REPORT

Narrow-headed Ant *Formica exsecta* Survey for Back from the Brink 2018-2020

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Saving the small things that run the planet

LOTTERY FUNDED

Narrow-headed Ant
Formica exsecta
survey for

Buglife - Back from the Brink Project

2018 - 2020

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Summary
This survey was conducted between 2018 and 2020 with Stephen Carroll (SC), Betsy Vulliamy (BV), Mark Bailey (MB) and Andrew Ross (AR) and other volunteers listed below. A complete survey of the Narrow-headed Ant *Formica exsecta* nests on the Devon Wildlife Trust Reserve at Chudleigh Knighton Heath (CKH) begun in 2018 was continued and about 133 active nests are currently being monitored at CKH. This includes 8 active nests on the road verge adjacent to CKH managed by Highways England.

Useful information has been gained through close observation of the ants nesting, foraging and their nuptial flight behaviour. This combined with habitat studies and nest monitoring has informed the development of nest translocation and introduction techniques. Eleven nests have been translocated from compartment 8 of Chudleigh Knighton Heath to compartments 1, 5 and 3 at CKH and also to Bovey Heathfield and Teigngrace Meadow, all these sites are Devon Wildlife Trust nature reserves. The results so far have shown limited success with these translocations with only 2 currently active. An alternative method of introducing queenless nests to other sites then releasing mated queens at these in July has been investigated. Results from this are inconclusive at the moment but with refinement this may be a good method of introducing the ant to other sites. In November 2019 a nest translocation was filmed by the BBC Natural History Unit for *The One Show,* this has yet to be broadcast.

Introduction
This survey was conducted at the Devon Wildlife Trust Reserves at Chudleigh Knighton Heath, Bovey Heathfield and Teigngrace Meadow. It follows on from work conducted in 2017 (J.M. Walters, 2017) which also included visits to Ramshorn Down near Bickington. The aim is to collect detailed information on various aspects of the ecology of the Narrow-headed Ant *Formica exsecta* to inform conservation work. A survey of all nests at Chudleigh Knighton Heath has been conducted with Stephen Carroll, Betsy Vulliamy and Mark Bailey and Andrew Ross with additional help from Racheal Lee and Christine Whittle.

All known nests were monitored weekly between between March and November with further visits during the winter. Due to Covid restrictions in 2020 less monitoring took place but all the nests in Compartment 5 at CKH were monitored regularly by MB, this enabled BV and JW to make obervations of the winged adults and the nuptial flight in June and July. In 2018 BV and SC conducted mark and observation work at some of the nests to establish their foraging range and movements of workers. Close observations of the ants nest building, aphid tending, foraging, the nuptial flight and nest movements have also been made. Small felt tiles have been laid on the thatch of each nest to enable monitoring of brood production. The ants often gather under the tiles as these warm and retain heat for longer than the surrounding nest thatch. This is particularly useful for observing the ants in cool conditions. When it is very hot the ants retreat deep into their nests. Larger felt mats have been placed at Bovey Heathfield and Teigngrace Meadow to aid location of *Formica fusca* nests. This is one of the host ants used by *Formica exsecta* to establish new nests. The information gathered has been used to inform the translocation of eleven nests in 2018 (9) and 2019 (2). Three nests to Bovey Heathfield where the ant had last been seen in 2004 and two nests to the recently established Teigngrace Meadow reserve to the south of CKH. The other nests were translocated within CKH. Two nests have been taken in to captivity by BV and SC both of these are currently still active.

Liaison with Highways England has been made in relation to the management of the verge containing eight *Formica exsecta* nests on the A38 slip road adjacent to the reserve at CKH. New signs have been installed on the verge in 2020 to help manage the degree of mowing taking place here.

Red wood ant *Formica rufa* nests in the vicinity of the above sites are also being monitored as this ant could pose a threat to the *Formica exsecta* population.

History of *Formica exsecta* in the UK

Formica exsecta was first discovered in the UK in the Bournemouth area in 1865 by F. Smith. It was also found in Woking, Surrey in 1913. Brockenhurst, Lyndhurst and near Beaulieu Road, New Forest, Hampshire in the 1930s (last seen in 1971). A probably dubious record from Lyme Regis, Dorset in the early 1900s. Land's End, Cornwall early 1900s (based on a record of the inquiline beetle *Dinarda hagensii* (see page 20) and on the Isle of Wight at Parkhurst Forest. In 1931 H.G. Jeffery stated 'it occurs practically all over Parkhurst Forest and really should be described as common there...' (Jeffery, 1931, *Proceedings of the Isle of Wight Natural History Society*, **2**: 125-128). It was first recorded in Scotland in the Spey Valley in 1909 and still occurs at several sites in Scotland (Hughes, 2006). The first Devon records were from 'the eastern edge of Dartmoor near Bovey Tracey' in 1902 by A. H. Hamm. In the early 20th Century it was found commonly in the Bovey Tracey area up to the edge of Dartmoor. The first definite record from Chudleigh Knighton Heath was in 1928 by G. M Spooner.

Formica exsecta ranges from central Spain to the Urals, occurring as far as northern Norway and to the Apennines, Italy (Hughes, 2006). There has been a significant decline across its European range since 1950 and this has been reflected in the UK. The decline has also occurred in the UK with the last records from Parkhurst Forest, Isle of Wight between the early 1900s and 1962. By 1963 all the remaining sites in the Bournemouth area except one at Talbots Wood and Heath had been developed with the last record at SZ 069 925 on 6 August 1977 by P.J. Attewell and S.D. Mackey (*Entomologists Monthly Magazine*. 143:111-112. 2007). In 1968 it was recorded for the first and last time at Yeol Mouth, near Morwenstow on the north Cornwall coast by G.M. Spooner. This site was searched without success by D. Stradling in the 1990s.

Only four sites remained all in Devon: Bovey Great Plantation, Lustleigh Cleave, Bovey Heathfield and Chudleigh Knighton Heath. It was then lost due to changes in habitat management from Bovey Great Plantation and Lustleigh Cleave by the 1980s.

A nest that had been taken into captivity at Paignton Zoo was returned to Bovey Heathfield in 2004. was returned to the newly-acquired (2002) Bovey Heathfield Devon Wildlife Trust reserve but it did not survive and the other surviving nest died out at this time.

Relocation of a *Formica exsecta* nest at Bovey Heathfield in 24 February 2004.
David Stradling of Exeter University who conducted studies of the ant in the 1990s is second from the right.

Since then Chudleigh Knighton Heath has become the only site for this ant in England though it still survives at several sites in Scotland at Speyside. Three nests were translocated from Chudleigh Knighton Heath to Bovey Heathfield in 2018. A further two nests were translocated to Teigngrace Meadow Devon Wildlife Trust reserve in 2019. Other 'queenless' nests have been established at Teigngrace Meadow and Bovey Heath in 2019 and 2020.

Nest survey

This on-going survey has been conducted by SC, BV, AR, MB and JW and commenced in August 2018. Weekly visits during the main period of ant activity are made of all known active and inactive *Formica exsecta* nests on Chudleigh Knighton Heath and the translocated nests at Bovey Heathfield and Teigngrace Meadow. These have been located, tagged, photographed, a 10 figure grid reference taken and have a small c. 8 x 8 cm roofing felt tile placed on the nest thatch. The tiles can be lifted briefly to record any brood in the nests. This was found to be most effective in cloudy or cooler conditions. At these times it was more likely that the ants would bring the brood to the surface of the nest as the felt tile warmed and retained heat more readily than the thatch. This behaviour is most likely to aid maintenance of the temperature of the developing brood (usually pupae but occasionally larvae and eggs were seen). In very hot or very cold conditions the brood would be taken further in to the nest and were not usually visible under the tile. During the winter most of the ants remain dormant deep in the nest but a few are seen on mild, sunny days.

Formica exsecta nest with felt tile (left) and tile lifted to reveal ants tending brood (right).

During the course of the survey over 250 nests have been located. The majority of these are located in compartments 8 and 5 with smaller numbers in compartment 7 the 'ant glade' and compartment 1. Currently about 133 nests are known. This is lower than previous years totals and may indicate an overall decline but more extensive weekly nest surveys would be required to confirm this.

Formica exsecta nest tags.

During the summer of 2019 the group of cattle grazing Chudleigh Knighton Heath took a liking to the plastic tags and felt tiles. Virtually all of the nest tags were removed or destroyed by the cattle. After the cattle were moved in late summer 2019 all the nests were re-labelled using stones and more permanent metal markers produced by BV. All the felts were also replaced.

In 2020 the cattle were put onto the main compartment 8 in July about the time as the nuptial flight was taking place. This caused some disturbance to nests with the cattle being attracted to the nest thatch. The tiles were removed by MB and it was hoped that the stone and metal markers would remain in situ. Some were undisturbed but the majority of nest tags including many of the metal tags disappeared or were chewed beyond recognition.

Cattle on Compartment 8 Chudleigh Knighton Heath (left), eating Nest 7 thatch (right) and chewed metal tag (inset) 16 July 2020.

In late summer and autumn all the active nests were given new tags and markers though this did present some problems in identifying individual nests particularly those that had moved from the original location. BV produced more metal tags and these have been securely embedded in the ground near the nests. All nests now have multiple markers of stone, metal and some with the original plastic tags. Hopefully this will enable nests to be monitored effectively in the future.

Satellite nests formed by budding of existing nests were often located or established during the course of the survey. When these were known to be related to other nests in the vicinity they were given an additional letter eg 27a, 27b etc. Other nests that are close together have been given different numbers but could be the result of budding that took place prior to this survey. The main aim of the numbering is to enable individual nests to be monitored and give an idea of the population size present at CKH. Some nest movements have been observed and measured, the details of these are given below.

Survey effort was concentrated in compartment 8, 7 and 5. A significant number of nests were found during a public *Nest Quest* event on 29 August 2018 when about 40 volunteers conducted a sweep search across compartment 5.

This was repeated in Compartment 8 on 4 September 2019. The number of new nest structures found was approximately 8-10, but it was hard to tell for sure because of the earlier cattle depredations of our markers, and because some of the nests recorded by the volunteers' group were later not able to be confirmed as active nests. Due to Covid restrictions the public *Nest Quest* event was not held in 2020.

Habitat types in compartment 8 which contains the majority of the *Formica exsecta* nests - November 2018.

Formica exsecta nests compartment 8 (top), compartments 7 and 5 (middle) and compartment 1 and 3 (below)

Narrow-headed Ant Formica exsecta donor 'queenless' nest translocations from Chudleigh Knighton Heath to Bovey Heathfield

Formica exsecta nests at Bovey Heathfield (top) and Teigngrace Meadow (below)

Maps of the compartments have been produced to aid location of nests during the survey. Habitat management of the compartments have been added to these. As can be seen in the maps the majority of *Formica exsecta* nests are located in compartments 8 and 5. These areas have been most actively managed in the form of cutting, mowing and burning over the last 7 years. This may be significant in providing suitable open habitat for the ants to thrive. A large concentration of nests occurs in the south-west corner of compartment 8 where the gorse and scrub was burnt in the winter 2017-18. These nests were almost certainly not present in these exact locations in 2017 as the ground layer was shaded and unsuitable for them at that time. It is most likely that nests persisted along the mown margins and they gradually moved in during the spring. When these nests were first seen in May 2018 by SC and BV they were thriving with many producing brood. The burnt black soil will have warmed up quickly in the spring and it was noted that ants in this area were generally more active in late autumn 2019 than those in other areas. The nests in areas burnt in March 2019 were closely monitored during that year, there were a few small movements of nest sites which is typical but otherwise the nests fared well despite the barren look to the locations shortly after burning. The vegetation in burnt areas recovers quickly and being full of new growth attracts aphids and other insects which are of benefit to the ants providing honey-dew and prey.

Most nests were constructed within purple moor grass *Molinia caerulea* and bristle bent *Agrostis curtisii* tussocks or around small birch *Betula* trees and gorse *Ulex*. The nest chambers below ground are probably constructed around the root systems of these plants. During the course of nest translocation operations (see below) it was found that the nests were usually up to 50 cm below the soil surface. Virtually all nests have a well-insolated south-facing aspect. Aphid hosting plants eg gorse, birch and oak are usually present within 10 metres of each nest. Observations of particular interest are given below. A full inventory of active nests is provided in the separate documents:

Formica exsecta nests inventory 2019 1-100 latest version.qxp
Formica exsecta nests inventory 2019 101-221 latest version.qxp

Formica exsecta nest 86 site on compartment 5 Chudleigh Knighton Heath showing recovery of vegetation after burning.

Aphid tending and use of extra floral nectaries

Formica exsecta workers were frequently observed tending black-banded birch aphids *Callipterinella calliptera* on small birches within a few metres of their nest. Seven-spot ladybirds *Coccinella 7-punctata* were forcibly ejected from the tree if encountered by the workers tending aphids. Usually several ants would tend the aphids occasionally stroking them with their antennae to induce the aphids to produce honeydew. Its was observed that the workers would then pass on this honeydew to one of the individuals whose body was visibly swollen. Presumably this ant then returned to the nest holding the food resource. Whilst digging up nests during the translocation process in November 2018 similar looking ants with swollen abdomens were noted amongst the hibernating ants. This may be how they hold food reserves over the winter and early spring.

Workers were also observed tending the gorse aphid *Aphis ulicis* on western gorse *Ulex gallii* during July and August 1919. Earlier in the season during May SC and BV observed ants tending aphids on Cat's-ear *Hypochoeris radicata* which were active on the plants prior to flowering. There were aphids at the top of the flowers and the ants had built small canopies of thatch, similar to the nest thatch, over aphids at the bottom of the stem. *Formica exsecta* workers were also observed tending aphids on birch and gorse around that time. On two occasions workers were seen repeatedly visiting damaged sections of bracken stems, possibly the ants bit the stems and were taking the sap. On 20 April 2019 SC observed *Formica exsecta* foraging on oak leaf buds before they opened, workers from the translocated nest 87 on Compartment 5 at CKH. Presumably the leaf buds were slightly sticky with sugar before the leaf buds opened, and this is what the ants were after.

Formica exsecta workers tending aphids (left), worker with swollen abdomen containing honeydew (middle) and worker ejecting seven-spot ladybird *Coccinella 7-punctata* from birch.

Formica exsecta worker on wild carrot *Daucus carota*. Stephen Carroll.

Formica exsecta worker tending aphids on birch near Nest 92 Compartment 5 CKH 10 October 2020.

In May 2018 BV first saw the ants tending a (moth?) larva, or some aphids associated with this in a rolled up birch leaf. We made similar observations again in July 2018 but didn't conclude exactly what the ants were doing. This behaviour has not been observed again since then.

Previous studies (Stradling and Hoy, 1993) recorded *Formica exsecta* workers tending: black-banded birch aphids *Callipterinella calliptera* and shiny birch aphid *Symydobius oblongus* on birch *Betula*; *Tuberculoides annulatus, Thelaxes dryophila* and an unidentified scale insect on oak *Quercus*; *Aphis sarothamni* on gorse; *Brachycaudus cardui* and a *Uroleucon* sp on thistle *Cirsium*; *Chaitophorus salicti* on sallow *Salix*; *Phis ruborum* on bramble *Rubus* and *Aphis pomi* and a *Psylla* sp. on hawthorn *Crataegus*. SC observed *Formica exsecta* workers foraging on wild carrot *Daucus carota* flowerheads during the summer in 2019 when they appeared to be collecting nectar.

Formica exsecta worker tending gorse aphid *Aphis ulicis* (left) Worker at extra-floral nectary of bracken *Pteridium aquilinum* (middle). *Formica fusca* was also observed doing this (right). Many plants have these nectaries that attract ants which in turn prey on invertebrates that may cause damage to the plant.

Formica exsecta nest sites along road verge. This is grassland rather than heathland habitat. The ants here were seen using extra floral nectaries on common vetch *Vicia sativa* May 2019.

Nests containing *Formica exsecta* and *Formica fusca* workers

Two of the nests found during August 2018 in compartment 5 contained *Formica fusca* workers. Workers of *Formica* species are known to survive for about a year. This may indicate that these nests were established by newly-mated queen *Formica exsecta* during the summer. In nest 123 small numbers of *fusca* workers were noted until 8 October 2018 after this date just *Formica exsecta* workers were present. At nest 155, which was situated within 100 metres of nest 123, the ratio of *Formica fusca* to *exsecta* workers was 50:50 until 24 September when just a few *fusca* workers remained. It is presumed that the *exsecta* had relocated to a site nearby but despite extensive searching this was not found. By early October the *fusca* had deserted the nest as well. *Formica exsecta* workers were seen again in the original nest during 2019. Nest 188 was located in an area of compartment 5 which had been burnt on 1 March 2019. It was first seen with mix of *Formica fusca* and *Formica exsecta* workers on 24 June 2019. Presumably this nest had been established after the nuptial flight in July 2018. None of these nests were refound in 2020 but nest 221 in Compartment 8 was a mixed *fusca*/*exsecta* nest when first found then pure *exsecta* by October 2020.

These observations are very interesting as they show that the *Formica exsecta* population is still capable of establishing new nests presumably by queens invading *Formica fusca* nests. Nests 123 and 155 are situated in an area which was burnt during the winter 2017-18. It is presumed that these nests were formed by new queens in the summer of the years they were found but it is possible that they were established the previous year. Currently it is not known how long it takes for an *Formica exsecta* queen to establish a nest in a *Formica fusca* nest. Studies in continental Europe have indicated that socially parasitic nest formation is only possible in small queenless host nests (Seifert, 2018).

Formica fusca and exsecta workers together in nests 123 and 155.

Foraging behaviour

Prey items in the form of small invertebrates are vital for nests to be successful. Workers survive solely on carbohydrates in the form of sugar but queens and developing brood require protein for egg production and development. Observations have shown that a wide range of invertebrate prey is taken including true bugs *Hemiptera*, harvestmen *Opiliones*, *Lepidoptera* moth larvae and earthworms *Lumbricidae*. Workers carrying dead often dried prey was observed more frequently than with freshly predated items. The heathland and grassland habitats in which this ant occurs are rich in small invertebrates during peak of activity from March to September.

Formica exsecta workers with from above left to right a shieldbug, harvestman, dead earthworm and a true bug; left with a noctuid moth caterpillar.

Nest movement

Nest movement was observed several times during this study. The old nest was usually abandoned over a period of 1 -2 weeks and a new nest or nests established between 170 cm and 800 cm away. Nest material was seen to be carried to the new site and presumably brood was also transported though this was not observed. SC and BV did observe workers carrying single pupae or larvae away from nests but this was thought to be related to nest sanitation rather than nest movement. Occasionally old nests were re-occupied several weeks later. Newly established nests in *Molinia* tussocks could be easily identified as the grass around the nest was still green, after a few weeks the ants kill off the grasses around their thatch.

Nest 18 moved 465 cm and two new nests were established in early September 2018. By mid-October one of the new nests was inactive and presumably the ants had moved to the other nest. Nest 40 moved 200 cm to establish a new nest around a very small birch sapling in July 2018. During August and September the birch was covered with nest thatch and eventually killed.

Formica exsecta nest 40 established around a birch sapling.

In 2020 nest 64 near the cattle drinking trough in the north-west corner of Compartment 8 at CKH moved 8 metres along the edge of the scrub. This may have been due to disturbance of the nest by livestock.

Movement of nest 64 during 2020.

The translocated nest 86 has moved twice after being moved from Compartment 8 to Compartment 5 in July 2018. In 2018 it moved 3.5 metres to 86a and in 2020 moved 2.5 metres to 86b and appears to be thriving. The only other surviving translocated nest is Nest 194 (T3) at Teigngrace Meadow.

Colour marking ants

In 2018 workers from nests 73 and 108 were marked with *Rowney Cryla* acrylic paint and *Uni-posca* ceramic marker pens with mixed success. The ants appeared to be able to clean the paint from their abdomens often just leaving tiny patches of paint on their legs to show they had been marked. Previous studies have shown that the range of foraging workers was about 5 metres. In this study ants from nest 73 were found climbing a mature oak tree 10 metres away. Interestingly between nest 73 and the oak tree 'nest' 108 was located. A nest structure was not found here but workers marked at the oak tree and nest 73 were frequently observed at this location this was used again in a similar way in 2019. It appears to be a temporary refuge for the ants en route to the oak. BV discovered by climbing the tree that the ants were moving up the main trunk for at least 2 metres. It is likely that they were foraging for invertebrates and possibly tending aphids in the canopy. Attempts to find them by beating branches over a tray were unsuccessful. Previous observations by BV and JW have shown that the ants can climb for 2-3 metres in to birch trees to forage. Marking individuals at this and other nests appeared to show that the workers live for at least 3 months during the active season. The ants marked were in their external working phase and would have spent some time working inside the nest prior to this. Studies in continental Europe have shown that the average life expectancy is stated to be about 1 year for workers and up to 20 years for queens (Seifert, 2018).

Route between nests 73 and 108 and oak tree (left), marked ants using Rowney paint
Betsy Vulliamy (middle and right)

Brood and teneral workers

In 2018 brood was recorded at 143 of the 213 (67%) nests. Some of the nests were inactive when found but others were active throughout. Given that workers are known to live about a year these nests may be queenless. Brood was present in many nests up to late October with the last few pupae in nest 67 on 18 November 2018. Newly-emerged teneral workers were observed several times over the summer, autumn and during nest excavations during translocation work in November. They can be identified by their paler colouration. Observations of brood were disrupted in 2019 after the cattle destroyed the majority of the felt tiles on nests in compartment 9 and were limited during 2020 due to Covid restrictions.

Nest thatching

Pieces of dried grass and other leaf fragments are the most frequently used materials in thatch construction on nests. Snail and lepidopteran poo (frass) is also used in many nests. Grass seeds were occasionally used when available. Translocated nest 194 (T3) at Teigngrace Meadow has heather fragments in the nest thatch, similar to last recorded nests on Bovey Heathfield in the 1990s by Julian Perrett. A few nests eg 103b had little or no thatch but still contained healthy nests producing brood. The reason for the lack of thatch construction is unclear.

Formica exsecta nest 129 with grass seed thatch (left) and worker gathering dried snail poo for thatch nest 88a (right)

Nests in seasonally flooded locations

The majority of nests were constructed in *Molinia* tussocks or amongst other grasses on thin loose, peaty soil overlying ball clay and gravel deposits. The ant is known to use a variety of friable soils in dry and wet conditions. In wet conditions the presence of raised *Molinia* tussocks were essential for nest construction. Nests 126, 93 and 111 are situated in a seasonally flooded location on compartments 5 and 8. The ants must either overwinter within the raised tussock or in air pockets trapped around the grass roots below water level.

Formica exsecta nests 126abc in seasonally flooded location in compartment 8, December 2018.

Formica exsecta workers tending brood. Teneral individual centre left.

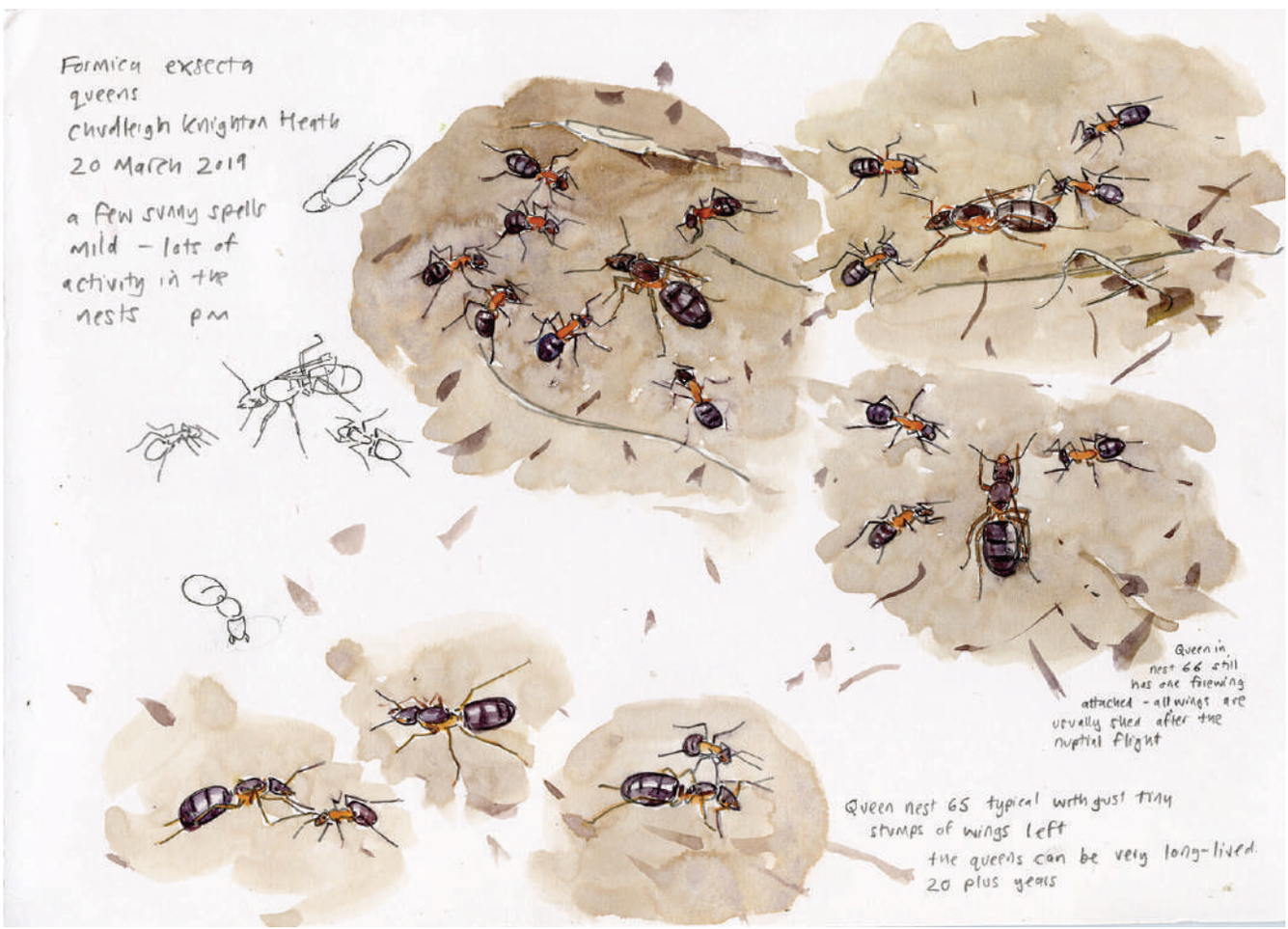
Early season queen sightings

Nest checks in February and March 2019 revealed that at this time of year some queen ants were at the surface in the nest thatch and visible under the tiles. The following observations were made:

18 February 2019 - queen under tile, road verge nest 114
27 February 2019 - queen under tile, nest 3
2 March 2019 - queens under tiles nests 65 and 98
11 March 2019 - queens under tiles in nests 8, 64, 66 and 67. The queen in nest 66 has the remains of one wing on her right hand side.
19 March 2019 - queens under tiles in nests 65 and same 'winged' queen in nest 66

After the latter date no more queens were seen until newly emerged fully-winged queens and males in July. It is presumed that the queens come up to the surface for warmth very early in the season then retreat deep into the nest for the rest of the year, none have been seen in autumn.

No observations of this behaviour were recorded in 2020.



Formica exsecta queens in nests 65 and 66 - 20 March 2019.

Winged adults and the nuptial flight

The 'winged' queen being seen twice in nest 66 is in March 2019 (see illustration above) is the only evidence of any sort we have to show that any of the Chudleigh Knighton Heath nests may be monogynous (have a single queen). As some budding of nests definitely occurs it is likely that other nests are polygynous and polydomus but this requires further investigation.

The first winged queen and male ants were seen on 16 July 2019 gathering under tiles in cloudy conditions. The following observations were made:

16 July 2019 - winged queens in nest 5, winged males in nests 7 and 8
18 July 2019 - winged queens in nest 5, winged males in nests 7 and 8
July 2019 - winged queens seen at nests 5, 8 and 41. Males seen at nests 7, 23 and 73

The nuptial flight was observed in the early mornings 22 and 23 July 2019 and a few winged adults taken into captivity, mated then released at queenless donor nests established at Bovey Heathfield (SC).

Formica exsecta winged adults under nest tile, males (centre left and centre right) winged queen (right) Chudleigh Knighton Heath, July 2020.

Field observations during the summer of 2020 were particularly focussed on the nuptial flight. MB and BV monitored the nests on Compartment 8 at CKH regularly. The first alate cocoons were seen on 6 June, they can be distinguished from worker cocoons by their size and colour. 49 nests had alate cocoons, of these 33 were observed with winged adults, 12 with queens and 28 with males, 7 nests had males and queens (Vulliamy, 2020). The first winged males were observed sheltering under nest tiles in nests 8 and 6 on 19 June and the first teneral queen in nest 12 on 7 July. BV and JW observed the nuptial flight between 12 July and 30 July, no visits were made immediately after this so the flight may have continued a little longer.

Formica exsecta workers with alate cocoon (arrowed), Chudleigh Knighton Heath, 27 June 2020.

Each flight commenced early in the morning usually from about 7.30 to 9.30 am in sunny warm weather when the first sunlight strikes the nest mound, as has been observed previously (Seifert, 2018). If it is cloudy during the early morning the flight may be delayed. This was observed on 18 July with alates flying in the first sunshine at 10.30 am. If it is cloudy until the afternoon the flight will not take place that day (Seifert, 2018). The males usually emerged before the queens and both climbed vegetation around the nests before taking flight. Sunshine was key to this, especially very early in the morning. On part cloudy days the alates would emerge and then sit in the vegetation before the next burst of sun. Then there would be a surge of activity within a few minutes. The flight at all nests was synchronised so it was difficult to watch more than 2 or 3 adjacent nests on any morning. The alates often took several attempts to fly with short hops between grasses or gorse stems before launching cleanly in the air and flying off. They climbed straight up to 20 metres then either moved off south towards the road or north towards the trees between Compartments 8 and 5. In Europe observations have been made of winged adults flying 'to external mating places at hill tops and other higher points in the terrain' (Seifert, 2018). Tree tops seem to be the most likely places for this to occur at CKH.

Formica exsecta nuptial flight, Chudleigh Knighton Heath 16 July 2020.

Details of the flight are recorded by Vulliamy (2020) along with information on captive mating of alates taken into captivity. A video of the nuptial flight was made and can be viewed at:

https://www.youtube.com/watch?v=iTAwLCZQ4rE

JW also took some alates into captivity and achieved similar results to BV by keeping them in a net cage hung above a window. Similar observations of mating lasting about 20 seconds and mate guarding were recorded. It was noted that the ants were very active during the early morning and the males survived about a week after collection. It is likely that alates fly again each suitable morning after leaving the nest and multiple matings occur. As the ants could not be followed more that 30 metres in flight it was impossible to find any of the mating aggregations. If the ants were to become established at Bovey Heathfield again it may be possible to observe this behaviour here as there is an obvious hill top in the middle of the site.

Formica exsecta alates kept in net cage (left) and mating pair (inset) and male guarding queen (right).

The mated queens and males were released at Bovey Heathfield (Vulliamy, 2020). Brief observations were made of this. At some nests the queens walked in amongst the workers or moved away from the nest. At other nests eg Donor 6 at Bovey Heathfield the resident workers were aggressive towards the new queen. In this case the queens were moved into the vegetation away from the nest mound. It is hoped that one or more of these queens would be adopted in the queenless nest. No observations to prove this has taken place have yet been observed in the surviving donor nests at Bovey Heathfield and Teigngrace Meadow. One captive donor nest established by BV may have adopted the queen as worker brood was seen in September (Vulliamy, 2020). Further observations are required in 2021 at wild nests to establish if the introductions have been successful.

Formica exsecta mated queen placed in Donor 6 nest - aggression shown by resident workers July 2020, Bovey Heathfield.

Relationships with other ants and insects
Other ant species found nesting alongside *Formica exsecta* on Chudleigh Knighton Heath are *Lasius niger* s.l., *Myrmica scabrinodis, Myrmica ruginodis* and *Formica fusca*.

At nest 84 on compartment 5 in 2018 the *Formica exsecta* nest had nests of *Lasius niger* s.l. and *Formica fusca* within 50 cm and there appeared to be little interaction between the species.

Formica exsecta nests 88a and 88b were situated about 50 cm apart in separate *Molinia* tussocks during 2018. In mid-August 88b was deserted and the nest taken over by *Formica fusca* which raised brood and lived alongside the *Formica exsecta* until early October when the *Formica fusca* disappeared. In 2020 nest 88 was rediscovered having moved 2 metres probably after being shaded out by encroaching gorse.

At several other nests *Myrmica scabrinodis* were found nesting in close proximity to *Formica exsecta*. *Formica exsecta* is known to predate *Myrmica* ants though this was not observed. The presence of *Formica rufa* is known to be detrimental to populations of *Formica exsecta*, this ant occurs close to and on Chudleigh Knighton Heath but is not currently seen as a threat to the population. *Formica rufa* requires scrub and trees to forage in and is unlikely to venture far out on the open heath.

The presence of *Lasius niger* s.l. may have been detrimental to one of the last *Formica exsecta* nests at Bovey Heathfield in 2004 so the presence of this ant may be a consideration when translocating nests - see below. While *Formica exsecta* dominates over *Lasius* and *Myrmica* in fully established nests, this may be reversed for newly colonising nests in early stages. If the species that was there first predates on early coloniser nests of the newly arriving species, even if the new arrivals are typically the dominant species otherwise (Stockan, J.A. and Robinson, E J.H 2016).

During 2019 Clive Turner tried inserting small bundles of twigs into six *Formica exsecta* nests at Chudleigh Knighton Heath in an attempt to find the rove beetle *Dinarda hagensii* that is an inquiline in their nests. This beetle has not been recorded in the UK for many years but in the past has been recorded from *Formica exsecta* nests in Dorset and there is a record from Lands End in the early 1900s (Hughes, 2006). The bundles of dried twigs and grass, about 10 - 15cm long and diameter of the whole bundle, 8-10 cm were tied around the middle with cord. These bundles were inserted 5 - 10 cm under the nest thatch, with the cord loose leading out from the nest (discreetly), so it could be pulled out for inspection at a later date. However in the event the cattle found all of the cords/bundles and removed or ate them!

Several *Formica rufa* nests are present on Chudleigh Knighton Heath at the north end of compartment 5 on concrete foundations from World War 2 buildings close to the road in the area around SX 83455 77614 and SX 83505 77542. These nests are close to nest 174 but separated by a road. Several *Formica rufa* nests are also present along the northern verge of the A38 to the west of Chudleigh Knighton Heath at SX 8365 7617.

The continued presence of at least three large *Formica rufa* nests on compartment B of Bovey Heathfield makes this site unsuitable for translocations of *Formica exsecta* nests even though it formerly held a population of the ant.

Formica rufa nest at Chudleigh Knighton Heath SX 83455 77614 this nest has been predated by a green woodpecker.

Formica rufa nest at Chudleigh Knighton Heath SX 83505 77542 on concrete base of old buidlings.

Map showing *Formica rufa* nests in the vicinity of *Formica exsecta* nest at Chudleigh Knighton Heath, Teigngrace Meadow and Bovey Heathfield.

Green woodpecker predation

Green woodpeckers *Picus viridis* are specialist ant predators. They have a long tongue which is accommodated in a special groove around the top of the skull. This enables them to dig in to the nest and extract ants and brood even during the winter. Tell-tale drill holes are a sign of their presence. The woodpeckers are extremely wary when feeding on the ground and tend to choose nests in very open situations or undisturbed clearings amongst trees. Nest 174 showed signs of predation by a woodpecker in December 2018 and a *Formica rufa* nest in the tree belt within 100 metres of this nest had also been predated.

Formica exsecta nest 174 predated by green woodpecker (left), woodpecker poo (inset) and green woodpecker predating *Formica rufa* nest (right).

***Formica exsecta* predated by spiders**

Occasionally the ants are predated by other invertebrates. During 2020 an immature female Wasp Spider *Argiope bruennichi* was observed catching a few of the winged adults as they emerged from nest 12 on CKH in July. On 7 November 2020 a crab spider *Xysticus* sp was observed preying on a worker at Nest 218 Compartment 8 at CKH.

Formica exsecta preyed on by a Wasp spider (left and middle) and crab spider (right).

Road verge nests

Two *Formica exsecta* nests (114 and 115) were located alongside the slip road of the A38 adjacent to nature reserve in 2018 on land owned and managed by Highways England. There have been nests present here since about 2005. These nests are interesting in the fact that the habitat is acid grassland rather than heathland. This raises the possibility of translocating the ant to non heathland sites.

SC and JMW met with Highways England ecologist Leo Gubert on 21 September 2018 to discuss the verge management prior to works taking place. It was decided to leave blocks of vegetation uncut around the nests and then monitor the nests and habitat over following years. The vegetation immediately adjacent to the nests will require ongoing small scale management through cutting back vegetation with hand tools. These nests 114 and 115 were located again in 2019 and an additional seven nests were also found, all small nests close to the tarmac footpath edge. Whether these are new nests or satellite nests is currently unknown. A queen was seen in nest 114 on 18 February 2019. Currently 8 nests are active along the road verge including nest 221 further south along the verge in an area that hasn't been surveyed for the ant in previous years. BV located this large nest in 2020, it looks like it has been established for several years.

Sowing yellow rattle seed on road verge 2 December 2019 and new Highways England road sign November 2020.

A small amount of trimming of vegetation eg bramble, sallow and other low vegetation has been made around the nests. During November 2019 a narrow strip was mown along the entire road verge adjacent to the path. The nests were mostly inactive by this time and little damage was done. The same happened in 2020 but again little damage to the nests occured. To prevent innapropriate cutting ocurring new signs were placed at either end of the verge in November 2020.

Yellow rattle *Rhinanthus minor* seed was sown in disturbed ground along the verge during December 2019 and January 2020. This plant is known as the 'meadow maker' and is often used to create flower meadows in rank grasslands. It is a hemi-parasite on grasses reducing their vigour and allowing flowering herbs to dominate. This was successful but the plants were mowed on 9 June 2020 before they went to seed. The verge was mown except for areas around the 8 nests on 23 November 2020 and more yellow rattle seed was sown on the scarified ground.

Formica exsecta nest sites along A38 slip road. Management work, 24 September 2018.

Formica exsecta nest 114 road verge site in 2019.

Data loggers and hemispherical photographs

Plymouth University student Ziad Ibbini collected data on temperature within and outside *Formica exsecta* nests during 2018 using data loggers and also took hemispherical photographs off all nests to record the shading and insolation levels. It it hoped to use the data collected along with other field observations to gain a better understanding of the ecology of this ant. Ziad has kindly provided a summary of his findings given below.

Ziad Ibbini conducting hemispherical photography on a *Formica exsecta* nest 2018

Summary of results

Temperature

Initial exploration into the data from logging nest temperatures and soil temperatures (1m away), for 74 days during the nests' peak season, found that nest temperatures did not follow expected results. As would be assumed with any species that undergoes thermoregulation in some form, we had expected within nest temperatures to be more stable and more constrained around a mean than soil temperatures. However, this was not the case when we processed the data after retrieving the loggers; surprisingly, nest temperatures were more erratic and had exaggerated extreme values.

After some discussion, we then theorized that nest temperatures could be behaving in this way because of the biology of the ants or because of the structural composition of the nests themselves. To investigate this further, we deposited a further set of loggers, in inactive and active nests for a total of 2 weeks. After undergoing the appropriate statistics on the subsequent dataset, we found that the structural composition of the nests significantly affected the nest temperatures when considering the overarching trends. On the other hand, when considering the incremental fluctuations at smaller time steps, the presence of the ants within the nest structure significantly affected the resultant temperature. It could be argued that the placement of the loggers themselves produced these results, as they were situated in the vegetation thatch above the soil compartment of the nest. Airflow in this area is substantially higher than would be in the soil itself, and could produce the pattern we saw in the datasets. However this does not explain the second set of results, wherein presence of the ants did yield a significant effect.

Photography

Photography was carried out to further inform our understanding of where the nests are located, as this species is heavily dependent on the availability of sunlight. Leaf area index further from the zenith was higher for almost all nests. This suggests that the ants choose areas where the majority of the canopy openness is situated towards the zenith, at which the intensity of the sun is at its greatest. Whilst keeping vegetation, if any, located towards the horizon in relation to the 360-degree view of the nest. Additionally, total and average sunfleck frequency was very low for the majority of the nests. A characteristic result of very open areas, as there is less opportunity for sunflecks to occur due to the minimal canopy cover.

Statistics

Paired sample t tests were undergone using Rstudio and SPSS software to elucidate the differences in temperatures found. Gap light analyser and ImageR software were used to produce the data ouputs from the hemispherical photographs.

Translocation criteria

The following criteria were used to identify potential introduction sites for translocated nests or potential introduction of mated queen *Formica exsecta* in the future.

1. Presence of low heathland vegetation. This could be heathers, gorse and grasses or possibly areas dominated by grasses e.g. grass heath habitats. Within this vegetation structures such as grass tussocks or heather clumps should be available for nest sites.

2. Close proximity (within 5 metres) of suitable aphid host plants most typically birch, oak, gorse and sallow. These trees and shrubs would also provide suitable hunting areas for the ants with prey such as lepidoptera larvae and true bugs.

3. A south-facing aspect with some areas of bare ground. This may be sheltered by scrub and trees.

4. A substrate of friable soil and suitable dead vegetation fragments available for thatch construction.

5. An absence of red wood ant *Formica rufa* nests within 100 metres. Presence of *Lasius niger* s.l. nests may also be detrimental to establishment of *Formica exsecta* nests but more information needs to be obtained on the relationship between these two species.

6. A presence of the host ants *Formica fusca, Formica lemani* and *Formica cunicularia* (Seifert, 2018).

Translocation sites

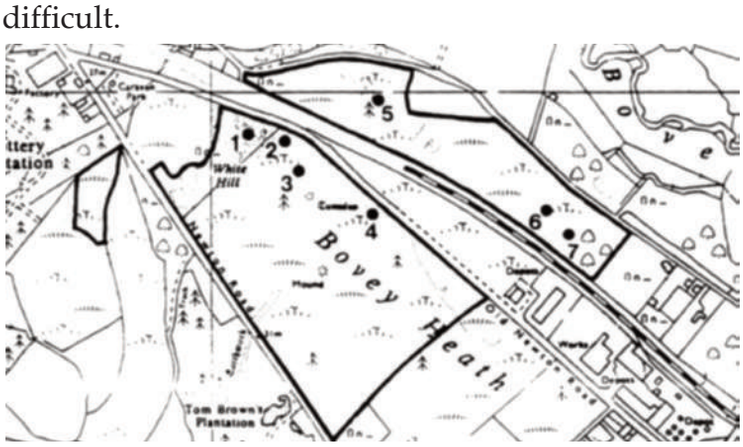
Bovey Heathfield

The Devon Wildlife Trust nature reserve was chosen as the obvious first choice for reintroducing *Formica exsecta*. The ant was last recorded here in 2004. Since that time work by the Devon Wildlife Trust has greatly improved the condition of the habitat in the compartments under their management (Compartments A and B see aerial photo below). Prior to it becoming a nature reserve the heathland was subject to large scale erosion from motorcycling and other off-road vehicle use.

A thin strip of habitat (marked C on aerial photo) to the south of the main compartment is managed by Teignbridge District Council. The very limited area here is managed for the silver-studded blue butterfly *Plebejus argus*. As this butterfly relies on an abundance of *Lasius niger* s.l. ants the limited size of the site makes it unsuitable to support colonies of *Formica exsecta* as well.

Another compartment to the west in Tom Brown's Plantation (marked E is owned by Sibelco) appears to have been recently managed exposing bare ground heathland habitats. Further investigations would have to be made with the owners regarding the possibility of this being a site which has potential to support *Formica exsecta* nests. The privately owned compartment immediately to the north of the main compartment (marked D) has suffered from a lack of management in recent years. This is the location of the last *Formica exsecta* nest found in 2004. If management work was conducted in this area to create more early successional heathland habitats it could provide a suitable area area for the re-introduction of *Formica exsecta*. It appears to be unsuitable at present except possibly the extreme southern edge along the boundary with the Wildlife Trust reserve.

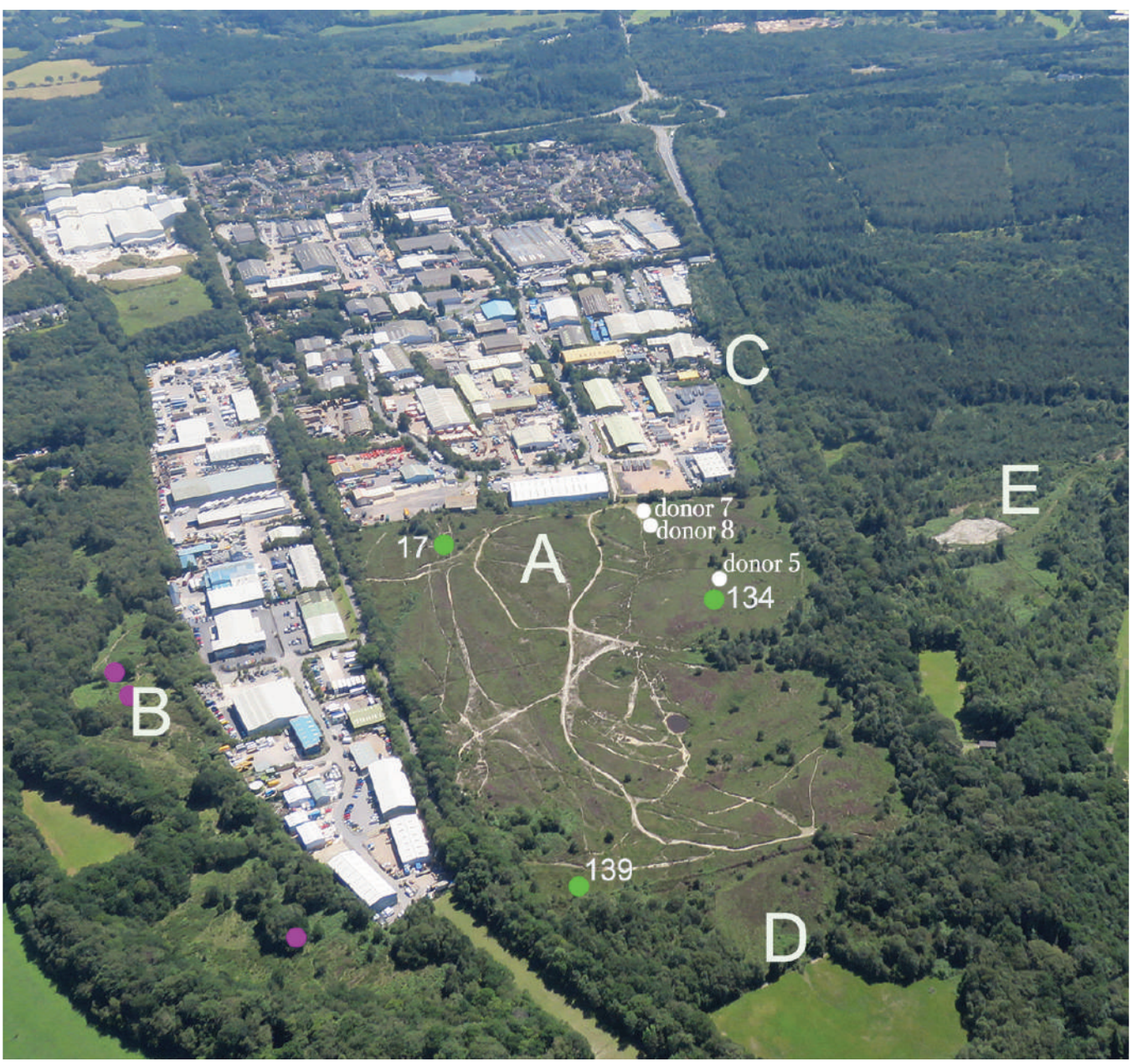
Compartment B of the Devon Wildlife Trust reserve held *Formica exsecta* colonies in the 1990s. Since that time scrub has encroached over much of the site allowing colonisation by the Red Wood Ant *Formica rufa*. At least 2 large nests are now established (marked in red on aerial photo) at the following grid references SX82327699 and SX82487687. The presence and probable expansion of *Formica rufa* in this compartment renders it unsuitable for *Formica exsecta* despite recent habitat management work conducted here. Relocating the *Formica rufa* nests off-site may be a solution to this but the ant has probably colonised from sites nearby. Action may then be required further afield as well to prevent further recolonisation which may prove to be very difficult.



Formica exsecta nests at Bovey Heathfield from David J Stradling & Simon P Hoy 1993 *The ant Formica exsecta An endangered British species Distribution Ecology and Conservation.* Report to Worldwide Fund for Nature on Project 199/88 (Heathland ant colony establishment). Dept of Biological Sciences, Univ. of Exeter, September 1993.

The remaining area is the main compartment A of the Devon Wildlife Trust reserve at Bovey Heathfield. The undulating nature of the site provides many south-facing slopes in areas dominated by heathland vegetation. Scattered birch, sallow along with gorse are present providing suitable host plants for aphids. The soil is light and friable and suitable nest building thatch materials are available. During field surveys conducted in 2017 and 2018 potential areas were identified using the above criteria. Felt mats were placed in various locations on the heath in March 2018 and these were successful in locating further nest sites of *Formica fusca*. This ant can be difficult to locate as it nests are often small and the workers non-aggressive near their nests. The felt mats offer excellent nesting conditions so if present the ant will often establish nests beneath them. This is also the case with another host species *Formica lemani*.

Teigngrace Meadow and Ramshorn Down, near Bickington are also potential translocation sites as they have populations of *Formica cunicularia* see below.



Bovey Heathfield and Tom Brown's Plantation (E) showing *Formica rufa* nests (pink) and translocated *Formica exsecta* nests (green) and 2019 donor nests (white). Photo July 2017.


Formica fusca (left) and the closely related *Formica cunicularia* occur on Bovey Heathfield, Teigngrace Meadow and Ramshorn Down. Both are known hosts of *Formica exsecta*.

Translocations

During July 2018 SC and BV arranged for two nests, 86 and 87, to be translocated from compartment 8 to compartment 5 on Chudleigh Knighton Heath. This was achieved with the use of a mini-digger. After translocation both nests were supplied with extra food in the form of sliced apple and pear placed around the nest. During August both nests relocated a short distance. Nest 86 moved 380 cm in to a clearing amongst low western gorse and heather. Currently the nest looks healthy and brood was recorded over the summer. Some hand clearance of vegetation took place in the vicinity of this nest in September 2018. Nest 87 moved about a metre in to another *Molinia* tussock. Brood was recorded in May 2019 and the nest was still active in November 2019. On 10 December 2018 nest 68 was taken in to captivity by SC to enable behavioural observations to be made.

Following on from this four more nests were translocated from compartment 8 to compartments 1 and 3 in November 2018. Nests 1 and 40 were translocated to compartment 1 under the pylon base close to nest 174. Nests 13 and 98 to compartment 3. These have been fed with sliced fruit and were still active in mild conditions during December. On 26 November 2018 three nests were translocated to Bovey Heathfield. These have been monitored regularly and were still active in late December.

The translocation process

Initially a receptor site was chosen using the above criteria. The translocation day was chosen when the weather conditions were mild and dry. A receptor hole was then dug out with a diameter of about 100 cm to a depth of about 50 cm. The nest was then dug up using hand tools. It was usually possible extract the bulk of the nest down to a depth of about 40 cm and place this on a sheet in a wheelbarrow. Any ants remaining in the hole were then extracted and placed in a separate container. The nest was then transported by car and wheelbarrow to the receptor site. Here it was carefully positioned so that the tilt of the nest thatch was facing south. The hole was then filled in and any extra ants placed around it. Pieces of apple and pear were placed around the nest as food for the ants. The nests were checked during December and given extra food.

Translocating a *Formica exsecta* nest 17 to Bovey Heathfield, November 2018.

Bovey Heathfield locations of translocated *Formica exsecta* nest 17 to SX 82418 76592 (left), nest 134 to SX 82183 76599 (middle) and nest 139 to SX 82113 76922 (right).

Filming for *The One Show* Chudleigh Knighton Heath 12 November 2019

Teigngrace Meadow
This newly acquired Devon Wildlife Trust reserve is situated to the south of Chudleigh Knighton Heath on old spoil heaps remaining from quarrying activities. A heathland community of plants is establishing itself on this site. Management work has been conducted to prevent encroachment of the site by gorse and pioneer birch woodland.

The site has south-facing slopes with heathland vegetation on friable soil. Scattered trees and shrubs including birch, gorse pine and bramble are available as host plants for aphids. The ant species found here are *Lasius niger s.l., Lasius flavus* and *Formica cunicularia*. Several felt mats were placed around grid reference SX 841 758 in 2017. These were checked in August 2018 but no *Formica fusca* nests were found under them or anywhere else on the site.

Formica cunicularia is a known host of *Formica exsecta* so its presence gives this site potential for the translocation of nests. In 2019 two nests, 194 and 198, were translocated from Compartment 8 at Chudleigh Knighton Heath to Teigngrace Meadow. Methods developed in 2018 listed below were used to do this.

The translocation of nest 198 on 12 November 2019 was filmed by the BBC Natural History Unit for a short film presented by George McGavin with SC and BV for *The One Show*.

Establishing queenless donor nests

Formica exsecta nests are known to be established in queenless nests of host ants in the *Formica fusca* group (Seifert 2018). During 2019 attempts were made to establish queenless nests that would then have the potential to be seeded with freshly-mated queen *Formica exsecta* or have the potential to receive mated queens after the summer mating flight.

Large nests were chosen as donors. A trowel was used to scoop up a section of the nest containing around 300 workers along with nest thatch. This was placed in a sealed plastic container. At the donor site a suitable *Mollinia* tussock was chosen. A hole was dug in the top of the tussock and a chamber excavated about 10 cm below this into centre of the tussock (see photos below). The thatch and ants was then placed on top of the tussock and and a felt tile placed on top with some slices of apple as food. The ants quickly rearranged the thatch and established a nest. Five donor nests were established during June and July 2019 at Bovey Heathfield and one at Teigngrace Meadow. By the end of the summer six of these had failed but donor nest 8 was still active so topped up with about 200 more workers from the donor nest. Nest were labelled after donor nest eg Donor 8 on Bovey Heathfield contains workers from nest 8 on Chudleigh Knighton Heath. An initial attempt was made to seed these nests with mated females by SC in late July.

23 July 2019 7 - 8am - SC collected 4 males from nest 7; 2 queens from nest 5, 2 queens from nest 41
Queens from nest 41 mated with males (from nest 7). First, 1 x male and 1 x queen put together in the same container; mating observed in both 24 July early morning. Males then put with queens from nest 5 together 25 – 27 July; unsure if males mated again, not observed but same climbing behaviour and approaches to queens seen. Active in the mornings 26 - 27 July. Males died 28 July.

28 July 2019 queens returned to Bovey Heathfield, 11 am-12 pm.
Known mated queen from nest 41 released near translocated Bovey Heathfield nest 134 between queenless nests from 5 and 7. Queen climbed a heather stem, on gust of breeze lifted off and dispersed northwards

One queen died. Other 2 queens from nest 5 released on top of donor nest 5 on BoveyHeathfield– both taken into nest by workers.

Method used for creating donor *Formica exsecta* nest, June 2019.

Donor 5 Bovey Heath Established 18 July 2019. SX 82180 76591
2 mated queens and males added 28 July 2019. More workers added 2 May 2020. Larvae in nest 22 May 2020. Cocoons 19 June 2020. 10 plus males in nest 15 July 2020. Mated queen and 2 males added 16 July 2020. Active 23 August 2020 and a few workers still active 23 November 2020. **Current Status ACTIVE**

Donor 6 Bovey Heath Established 4 May 2020. SX 82223 76662
More workers added 15 May 2020, 18 and 19 May. Brood 22 May 2020. Males and cocoons 19 June 2020. Males 30 June 2020. Mated queen and a few males put near nest 15 July 2020 queen attacked by resident workers but moved away from nest. Mated queen and males put near nest 28 July 2020. Nest active 23 August 2020 and 16 September 2020. **Current Status ACTIVE**

Donor 7 Bovey Heath Established 18 July 2019. SX 82172 76593
A few males and queen added July 2019. Appeared inactive August 2019. Workers and eggs added 11 April 2020. Active 30 April 2020. Brood present 4 May 2020. Larvae 22 May 2020. Cocoons 19 June 2020. Little activity 15 July 2020. Workers added 18 July 2020. Active 23 August 2020. **Current Status ?ACTIVE**

Donor 8 Bovey Heath Established 10 June 2019. SX 82178 76609
Workers added 18 July 2019. Active 26 March 2020. Eggs 11 April 2020. Brood 4 May 2020. Brood 22 May 2020. Male and cocoons 19 June 2020. Little activity 15 July 2020. Workers added 18 July 2020. Mated queen added 28 July 2020. **Current Status INACTIVE**

Donor 26 Bovey Heath Established 13 May 2020. SX 82171 76592
Cocoons 22 May and 19 June 2020. Active 15 July 2020. **Current Status INACTIVE**

Donor 45 Bovey Heath Established 2 May 2020. SX 82406 76592
Active 22 May 2020. Cocoons 19 June 2020. Male 30 June 2020. Males present in nest 30 June 2020. 10 plus males present and 10 queens added 18 July 2020. **Current Status ?ACTIVE**

Donor 60 Bovey Heath Established 18 June 2020. SX 82289 76494
Several mated queens and males added 28 July 2020. **Current Status ?ACTIVE**

Donor 126 Bovey Heath Established 18 June 2020. SX 82182 76625
Active 23 August 2020. None seen in September. **Current Status INACTIVE**

Donor 165 Bovey Heath Established 4 May 2020. SX 82228 76659
Larvae 22 May 2020. Cocoons 19 June 2020. Mated queen added 15 July 2020. Active 23 August 2020 and 16 September 2020. **Current Status ?ACTIVE**

Donor 175 Bovey Heath Established 2 May 2020. SX 82421 76567
invaded by Lasius niger failed 3 May 2020. **Current Status INACTIVE**

Donor 175B Bovey Heath Established 13 May 2020. SX 82170 76602
Workers added 18 May 2020. **Current Status INACTIVE**

Donor 176 Bovey Heath Established 19 July 2020. SX 82226 76656
Active 23 August and 16 September 2020. **Current Status ACTIVE**

Donor 179 Bovey Heath Established 13 May 2020. SX 82222 76617
Workers added 19 May, 22 May and 18 July 2020. Active 23 August 2020. **Current Status ?ACTIVE**

Donor 180 Bovey Heath Established 7 July 2020. SX 82279 76506
Alate cocoons 15 July 2020. None seen in September. **Current Status INACTIVE**

Donor 23 (T1) Teigngrace Meadow SX 84054 75750
Established 1 July 2019, with a smaller number of workers, c.80-100. After 1-2 weeks, original nest contained *Lasius* and nest assumed lost, but workers seen subsequently in nearby birch scrub and new nest location found August 2019, moved from original tussock c.2m south east to mossy clump below birch tree. Overwintered 2019 and seen active in spring 2020, including with brood seen by AR. Seen active, but low numbers on 14 July 2020. Limited monitoring 2020 due to Covid. Not believed to be active any longer **Current Status Probably INACTIVE**

Donor 165 (T4) Teigngrace Meadow Established 30 June 2020 SX SX 84077 75761 active all summer, last seen October 2020 and estimated still active. **Current Status ACTIVE**

Donor 41 (T5) Teigngrace Meadow Established 30 June 2020 SX 84076 75760 Active until August 2020 then no ants seen. **Current Status INACTIVE**

Heathland at Ramshorn Down, Bickington, a potential site for introducing *Formica exsecta*, August 2018.

Drilling on Chudleigh Knighton Heath

This owners of Chudleigh Knighton Heath Sibelco conducted some test drilling on compartment 5 during November and December 2018. The drilling plots have created some bare ground habitat which may be colonised by heathland invertebrates especially bees, wasps and ants. More plots were drilled in Compartment 5 during 2019 these are marked on the habitat management map above. Further drilling took place in Compartment 5 in 2020.

Test drilling plots on compartment 5 Chudleigh Knighton Heath, November 2018.

12 November 2019

12 November 2020 Drilling took place in the northern part of Compartment 5 outside the area known to be occupied by *Formica exsecta*.

Future work

The main aim of this Back from the Brink Project is to establish the Narrow-headed Ant on at least two other sites and to trial translocation techniques to enable this to be successful. Whole nest translocation have been mainly unsuccessful with the majority of nests failing within a year so far. The reasons for these failures are currently unknown but the fact that two have survived gives hope that this method could be used in the future if required.

Introduction of mated queens to queenless nests is probably a better method to use than translocation. This method has been trialled in 2019 and 2020 by establishing queenless donor nests at Bovey Heathfield and Teigngrace Meadow then introducing mated queens after the nuptial flight. It is too early to establish whether this method will work but should be continued as there are some small signs of success to build on. Especially BVs captive queenless nest to which a mated queen was added then worker brood seen and some nests on Bovey Heathfield and Teigngrace that may have adopted captive mated queens.

Releasing mated queens after the nuptial flight into suitable areas containing the host ants *Formica fusca, Formica cunicularia* and *Formica lemani* may be an easier and non invasive way to establish new nests. Nests 174 and 174a at Dunley Cross CKH are almost certainly the result of mated queens being released in this area in 1997 (Perrett 2019).

Nest monitoring has provided valuable information and it is hoped to continue this after the project finishes in December 2020. Then liaison with Andrew Bakere and Jackie Gage will be continued in regard to winter habitat management on Chudleigh Knighton Heath and Bovey Heathfield.

The captive nests will continue to be monitored to enable close observations of the ants' behaviour to be made. These nests may be returned to one of the translocation sites by the end of the project if they are still active.

Continued monitoring of the road verge nests should be made and liaison with the Highways Agency continued to determine the most appropriate management methods to be employed here. The ants appear to be thriving with 8 nests currently active and it is hoped that this will continue or even expand into other areas of the verge. Yellow-rattle has been seeded in the verge and its growth and effect on the grassland should be monitored. If successful in reducing the vigour of grasses the verge could be seeded with meadow plants eg vetches that provide extra-floral nectaries for the ants during the autumn.

Given that the verge nests are not in heathland habitat and are not dissimilar to many verges in the area wider searches should be made to see if there are any other nests that have been overlooked. There may be other opportunities to establish *Formica exsecta* populations on other verges where the host ants exist eg along the A38 at Haldon Hill.

The nests of *Formica rufa* adjacent to the *Formica exsecta* nests at Chudleigh Knighton Heath and Bovey Heathfield should continue to be monitored.

Observations in 2019 showed that queen *Formica exsecta* come to the surface of the nests in late February and March. If the queen can be captured with workers at this time they could be translocated to other sites using the same method as used for establishing queenless donor nests (see above). It may be necessary to keep these nests in captivity for a short while in spring to protect them from adverse weather conditions.

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