri* Stephens, 1835	—	Nb	NS	LC
Forficulidae				
Short-winged or Hop Garden Earwig *Apterygida media* (Hagenbach, 1822)	—	Nb	NS	LC
Lesne's Earwig *Forficula lesnei* Finot, 1887	—	Nb	NS	LC
Labiduridae				
Tawny or Giant Earwig *Labidura riparia* (Pallas, 1773)	—	—	—	RE

Key:

Old IUCN criteria designations: RDB1 (Endangered), **RDB2** (Vulnerable), **RDB3** (Rare), **Na** (species thought to occur between 15 and 30 10km squares), **Nb** (between 31 and 100 10km squares).

New IUCN criteria designations: RE (Regionally Extinct), **CR** (Critically Endangered), **EN** (Endangered), **VU** (Vulnerable), **NT** (Near Threatened), **LC** (Least Concern), **NR** (Nationally Rare, native species recorded from 15 or fewer hectads of the Ordnance Survey national grid in Great Britain since 31 December 1989), **NS** (Nationally Scarce, native species which are not regarded as Nationally Rare AND which have not been recorded from more than 100 hectads of the Ordnance Survey national grid in Great Britain since 31 December 1989).

and the Netherlands (Bakker *et al*., *loc. cit*.). Field Cricket *Gryllus campestris* is another species under threat, and while it is still comparatively widespread in countries like France and Germany, its dependence on dry nutrient-poor habitats that are rapidly declining (through eutrophication, agricultural intensification or cessation of traditional farming practices) resulted in this species being considered vulnerable to extinction on the German Red List (Maas *et al*., 2002). Other notable examples are Heath Bush-cricket *Gampsocleis glabra* and Rattle Grasshopper *Psophus stridulus*, whose remaining isolated colonies in northern Europe are now completely dependent on human intervention to prevent their imminent extinction (Bakker *et al*., *loc. cit*.). The first IUCN Red List of European Orthoptera has recently been published, with more than 25% of the 1,082 species threatened with extinction, making Orthoptera the most threatened insect group assessed so far in Europe (Hochkirch *et al*., 2016).

Conservation effort to maintain viable populations of some of our rarest orthopterans is best informed by detailed research to provide an accurate assessment of their ecological needs and threat status. Recent changes to the way threat status is analysed means that the former categories used, in accordance with the Red List system initiated by IUCN in 1966, have now been modified to provide a new, quantitative approach (IUCN, 2013). All recent Red Lists and reviews now follow these revised IUCN guidelines.

The threat status of orthopteroid insects in Britain (which excludes Northern Ireland, the Isle of Man and the Channel Isles) has been comprehensively reviewed in accordance with the new IUCN criteria (Sutton, 2015a). The current threat status of British orthopteroid insects is summarised in Table 2.

Several of the British species that were classified as threatened in 1987 have been the subject of focused research, leading to a more complete understanding of how to effectively manage their remaining habitats. There is little doubt that in the absence of this research and two major breeding and re-introduction programmes, conducted as part of the 1991 English Nature Species Recovery Programmes (SRP), Field Cricket and possibly Wart-biter may have become extinct in Britain.

The status of **Wart-biter** has been reviewed by Cheesman (2013), who considered only three of the seven sites where this species was known to occur in the latter half of the twentieth century, as currently holding relatively stable populations. These populations are all situated on chalk downland and have been observed to reach numbers in the low hundreds in good years at sites in Wiltshire and Kent, and possibly above 1,000 individuals in good years in East Sussex. This latter site has long been considered the stronghold for this species in Britain and it was from here that individuals were taken to establish a breeding population at London Zoo for the Species Recovery Programme, and introduce or re-establish other populations.

Adults from the East Sussex site were used to populate the Kent site where this species had become extinct in the mid-1970s. A total of 54 specimens were translocated in 1993 to bolster this re-introduced population, followed by the addition of 425 captive-bred individuals from the breeding programme during the 1994 and 1995 seasons.

At two other sites—on Lewes Downs (where the species was introduced to this new site as part of the SRP from 1995 onwards) and near Kingston in East Sussex—numbers were considered to be precariously low with populations under threat of extinction, and at the final two sites—at Stoborough Heath in Dorset (last recorded in 1998) and Deep

Wart-biter *Decticus verrucivorus* (male), pink-purple colour variety. Lewes Downs, East Sussex, 23 August 2016 (Photo: M. Dowse).

Wart-biter *Decticus verrucivorus* (male), purple and yellow colour variety. Castle Hill, East Sussex, July 1991 (Photo: P. Sutton).

Wart-biter *Decticus verrucivorus* (female) with partial characteristics of the purple and yellow colour variety. Lewes Downs, East Sussex, 31 July 2015 (Photo: D. Browne).

Dean in East Sussex (last recorded in 1977)—the populations were considered to be extinct.

In 2015, after 20 years of habitat management to create conditions suitable for Wart-biter, a collaborative effort between South East Water (the site owners), Buglife and Natural England, saw the reintroduction of Wart-biter to Deep Dean in East Sussex, where it had not been seen for almost 40 years.

It should be noted that the population in Wiltshire, which came precariously close to extinction in the early 1990s, managed to survive and is now considered to be relatively stable and increasing.

Similarly, the site on Lewes Downs which was considered vulnerable to extinction has seen a considerable reversal in fortune. This site received 177 captive-bred individuals from the London Zoo breeding programme between 1995–1999. After half a decade of little or no evidence, an intensive survey by David Browne in 2015 revealed that the population may now number over 100 adults (Sutton, 2015b). Interestingly, individuals were found with partial characteristics of the purple and yellow form that once occurred at the original East Sussex site. After many years of assuming that *Decticus* only existed as a green variety in the UK (e.g. Ragge, 1965), this spectacular colour form, and a grey variety, were described in 1991 (Cherrill & Brown, 1991) during an intensive study to ascertain the complex habitat requirements of this species. However, both varieties were apparently lost as a result of a genetic 'bottleneck' that occurred when this population fared badly during the 1990s. While the grey variety has not been observed since, partially purple and yellow varieties have now been recorded from two sites that were repopulated using specimens bred from the original East Sussex site, as well as the original site itself.

Mole Cricket *Gryllotalpa gryllotalpa* (male). A Gloucestershire record from a horticultural import, 14 September 2004 (Photo: D. Browne).

In an extraordinary turn of events, after a request for observations of different colour forms of British and Irish Orthoptera (Sutton, 2016), Matthew Dowse kindly provided a spectacular picture of an almost completely purple male *Decticus*. This variety has not previously been described, and was observed on 23 August 2016 at one of the East Sussex re-introduction sites.

The situation for **Mole Cricket** *Gryllotalpa gryllotalpa* is less hopeful. With the exception of a population on Guernsey in the Channel Islands, a viable population of this insect has not been recorded with certainty since the 1970s when it was known from isolated colonies in south Hampshire, the Hampshire/Wiltshire border, and Surrey.

A summary of recent records (the majority of which are assumed to be introductions with horticultural material) is provided by Benton (2012), which includes tantalising reports of Mole Cricket activity at a site in the New Forest since 2003. Ongoing evidence of stridulation and tunnelling activity was provided in 2008 (Pinchen, 2009). Paul Brock has been monitoring this site and updating the scheme with his observations and in 2014, singing males were again heard and a sound recording was made. On 23 May 2015 a single male was heard, and Paul again recorded individuals singing in 2016. On 8 May a male sang continuously from 21.00 until after 22.00hrs, and at least two males were heard singing on 12 May (Sutton, 2016). However, in parallel with, for example, a temporary Oxfordshire colony that proved to be a different European species, it should not be assumed that the New Forest insects are necessarily *Gryllotalpa gryllotalpa*. The complete history of the Mole Cricket in the New Forest, Hampshire, which includes tips for finding this species, has recently been summarised (Brock, 2017).

Field Cricket *Gryllus campestris*. Adult female at the entrance to a burrow, West Sussex re-introduction site, 1 June 2013 (Photo: D. Browne).

Field Cricket came precariously close to extinction in the late 1980s, with perhaps less than 100 individuals remaining at a single site in West Sussex. The English Nature (now Natural England) Species Recovery Programme came just in time for this insect, and efforts to re-establish old and new populations using stock from a London Zoo breeding programme that was set up have resulted in currently extant colonies at six locations: West Sussex (three), Hampshire, Surrey and the Isle of Wight (one each). However, the species has been lost from ten other sites where reintroductions were attempted, and at one of the sites where it still persists in West Sussex, it had to be reintroduced after the large and apparently stable colony rapidly dwindled to extinction through a combination of poor weather conditions and habitat deterioration. While this species is classified as Vulnerable according to IUCN criteria, its susceptibility to dramatic population loss in suboptimal conditions suggests that it could possibly be regarded as Endangered.

Scaly Cricket *Pseudomogoplistes vicentae* provided one of the most fascinating stories in the recent history of British orthopteran study. For many years, since its discovery in Dorset in 1949, it was considered likely to be a naturalised alien from the Mediterranean region, which had somehow survived in the comparatively sheltered habitat of Chesil Fleet lagoon. This apparent myth was dispelled by the work of Peter Kirby in the 1990s, who showed that the population was much larger than previously thought (Kirby, 1995). Subsequently, this population (Timmins, 1996), and the newly discovered population at Branscombe in Devon (Sutton & Cooper, 1999), were shown to occupy shingle habitat along the seaweed strand line, i.e. where they could be regularly exposed to inundation with seawater. A

complete review of the history of this species in Britain, including new discoveries in France, Britain and the Channel Islands, together with the taxonomic redeterminations of Gorochov (1995, 1996), showed that Scaly Cricket was in fact likely to be a genuine artefact of shingle fauna in north-west Europe (Sutton, 1999). It is currently known from the Chesil Fleet area in Dorset, the Branscombe to Beer Head stretch of shingle in Devon, and at Marloes Sands and the adjacent Dale Peninsula in Pembrokeshire.

Karim Vahed at the University of Derby, who is currently studying the life cycle and ecological requirements of this species in Britain (Vahed, in prep), has been working with Rose Poston-Saynor to survey Scaly Cricket at its known locations in England and Wales in 2016 (Vahed & Poston-Saynor (in prep)). For the purpose of comparison, their work has incorporated the baseline studies of: Hudson (2007) at the Marloes site in Wales; the unpublished survey of Laney & Shute (2010) at Branscombe; and the surveys of Chesil Beach by Peter Kirby (2004) and Chris Timmins (2006).

The initial results of these thorough and methodical surveys were presented at the Annual Orthopterists' Meeting at the Natural History Museum on 1 November 2016 and revealed that at two of the sites—Marloes Sands and Branscombe—the range of the core population of Scaly Crickets along the beach appeared to have contracted. This may be linked to the observed loss of shingle habitat that occurred after the severe Atlantic winter storm surges of 2013/14 and 2014/15, and it was evident that significant loss (e.g. approximately half the shingle habitat in the eastern part of Marloes Sands) had occurred at these sites. In all three sites surveyed, the number of crickets caught per trap was lower than in pre-2013 surveys (although this difference was only statistically significant at Branscombe and Chesil Beach).

Scaly Cricket *Pseudomogoplistes vicentae* (male). Chesil Beach, Dorset, June 2016 (Photo: A. Hyde).

Table 3. Details of the known global distribution of Scaly Cricket *Pseudomogoplistes vicentae* (Gorochov, 1996).

Site and grid reference	Date of discovery/notes	Reference
Chesil Beach UK: SY67, SY68	Known from 1949, largest UK colony, perhaps numbering thousands	Kirby (1995); Timmins (1996); Sutton (1999); Vahed & Poston-Saynor (in prep)
Branscombe—Beer Head UK: SY28	1998–2016 Small diffuse colony, perhaps numbering low hundreds. Recent evidence suggests decline (Vahed & Poston-Saynor, in prep)	Sutton & Cooper (1999); Sutton (1999); Vahed & Poston-Saynor (in prep)
Marloes/Dale Peninsula UK: SM70, SM80	1999–2016 Small diffuse colonies, perhaps numbering low hundreds. Recent evidence suggests decline (Vahed & Poston-Saynor (in prep))	Widgery (2000); Marshall (2001, 2010); Gorochov & Marshall (2001); Hudson (2007); Sutton (2008); Vahed & Poston-Saynor (in prep)
Channel Islands (Guernsey: WV38, Sark: WV47)	1998–2016 Small isolated colonies. In the light of population contractions observed in England and Wales, these colonies need to be re-surveyed	Marshall (2001, 2010); Gorochov & Marshall (2001)
Northern France Cherbourg Peninsula/ Normandy/Brittany coast/Finistere	Pre-1951 record confirmed with the rediscovery of this species in 1998, followed by the discovery of a handful of colonies. This species has been assigned Critically Endangered status on the French IUCN Red list (Sardet & Défaut, 2004)	Beaufils (1999); Morère & Livory (1999a, 1999b); Stallegger (1998, 2000); Livory *et al.* (2000); Fouillet (2001); Herbrecht (2007)
Portugal (Algarve, Lisbon)	Museum material studied by Gorochov dating from the 1950s	Schmidt *et al.* (2009); Gorochov (1996); Gorochov & Llorente (2001)
Morocco	Per Gorochov (1996)	Gorochov (1996)
Canary Islands (Gran Canaria)	Museum material studied by Gorochov dating from the 1950s	Izquierdo *et al.* (2004)

It is apparent from these results that Scaly Cricket populations in England and Wales have declined, highlighting the vulnerability of these populations to storm damage. This species also remains vulnerable to marine pollution events.

Interestingly, Vahed has found that Scaly Cricket preferentially lays its eggs in driftwood, suggesting that this may allow it to recolonise areas of shingle where driftwood is deposited after storms, and noted that excessive tidying of beaches and burning of driftwood may therefore be detrimental (Vahed, 2014; Vahed, 2015; Vahed, in prep).

British Scaly Cricket colonies are important in a global context and Table 3 provides a summary of the known global distribution of this species.

Large Marsh Grasshopper has shown a long-term trend of decline in Britain. The trend in Ireland is uncertain but the species remains widespread and its known range is more extensive than previously appreciated. Irish sites will certainly have been lost but it has not suffered the extensive losses seen in Britain. Its disappearance from the counties of Surrey and Somerset mean that it effectively experienced an 85% contraction in range over a period of 25 years (1979–2004). It is now only recorded from the valley mires of Dorset and the New Forest, which are afforded a degree of protection through their designation as Sites of Special Scientific Interest (SSSI's) or National Nature Reserves (NNR's).

There are 12 known colonies in Dorset, occupying valley mires in the Poole Basin. Edwards (2011) states that, "Those on Hartland Moor and Hyde Bog are particularly large. At present, the populations appear stable, but the species has been lost from two sites in the north-east at Cranborne Common and Slop Bog."

The New Forest continues to harbour colonies of this insect where suitable quaking mire habitat is found. It has

Large Marsh Grasshopper *Stethophyma grossum* (female) of purple variety. Bagnum Bog, New Forest, Hampshire, 6 September 2014 (Photo: D. Browne).

been recorded from nine hectads across the New Forest region.

In Ireland, Large Marsh Grasshopper is primarily associated with mire habitat, including wet heath, blanket and raised bogs. In Killarney and at Glengarriff it can be found on quite grassy sites dominated by *Molinia* that are recovering from burning. In central Ireland it is known from intact and damaged raised bogs as far east as Abeyleix in Co. Laois, where it was discovered as recently as 2012. At Glengarriff a small site supports Large Marsh Grasshopper with **Common Green Grasshopper** *Omocestus viridulus* and **Field Grasshopper** *Chorthippus brunneus*, suggesting its requirements may not be as strict as previously thought. In the west of Ireland in Counties Galway and Mayo it is found on extensive blanket bog and it is also found on Achill Island off the west coast. This species continues to remain under threat from development (e.g. Sutton, 2007a) and ongoing habitat degradation and loss from peatland operations (e.g. Sutton, 2012).

Heath Grasshopper has always been confined to the dry heathland habitats of Dorset and Hampshire in Britain. It has been recorded from a total of 14 hectads, but losses in recent decades due to building development and afforestation mean that it is now recorded from just nine hectads. In Hampshire this species is primarily restricted to dry heaths on the western side of the New Forest. In Dorset, populations survive on most of the fragmented remnants of heathland within the Poole and Bournemouth conurbation, where these small colonies remain vulnerable to heathland fires (Edwards, 2011). Substantial colonies still persist between Wareham and Studland (Marshall & Haes, 1988). Many of the populations are found on sites that are designated as SSSIs or NNRs, but again remain vulnerable to the threat of fire damage.

Heath Grasshopper *Chorthippus vagans* (female). Matley Bog, New Forest, Hampshire, 4 September 2015 (Photo: D. Browne).

Populations of species listed in Table 2 that are considered to be nationally scarce, i.e. those that have not been recorded from more than 100 hectads of the Ordnance Survey national grid in Great Britain since 31 December 1989, have remained relatively stable, primarily because much of the area in which they are found has some form of protective designation, e.g. **Rufous Grasshopper** *Gomphocerippus rufus* on chalk downland, which in turn should entail an appropriate level of habitat management. Others, e.g. **Lesne's Earwig** *Forficula lesnei*, have seen an apparent upturn in fortunes (Farmer, 2015; Williams 2016).

There is need for research on species that have formerly been regarded as comparatively ubiquitous residents. The possibility of population declines of Common Green Grasshopper should be investigated, where anecdotal evidence suggests that it has disappeared from areas where humid grassland habitat appears to have become drier in character (e.g. Sutton, 2003). The disappearance of species closely associated with bare ground habitats such as **Mottled Grasshopper** *Myrmeleotettix maculatus* should also be scrutinised, for example where a link between habitat loss and cessation of management or eutrophication through nitrogen deposition from anthropogenic sources can be established (Gardiner, 2010; Beckmann *et al*. 2015).

Recording Orthoptera and Allied Species in Ireland

As in Britain, the study of Orthoptera and allied insects in Ireland is building up a picture of species distributions and ecological requirements, and has seen some fascinating discoveries over the years. Since the discovery of **Lesser Marsh Grasshopper** *Chorthippus albomarginatus* in 1960 (Cotton, 1982), several other new species were added to the national

Dark Bush-cricket *Pholidoptera griseoaptera* (male). Gortigrenane, Co. Cork, Ireland, 2010 (Photo: R. Daunt).

list with **Greenhouse Camel Cricket** *Diestrammena asynamora* in 1975, Roesel's Bush-cricket in 1977, Dark Bush-cricket in 1983, Short-winged Cone-head in 1989, Lesne's Earwig in 1991, Southern Oak Bush-cricket in 2008 (Doyle O'Brien, *loc. cit.*), and a single example of a **Great Green Bush-cricket** *Tettigonia viridissima* brought in with a tent from a camping trip abroad.

Recent contributions have confirmed that there is much scope for recording and research to establish the known distribution of species in Ireland. In 2012, a collaborative effort to build capacity in the Irish recording community and gather information on key species in Ireland led to the discovery of Large Marsh Grasshopper at Clara Bog in Co. Offaly and, as previously mentioned, Abbeyleix Bog in Co. Laois, the latter being an important new midland site for this species. In addition, **Slender Groundhopper** *Tetrix subulata*, which was hitherto absent from the southern counties of Ireland, was found at a site to the south of Waterford City, indicating that this species might be found in suitable habitat along the full length of the River Suir (Sutton, 2012).

It is therefore likely that further discoveries of populations or species are possible. For example, in view of the discovery of Scaly Cricket colonies in Devon and Pembrokeshire in 1998/99, the possibility of locating a colony of Scaly Cricket in Irish shingle habitats should not be discounted, and the discovery of Dark Bush-cricket in The Burren (Speight, 1999) suggests that it may yet be found elsewhere.

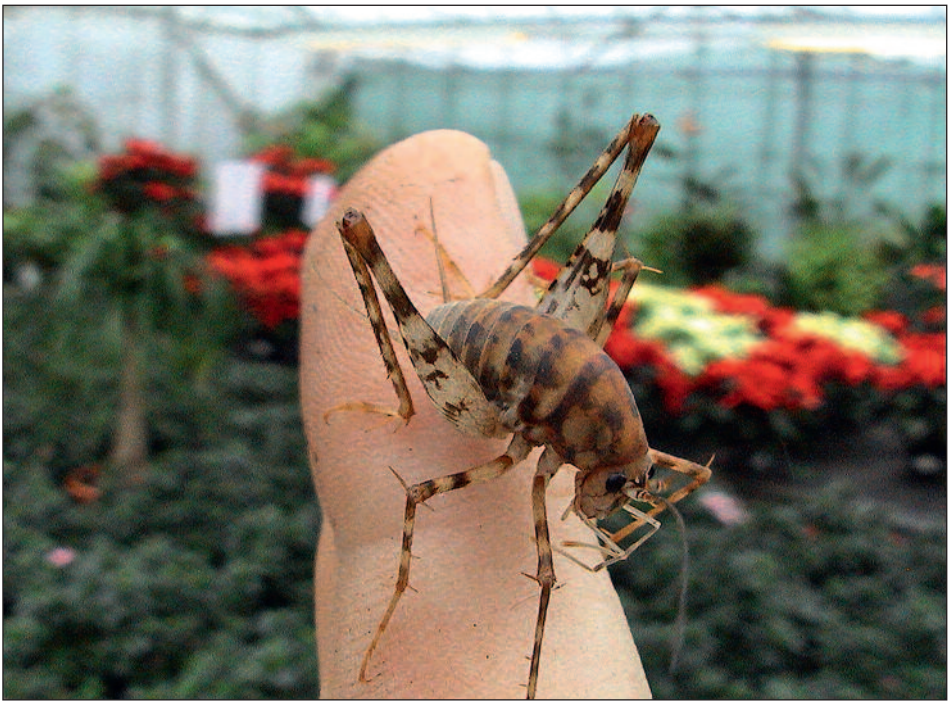
There is currently a concerted effort to increase recording activity under the lead of the National Biodiversity Data Centre and the Centre for Environmental Data and Recording and it is hoped that this work will continue to grow and attract additional recorders. Current distribution maps have been made easily accessible at http://maps.biodiversityireland.ie/#/DataSet/204/SpeciesGroup. A detailed understanding of Irish distributions for species like Large Marsh Grasshopper will be very useful in the context of their European distributions, and it will be fascinating to monitor range gains and losses in greater detail to see if species like Lesser Marsh Grasshopper and Roesel's Bush-cricket are responding to climate change in Ireland, as they appear to be in Britain and other European countries.

Plans to produce a Red List for the Orthoptera and allied species of Ireland are currently being discussed.

Aliens and Introductions

Established aliens have been a familiar feature of the naturalised orthopteran fauna of Britain and Ireland since recording began, and it was noted that Oriental Cockroach *Blatta orientalis* and House Cricket *Acheta domesticus* had become familiar residents by the time Moffet had written his works on British Insects in the seventeenth century (Marshall, 1974; Moffet, 1634, 1658). Several other species of cockroach became firmly established in Britain and Ireland, as did Greenhouse Camel-cricket, and stick insects which arrived from New Zealand at the turn of the nineteenth century have not only persisted, but in some areas considerably increased their naturalised range in recent years. Indeed, such has been the success of stick insect colonies that their fortunes are closely monitored by the Phasmid Study Group, which has produced detailed information and distribution maps for the seven naturalised species that now occur in Britain and Ireland (Lee 2006, 2012, 2015).

By 2001 there were 58 species recognised as 'aliens and introductions', of which 20 had



Greenhouse Camel-cricket *Diestrammena asynamora* (male). Leicester plant nursery, January 2007 (Photo: P. Sutton).

established breeding colonies (Marshall, 2001). There are many possible routes by which non-native species may become established in Britain and Ireland. Horticultural and agricultural imports and live insect food for the reptile and amphibian pet trade have been a significant source of records, from mole crickets to locusts, although few species have been able to colonise sites with any degree of permanence.

Improved hygiene and pest control has led to the eradication of pest species, and House Cricket and several species of cockroach are now far less prevalent than formerly. The recent loss of the Greenhouse Camel-cricket from its last known site in Derbyshire (Frost, 2011; Sutton, 2014) signifies the end of an era for those familiar with this species, which has been iconically depicted in all of the major works on Orthoptera, from Ragge (1965) to Evans & Edmondson (2007).

It will be interesting to see what the future brings regarding the movement and possible establishment of non-native species.

Conclusions

The recording of Orthoptera and allied insects in Britain and Ireland is building up a picture of species' distributions and ecological requirements, and continues to provide fascinating discoveries.

It is clear that habitat specialists and species with low dispersal ability remain under threat from habitat loss and fragmentation. Information gained from ongoing research to

elucidate the requirements of orthopterans informs conservation measures that attempt to prevent further decline and loss of vulnerable species.

Conversely, there have been large range increases observed for several species over recent decades, with climatic warming and land use change likely causative factors. New additions to the British and Irish fauna have also occurred and are likely to continue through natural and human-assisted colonisation in view of ongoing range expansions on the Continent.

In the context of the above, British orthopteroid insects have recently been used as part of a "national-scale assessment of the risks of range loss and opportunities for range expansion that climate change could pose for over 3,000 plants and animals" (Pearce-Higgins *et al.*, 2017). This initial study of the risks and opportunities presented by climate change to a wide range of temperate region species, many of which are at their poleward range limit, may lead to important decisions regarding the future conservation requirements of these species.

A new atlas of orthopteroid insects will be published in 2018, and we hope for much recording activity, particularly in little recorded habitats and areas. Resources like the recording scheme website www.orthoptera.org.uk and the new mobile app iRecord Grasshoppers will hopefully facilitate the transfer of data for recorders and stimulate interest in the group.

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The findings of this review are primarily based on the results of many years of recording effort by over 2,000 individual recorders who have submitted records, both recent and historical, to the Recording Scheme. Our sincere and grateful thanks are due to all recorders and county and national organisers, past and present, and also to the many contributors and funders of the Orthoptera Recording Scheme—a full list is given in the 2015 recording scheme newsletter. Mention must also be made of Liam Lysaght, Eugenie Regan and Brian Nelson for their considerable assistance, expertise and warm hospitality regarding the recording of Irish Orthoptera.

Our thanks are also due to all those who have worked tirelessly to provide research and information, through the English Nature Recovery Schemes and other projects, that have led to an understanding of how best to approach the ongoing conservation of scarce and threatened orthopteran species.

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