

FARMLAND CARABIDS IDENTIFICATION GUIDE

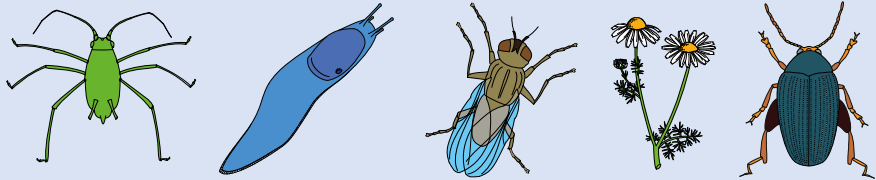


A simple ID guide for quick and easy identification of useful carabids to monitor pest control potential in farm habitats.

Dr Kelly Jowett, Rothamsted Research

PEST CONTROL BY CARABIDS

Carabid beetles in farmland habitats are mostly generalist scavengers, eating most pest species they come across, however there are some specialisms, including weed seed eaters.

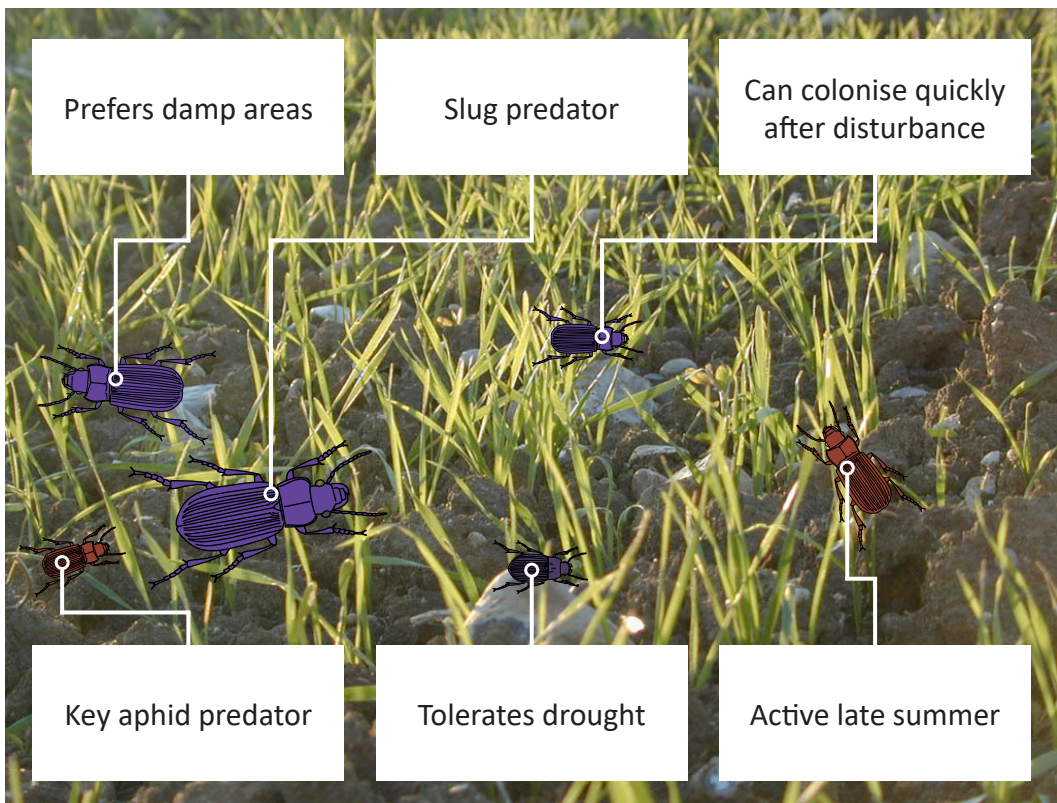


- Strawberry Seed-beetle (*Harpalus rufipes*), Copper Seed-eater (*Harpalus affinis*), and Sunshiner beetles (*Amara aenea*) can help to reduce seed stock of a weed species by 65 to 90% [1].
- Carabid beetles caused an 81% decrease in emerging adults of orange wheat blossom midge (*Sitodiplosis mosellana*) [2].
- Eggs and first-instar larvae of the cabbage root fly (*Delia radicum*) may be reduced by 90% by carabids including Pin-palps (*Bembidion lampros*) and Sienna Flat-beetle (*Trechus quadristriatus*) [3].
- The population of slugs (*Deroceras reticulatum*) in polythene tunnels of immature lettuce were reduced by 80% with the introduction of carabids [4].
- Copper Greenclock beetles (*Poecilus cupreus*) can eat up to 108 aphids per beetle, per day [5].

SERVICE EFFICIENCY AND STABILITY: LOTS OF DIFFERENT SPECIES

Different species specialise in different useful ways, and can tolerate different conditions. This means that having a diverse group of carabids on your farm will mean they can cope with changing needs (e.g. crops, weeds and pest occurrences) and conditions (e.g. weather).

There are over 350 species of carabid in the UK, around 30 of which are common in farmland.



Monitoring the species that occur on your farm can help to indicate which management practices would best encourage a diversity of carabid species, including key predatory species for your particular farm system.

HOW TO PITFALL TRAP ON YOUR FARM

WHAT DO I NEED?

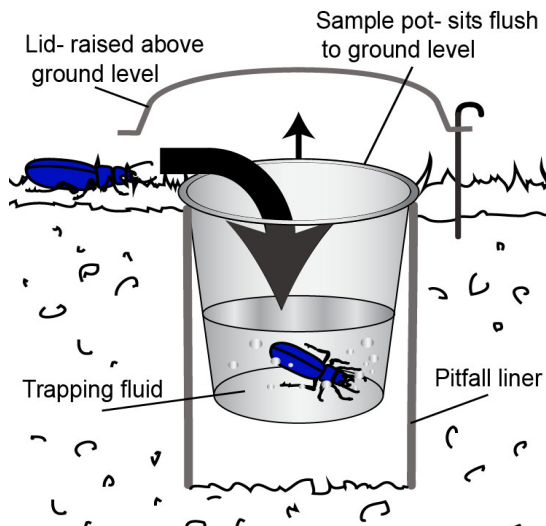
- A container – a jam jar or plastic cup will do
- A cover – a plant-pot saucer is ideal, but any flat object with sticks to sit on
- Fluid – propylene glycol (non-toxic antifreeze), or ethanol (mixed with 30% water) are ideal, but unscented detergent with water (2 drops per litre) will work

WHERE DO I PUT THE TRAPS?

Depends on how much time you have and what you want to find out. To start, it may be good to have one in a management feature, such as a field margin, and one in the adjacent crop. This way you can see if the beetles are moving between the two. Mark traps with a cane to find them again! Make sure they are not accessible by livestock, and avoid siting near public footpaths.

HOW DO I SET THEM UP?

- Dig a hole and set the container so that the lip is level with the soil surface, and ensure there are no gaps between the edge of the trap and the soil.
- To make it easier to reset you can have a liner – a tube or second container to sit in.
- Fill with the trapping fluid (unfortunately you need to kill the beetles to sample them, or they will eat each other). Fill the container to a depth of 4-5cm (1.5–2 inch).
- Set the cover raised 2–3cm (1 inch) above the soil surface – to protect from animals and the weather.



WHEN DO I COLLECT THEM?

Trapping period could last anywhere between 1 to 14 days, 7 days is usual. It is wise to have a test, then choose. It is best to stick to a standard period of time, so you can compare your samples over time.

HOW DO I PROCESS THE SAMPLES?

This depends on what level you want to go to. You can simply count the carabid beetles you have, or take the trap sample back to the farm/office to identify to genus or species - so you know what predators you have! Some dishes, a hand magnifying lens (10x magnification should reveal features in this guide) and tweezers are useful.

HOW OFTEN SHOULD I RUN TRAPS?

Insect numbers do vary a lot with weather, time of year, and resources available. So the more samples you have, the more accurate your conclusions are likely to be. However, knowing a little is better than nothing – so even once is good. A good medium could be two trapping occasions in spring and autumn, to catch the main carabid activity peaks.

STEP 1: IS IT A CARABID?

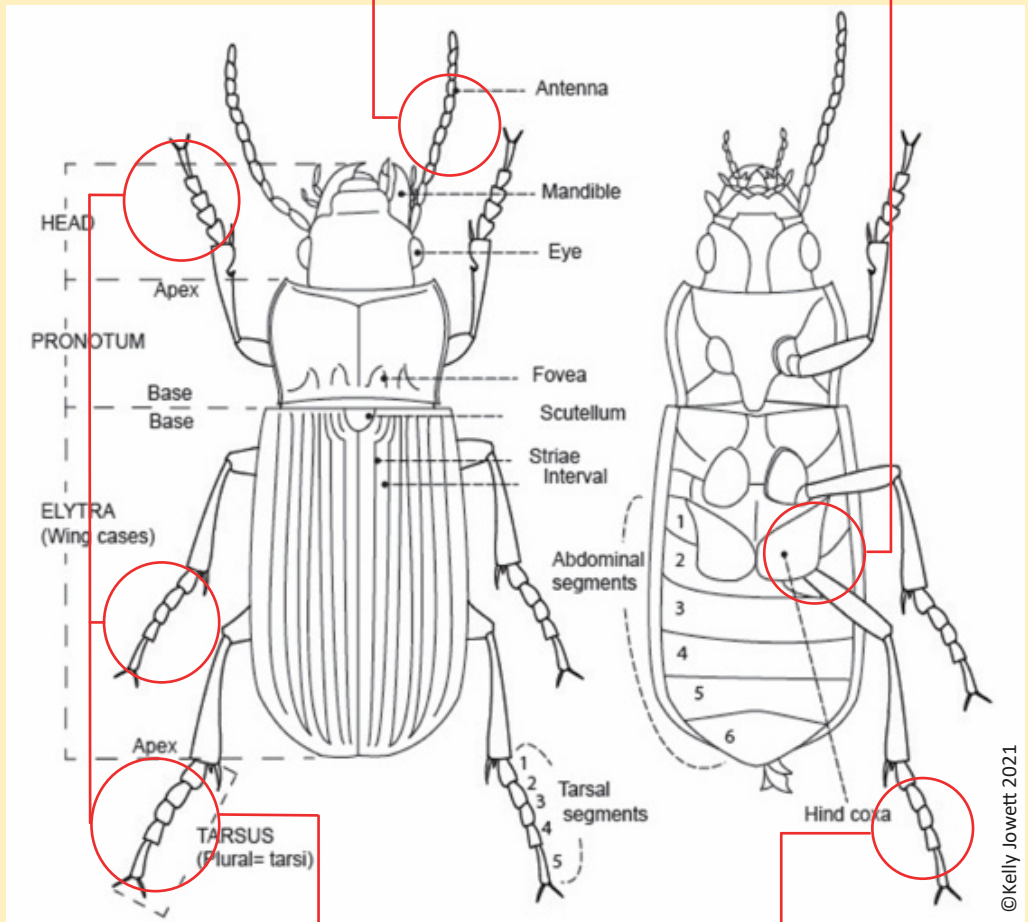
ALL CARABIDS HAVE THESE FOUR FEATURES:



Antenna threadlike and lightly hairy towards the ends



Hind coxa extending so that only sides of first abdominal segment can be seen



All tarsi (footlike end of the leg) have five segments



Hind tarsi NOT broad or fringed

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COMMON BEETLES CAUGHT IN PITFALLS THAT ARE NOT CARABIDS:



Burying beetles: Feed on carrion.

Can be orange banded or fully black.

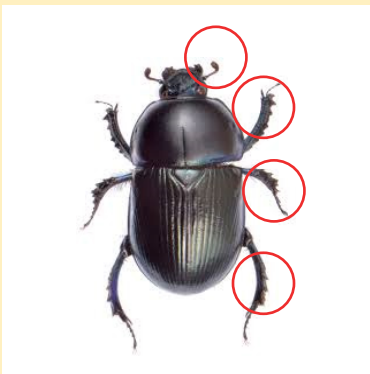
- Look for clubbed antenna and abdominal segments that protrude past the end of the wing cases.



Rove beetles: Predatory on a range on invertebrates.

Many species of different sizes and colours.

- Look for protruding abdominal segments, Rove beetles fold their wings tightly under very small wng cases.



Dor and dung beetles: Feed on dung or decaying matter.

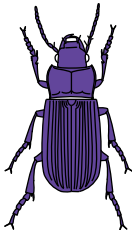
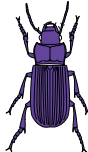


Many species occur of different sizes. Generally black, brown, or iridescent.

- Look for clubbed antenna and stout, ridged legs (for digging in dung).









KEY ID FEATURES FLOWCHART

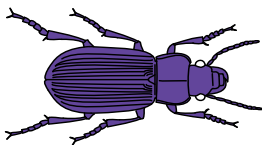
Look for these features first, then check the species page to confirm.

1. SIZE	2.	COLOUR
 21mm plus	Black	
	Metallic or iridescent	
 13 - 20mm	Black	
	Metallic	
	Brown	
 7 - 12mm	Black	
	Metallic	
	Brown	
	Patterns	
 4 - 6mm	Black	
	Metallic	
	Brown	
	Patterns	

3.

SHAPE

Waisted  	Rectangle  	Oval  
Violet Ground Beetle, p10, can appear black	Common Shoulderblade, p11	
Violet Ground Beetle, p10		
Common Heartshield, p16	Common Shoulderblade, p11; Great Blackclock, p12; Rain-beetle Blackclock, p13; Common Blackclock, p14; Sawfoot Ground Beetle, p20	
	Copper Greenclock, p19	
	Strawberry Seed-beetle, p15	
Hair-trap Ground Beetle, p17; Longjaw, P22	Sawfoot Ground Beetle, p20	Sunshiners and Moonshiners, p28
Prussian Plate-jaw, p23	Copper Seed-eater, p18; Copper Greenclock, p19	Sunshiners and Moonshiners, p28
Longjaw Ground Beetle, p22	Strawberry Seed-beetle, p15	Sunshiners and Moonshiners, p28
Copper Club-back, p25	Saddled Sawfoot, p21	
Pin-palps, p29		
Pin-palps, p29	Big-eyed beetle, p27	
Hairy-templed Thatcher, p24; Sienna Flat-beetle, p26		
Pin-palps, p29		



VIOLET GROUND BEETLE

Carabus violaceus

Size: 20-30mm

Habitat: Fields, margins, hedges

Breeding: Autumn

Activity: Nocturnal

Dispersal: Running only

Predation: Adults and larvae feed on slugs, snails, grubs.



Key ID features:

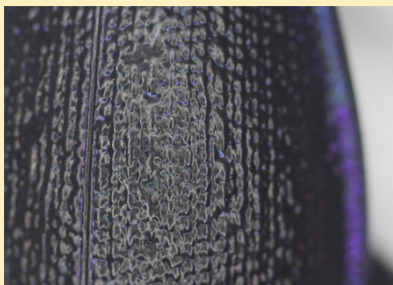
Size, Violet metallic colour at edges of wing cases, smooth texture of wing cases. Violet hue and metallic shimmer can be reduced in some specimens, especially in pitfall trap samples that are over a week old. Check for the pinched 'waist', with a rounded point to the end of the wing cases.



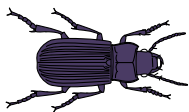
Violet Ground Beetle

Similar species:

Carabus problematicus: This is a species more commonly found in woodland habitats than on farms. Texture of elytra (wing cases) with noticeable parallel lines vertically.



Carabus problematicus



COMMON SHOULDERBLADE

Abax parallelepipedus

Size: 17-22mm

Habitat: Fields, margins, hedges, woodland

Breeding: Spring and summer

Activity: Nocturnal

Dispersal: Running

Predation: General crop pests including slugs, snails, grubs and aphids.

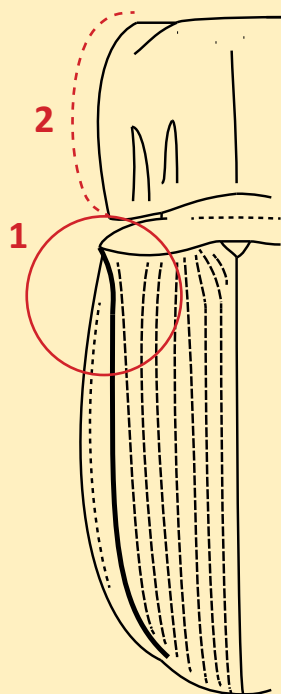


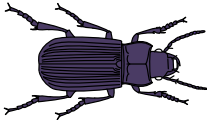
Key ID features:

Distinctive 'shoulderblade' ridge (1) along the side of the wing cases (elytra). Pronotum (middle section) quite straight towards the base (2), with two deep darts each side. Width of pronotum is almost as broad as the wing cases.

Similar species:

Common Blackclock *P. madidus*, and Great Blackclock *P. niger* both lack the shoulderblade ridge, and have more sinuate pronotums (middle sections), narrowed at the base, so that they are not as wide as the wing cases.





GREAT BLACKCLOCK

Pterostichus niger

Size: 15-21mm

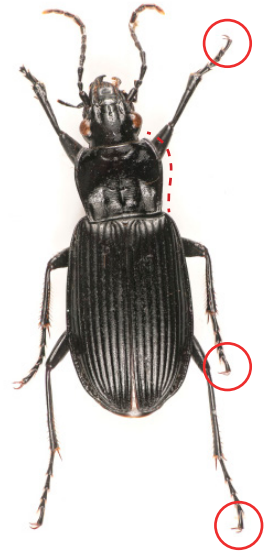
Habitat: Fields, margins, hedges, ditches

Breeding: Autumn

Activity: Nocturnal

Dispersal: Running

Predation: Adults and larvae feed on slugs, snails, and grubs.



Key ID features:

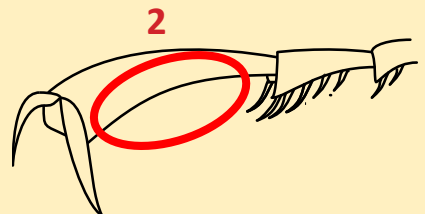
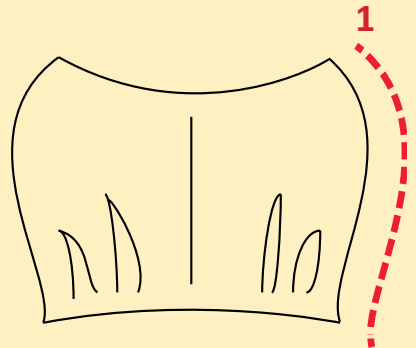
Size, less curved sides to pronotum (middle section) (1), no bristles on the underside of the end tarsal segment (with claw) (2).

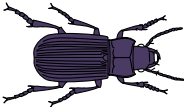
Similar species:

Rain Beetle Blackclock

P. melanarius - no bristles on end tarsal (foot) segment.

Great Blackclock is larger than other Blackclock species.





RAIN BEETLE BLACKCLOCK

Pterostichus melanarius

Size: 13-18mm

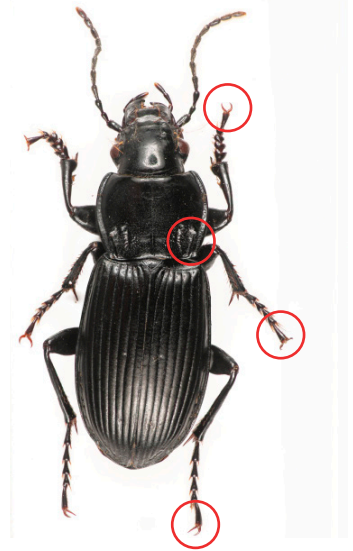
Habitat: Fields, margins, hedges

Breeding: Autumn

Activity: Mostly nocturnal

Dispersal: Running

Predation: Adults and larvae feed on pretty much all crop pests on the ground and in soil.



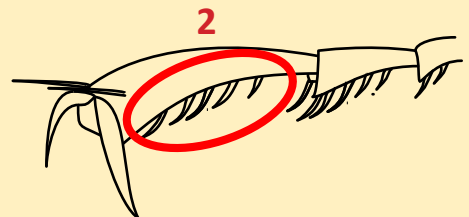
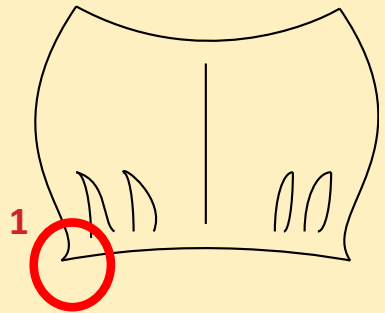
Key ID features:

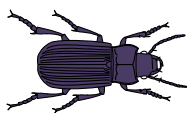
Pronotum (middle section) rounded with distinct tooth at the hind edge (1). Bristles on the underside of last tarsal (foot) segment (with claw) (2).

Similar species:

Common blackclock *P. madidus*: No tooth on hind angle.

Great blackclock *P. niger*: no bristles on the underside of end tarsal (foot) segment.





COMMON BLACKCLOCK

Pterostichus madidus

Size: 13-18mm

Habitat: Fields, margins, hedges, grassland

Breeding: Autumn

Activity: mostly nocturnal

Dispersal: running only

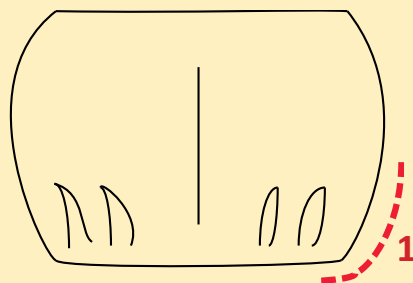
Predation: Adults and larvae feed on pretty much all crop pests on the ground and in soil.



Red-legged
form shown

Key ID features:

Legs can be black or reddish. Pronotum (middle section) rounded with no tooth at the hind edge (1), and two darts (fovea) each side. One dot like puncture on the 3rd line (interval) out from the centre of the wing cases, near the tip (2).

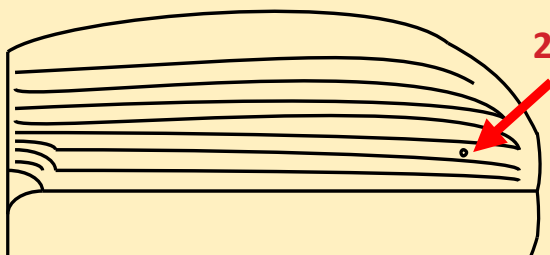


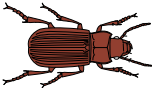
Similar species:

Rain Beetle Blackclock *P. melanarius*: tooth on hind angle.

Great Blackclock *P. niger*: no bristles on the underside of end tarsal (foot) segment.

Other scarcer *Pterostichus* species have rounded pronotums, but either none, or more than one puncture on wing cases.





STRAWBERRY SEED BEETLE

Harpalus rufipes

Size: 11-16mm

Habitat: fields, margins, open dry habitats

Breeding: autumn

Activity: nocturnal

Dispersal: flight



Predation: Weed seeds – particularly in larval stage.

Can be a pest in strawberry crops.

Key ID features:

Has the Seed-eater beetles (*Harpalus* species) characteristic wide head and offset jaws, notched forearms and hairy legs.

Unmistakable golden furred elytra (wing cases) – with muddy samples can look matte brown but still stands out.

Similar species: Other Seed-eater beetles – but these are much rarer.





COMMON HEARTSHIELD

Nebria brevicollis

Size: 10-14mm

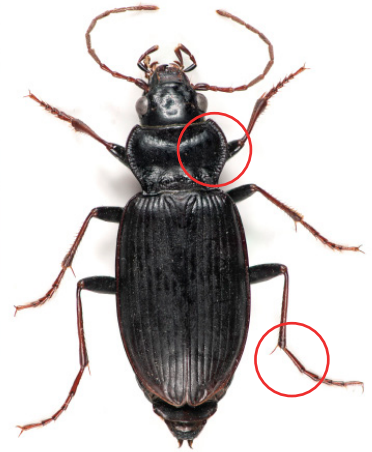
Habitat: Fields, margins, hedges, woodlands

Breeding: Autumn

Activity: Nocturnal

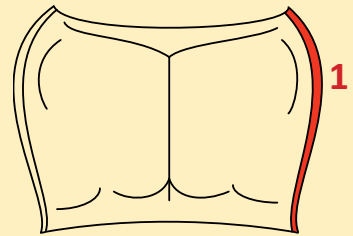
Dispersal: Rare flight

Predation: Adults are notable predators of pest fly larvae.



Key ID features:

Heart-shaped pronotum with broad edge line (1). Fine pale hairs on the upper surface of the hind tarsi (2). Gradual dark tips to tarsal segments.

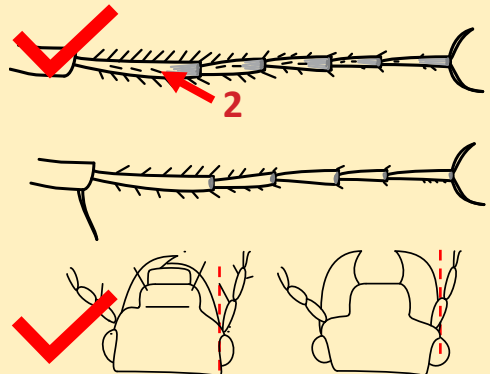


Similar species:

Other Heartshield species are smaller, with darker antenna.

Nebria salina have a narrow edge to the pronotum (middle section) and no hairs on the upper surface of the hind leg feet segments (tarsi). these are hard to see with a field lens, but *N. brevicollis* is more abundant in cropped area, so it is very likely to be this species.

Plate-jaw species – Heartshields have jaws narrower than antennas





HAIR-TRAP GROUND BEETLE

Loricera pilicornis

Size: 6-8.5mm

Habitat: fields, hedges, gardens, near water

Breeding: spring and summer

Activity: nocturnal

Dispersal: active flier

Predation: Adults and larvae feed on mites and springtails.

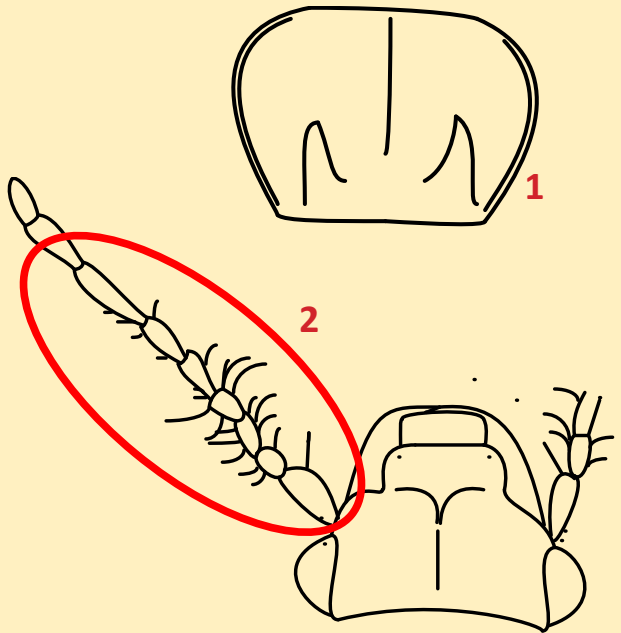


Key ID features:

Tear shaped pronotum (1).
Three clear depressions on the wing cases. Antennal hairs distinctive (used for trapping prey) (2).

Similar species:

Heartshield species - see opposite, pronotum (middle section) more rounded
Can be confused with Plate-jaws - check jaws narrower than eyes.





COPPER SEED-EATER

Harpalus affinis

Size: 9-12 mm

Habitat: Fields, open dry soils

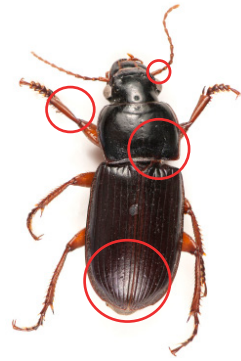
Breeding: Mostly spring

Activity: Night and day active

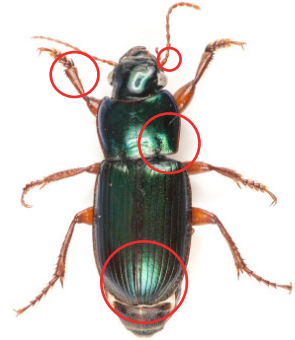
Dispersal: Flight

Predation: Adults and larvae eat weed seeds.

F



M



Key ID features:

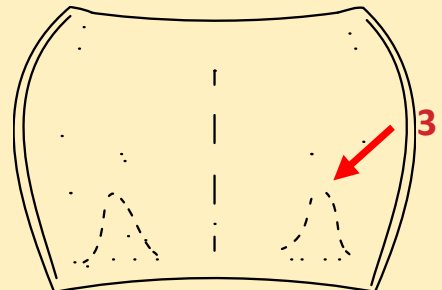
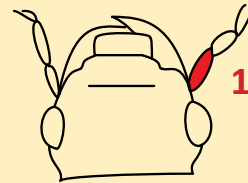
First antennal segment always pale (1). Variety of metallic colours, males brighter than females. Legs can be red or black. Seed-eater species characteristic wide head and uneven jaws, notched forearms and heavyset hairy legs (2) (see Strawberry Seed-beetle). Rounded end to wing cases (elytra). Single dart (fovea) indistinct (3).

Similar species:

Copper greenlock – see over

Sunshiner species – pronotum (middle section) is in line with elytra to give bullet shape

Other iridescent Seed-eaters – Copper seed-eater has punctured and hairy





COPPER GREENCLOCK

Poecilus cupreus

Size: 11-13mm

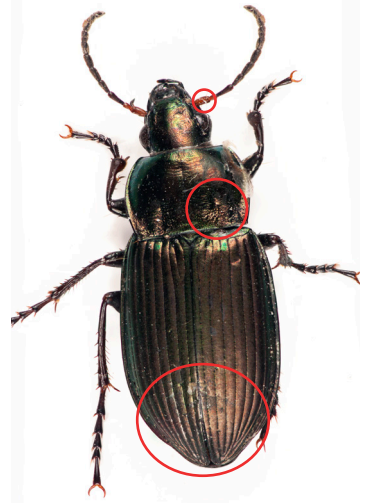
Habitat: Fields, margins, hedges

Breeding: Spring

Activity: Night and day active

Dispersal: Flight

Predation: Weed seeds and invertebrate crop pests.



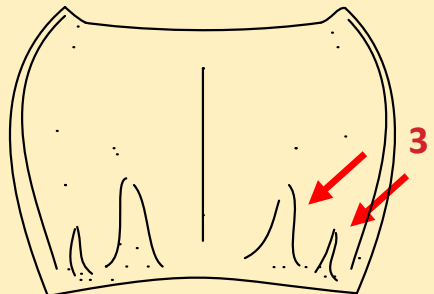
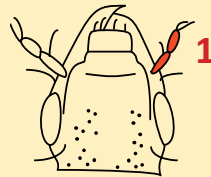
Key ID features:

Bright coppery green, rarely blue or purplish. Head clearly pitted. First two antennal segments pale (1). Legs black – rare form has red legs. Pointed end to wing cases (elytra). Two basal darts (fovea), very distinct (3).

Similar species:

Copper Seed-eater – see over, legs darker, finer, and less hairy (2).

Other Greenclock species *P. Versicolour* is smaller, has less than 8 hairs on hind leg (tibia), and indistinct pitting on the head.





SAWFOOT GROUND BEETLE

Calathus fuscipes

Size: 10-14 mm

Habitat: Open fields, margins, grassland

Breeding: autumn

Dispersal: some individuals fly (if conditions give rise to a dispersive generation)

Predation: Adults consume a range of invertebrate crop pests.

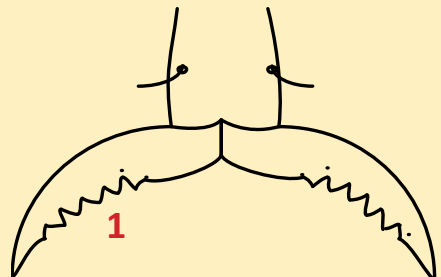
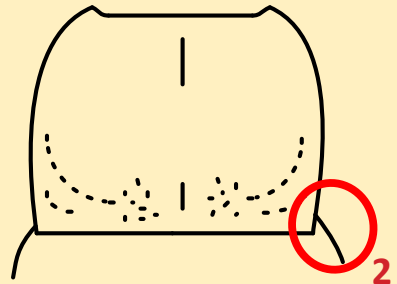


Key ID features:

Characteristic saw toothed feet of *Calathus* species (1). Black body, head and pronotum (middle section) shiny, elytra (wing cases) duller. Pronotum slightly narrower at base than the elytra (2), with pitting on the base. Legs can be pale OR dark.

Similar species:

Larger than other *Calathus* species.





SADDLED SAWFOOT GROUND BEETLE

Calathus melanocephalus

Size: 6-9mm

Habitat: Fields, margins, grassland heaths.

Breeding: Autumn

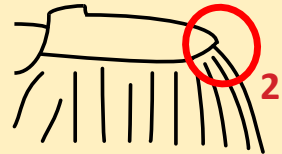
Dispersal: Some individuals fly (if conditions give rise to a dispersive generation)



Predation: Adults consume a range of invertebrate crop pests.

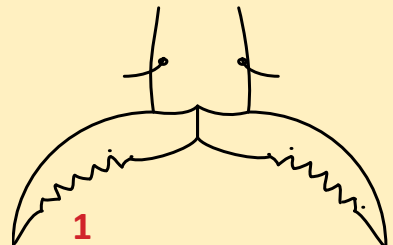
Key ID features:

Characteristic saw toothed feet of *Calathus* species (1). Head and elytra slightly metallic black or very dark brown. Pronotum (middle section) and legs reddish. Individuals in upland areas may have darker legs and pronotum.



Similar species:

Other scarcer *Calathus* species – *melanocephalus* has darker legs, and a protruding tooth on elytral (wing case) shoulders (2).





LONGJAW GROUND BEETLE

Stomis pumicatus

Size: 6.5-8.5 mm

Habitat: damp fields, margins, pond edges

Breeding: spring

Dispersal: running

Predation: Adults consume general invertebrate crop pests.

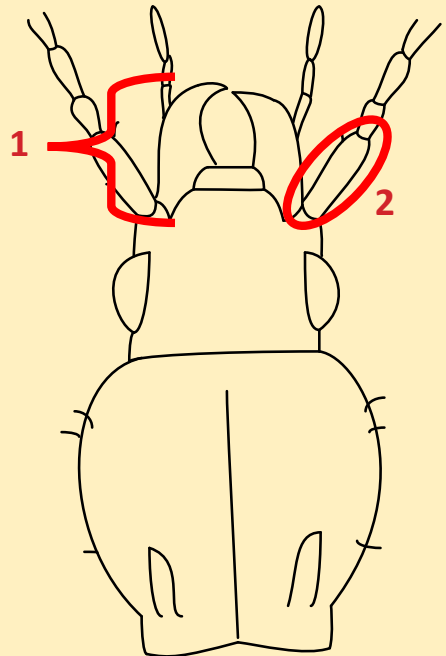


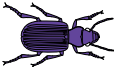
Key ID features:

Long protruding jaws (1), long first antennal segment (2), heart shaped pronotum (middle section) with single dart (fovea) and red legs.

Similar species:

Similar to small Blackclock (*Pterostichus* species), can be distinguished by long jaws.





PRUSSIAN PLATE-JAW

Leistus spinibarbis

Size: 8-10mm

Habitat: Fields, hedges, gardens, woodlands

Breeding: Summer and autumn

Dispersal: Flight

Predation: Adults feed on springtails and mites.



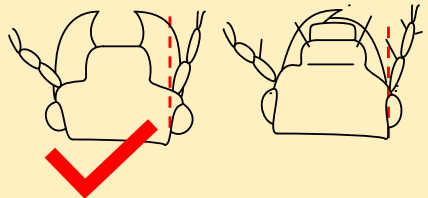
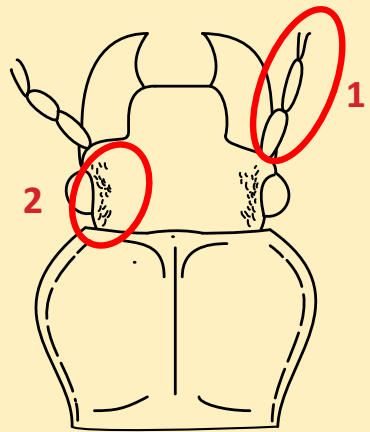
Key ID features:

Bright metallic blue shine on head, pronotums (middle sections) and wing cases. Legs can be dark or reddish.

Similar species:

Other Plate-jaw species:
Prussian has dark antenna (1),
blue colour and wrinkles on the
sides of its head (2).

Heart-shields – Plate-jaws have
jaws wider than antennas.





HAIRY-TEMPLED THATCHER

Demetrias atricapillus

Size: 4.5-5.6mm

Habitat: Fields, margins, dry grassland, dunes

Breeding: Spring

Activity: Diurnal

Dispersal: Flies readily, climbs vegetation to hunt

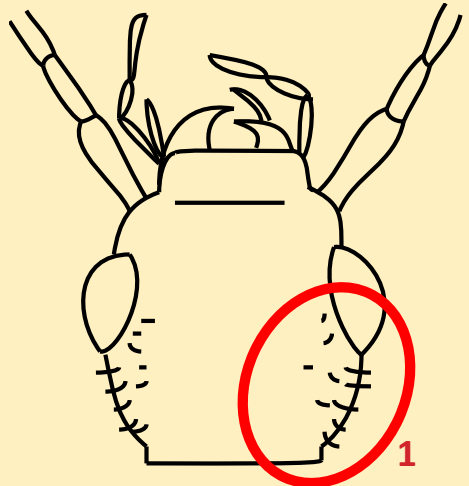


Predation: Key predator of pest aphids.

Key ID features:

Small heart shaped pronotum (middle section) and rectangular wing cases, blunt at the end, distinctive to *Demetrias* species. Straw coloured elytra and legs, with dark head and reddish pronotum.

Similar species: Can be distinguished from other *Demetrias* species by its hairy temples (1), and black centre to underside.



1



COPPER CLUB-BACK

Anchomenus dorsalis

Size: 8-9mm

Habitat: Fields, open dry habitats.
Aggregates in field margins overwinter

Breeding: Spring

Activity: Day active

Dispersal: Readily flies



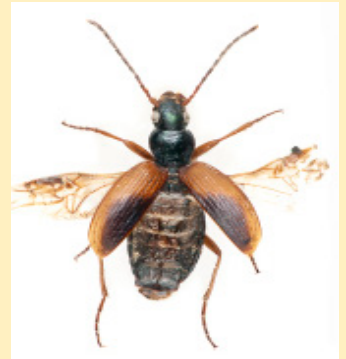
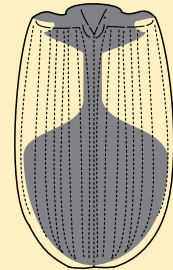
Predation: Adults are a notable predator of pest aphids, and other small crop pests.

Key ID features:

Greenish iridescent pronotum (middle section) and head.

Unmistakable 'club' pattern on wing cases (elytra). In wet and muddy samples can be hard to see, but pulling wing cases out reveals pattern.

Similar species: Prussian plate-jaw has unpatterned elytra, large jaws, and a wider pronotum.





SIENNA FLAT-BEETLE

Trechus quadristriatus

Size: 4mm

Habitat: Fields, margins, grassland

Breeding: late autumn

Dispersal: Active flight, can form swarms

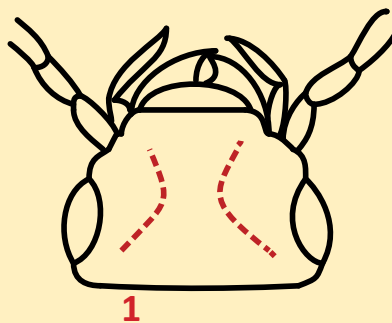
Predation: Adults predate in soil at base of crops. Eats eggs and pupae of flea beetles.



Key ID features:

Size, colour. Rounded pronotum (middle section) and elytra (wing cases). Prominent brow ridges characteristic of *Trechus* species (1). Many small brown carabids are hard to distinguish with a hand lens, but Sienna Flat-beetle is the most common of cropped areas.

Similar species: Wingless Flat-beetle (*Trechus obtusus*) – Sienna Flat-beetle has wings, which are easy to open out in samples by pulling the elytra back. Wingless Flat-beetle is unwinged.





BIG-EYED BEETLE

Notiophilus biguttatus

Size: 5-6mm

Habitat: Fields, margins, woodland hedges

Breeding: Spring, but may have 2nd generation late summer

Activity: Day active

Dispersal: Flight

Predation: Adults and larvae eat springtails and mites.



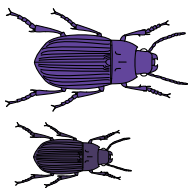
Key ID features:

Huge eyes are distinctive of *Notiophilus* species. This species has coppery metallic colour, with a paler patch towards the end of the wing cases, the extent of this patch varies. A pattern of indented stripes on wing cases (elytra) with a gap at the middle should be visible with a hand lens.



Similar species:

Other scarcer Big-eyed Beetle species (*Notiophilus*).



SUNSHINERS AND MOONSHINERS

Amara species

Many *Amara* species prefer to live in oilseed rape crop.

Predation: General crop pests and weed seeds.



Amara eurynota



Amara lunicollis



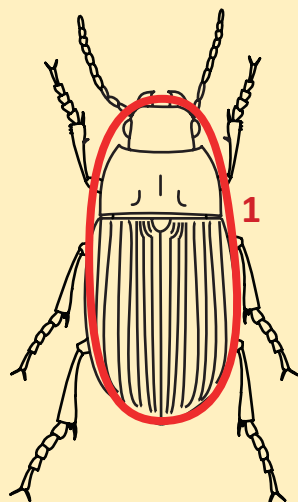
Amara similata

A group of very similar species difficult to identify to species level. However they predate and behave similarly, so for functional approaches, genus level ID (*Amara*) is sufficient

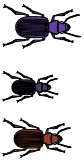
Key ID features:

Smooth line from pronotum (middle section) to wing cases (elytra), making a distinctive rounded bullet shape (1).

Sizes vary from 5-12mm



1



PIN-PALPS

Bembidion species

Mostly spring breeding and fly to various degrees (brachypterous).

Predation: Aphids and other small crop pests.



Bembidion lampros



Bembidion tetracolum

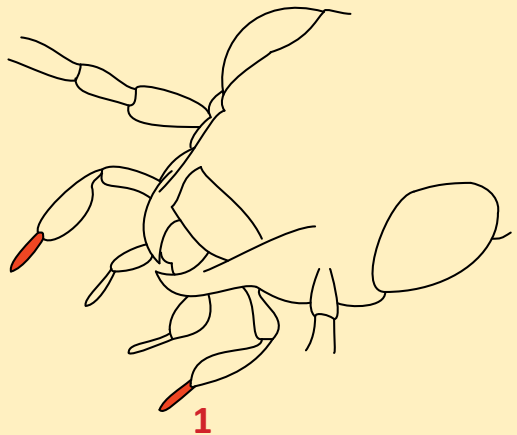
A group of very similar species difficult to identify to species level.

However, they predate and behave similarly, so for functional approaches, genus level ID (*Bembidion*) is sufficient.

Key ID features:

Small size: around 5-7mm.

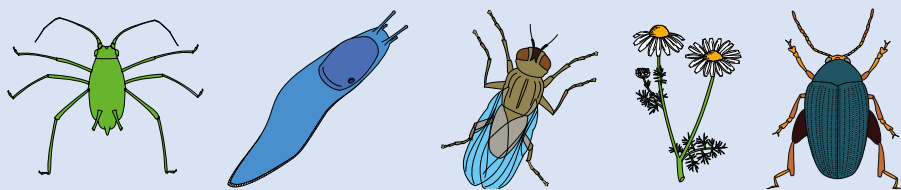
Large eyes, narrow waist. Flattened body, often shining or metallic. Named for the narrow ends to the mouthparts (palps) which may be visible with a hand lens (1).



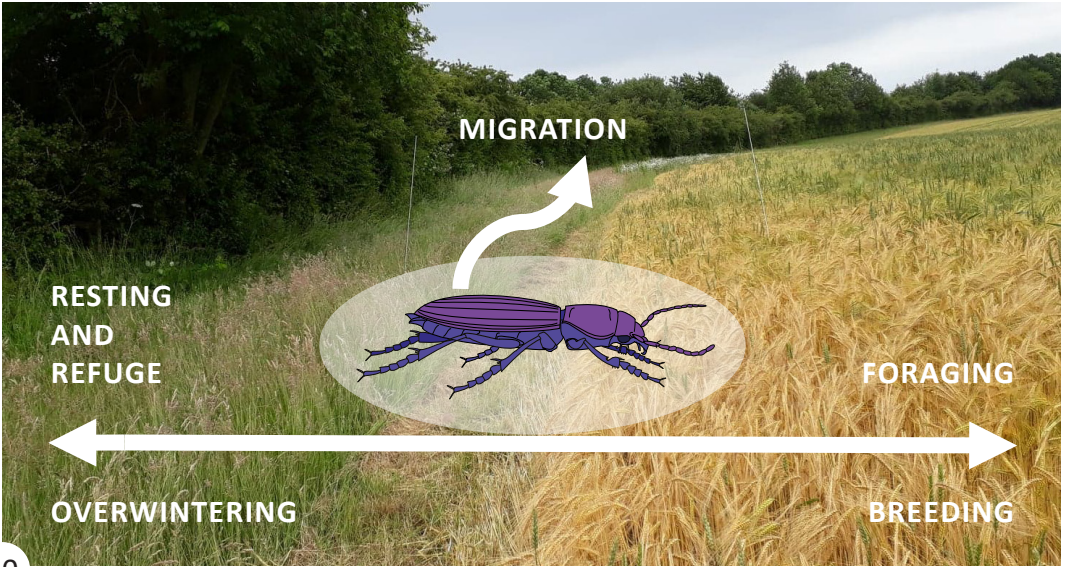
FARM HABITAT MANAGEMENT FOR CARABIDS

To boost numbers, farmed environments should provide the resources that carabids need to Feed, Breed, and Shelter.

FEED

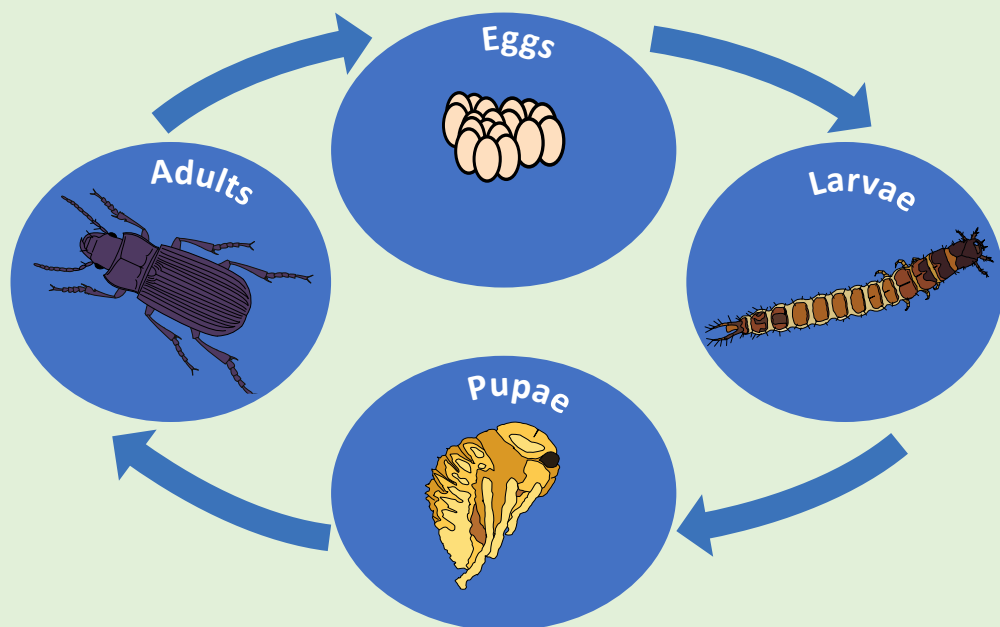


Carabids eat crop pests and weed seeds, but they need food resources all year round, not just when these are problematic in crops. Providing semi natural habitat adjacent to fields will provide stable resources over time. Having a range of crops, especially with a range of timings and structure, will help to provide a variety of resources to sustain a diverse range of carabid species.



BREED

Carabids, like all invertebrates, have a number of life stages. Carabids common in agricultural areas generally breed either in the spring or autumn, depending on the species. They lay their eggs in the soil, where they hatch into larvae. Carabid larvae live in the soil, occasionally coming to the surface to feed, and are generally more carnivorous than adults. After generally one season, the larvae pupate, then emerge as new adults. Spring breeders develop through summer, and overwinter as adults, whilst those breeding in the autumn overwinter as larvae and emerge as fresh adults in the spring.



SHELTER

Carabids need daily shelter from predators such as birds and mice, but also seasonal shelter for hibernation and aestivation (a summer rest period). Semi-natural areas (such as grassy margins and hedgerows) close to crops provide this shelter, but in-field measures such as undersowing and companion cropping will also provide these areas to encourage beetles in crop centres. It is also important to consider the connectivity of habitats in the landscape to encourage a range of species to migrate into your farm, and help them to move around your farm and disperse into crops.

REFUGE FROM PESTICIDES

Broad spectrum insecticides are effective in killing pests, but may also kill non-target invertebrates, including beneficial insects. Unfortunately, pest species may recover from insecticide applications more quickly than predator species such as carabids, as carabids have longer reproductive cycles. Over time, this reduces the populations of carabids, relative to pests, in an area - even when they may recolonise from source habitats.

While carabids are generally quite resistant to mortality caused by direct exposure to insecticides, indirect and persistent effects of insecticides can be considerable, for example, reducing the ability of carabids to feed and reproduce effectively.

Herbicides can also affect carabids indirectly, by removing food resources in seed and pollen, and shelter areas, that they rely on all year round.

General advice:

- Think about buffering resource areas. One sprayer's width at least.
- Use less toxic or persistent chemicals. More pest-specific formulas are likely to impact less than broad spectrum.
- Spray only when necessary, e.g. when pests reach threshold levels.

This minimises population losses, and ensures carabid populations recolonise fields quickly.

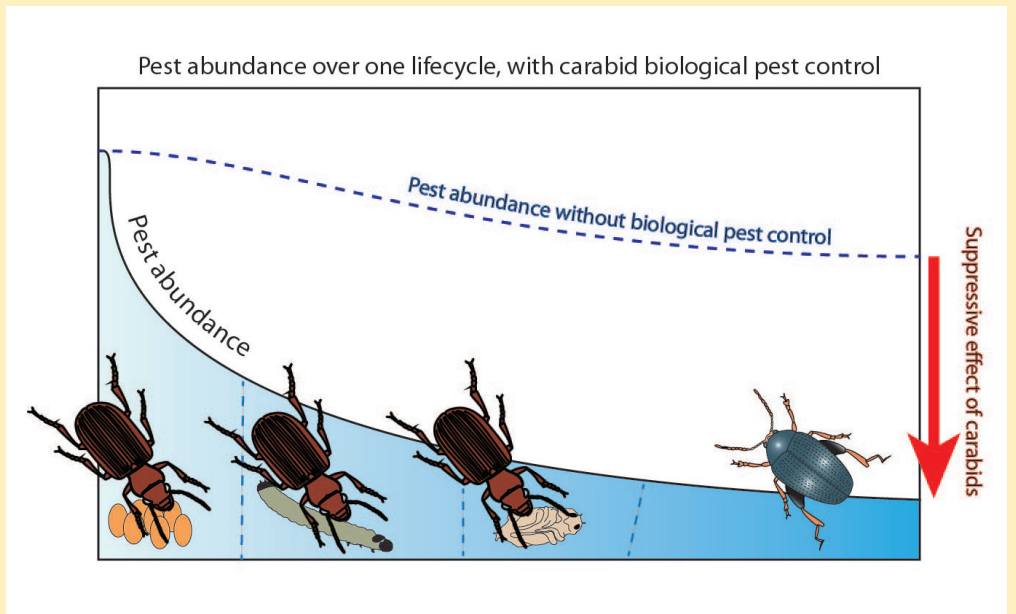


Boosting the abundance and diversity of carabid beetles on your farm could act to reduce the need for chemical control in the future. A diversity of species of carabid can effectively control a variety of pests, under a range of conditions.

Though carabids can respond to pest outbreaks, there is often a lag time, whereby they detect the pest in the field, and then congregate to feed. In some circumstances the pest population may have multiplied in the interim, to levels where the resident carabid population cannot control it enough to prevent crop damage at unacceptable levels. **Monitoring and use of pesticides only when over threshold levels have been breached, as part of integrated pest management, is important when moving towards increased biological pest control.**

Carabid pest control works best over time by suppressing pest populations, often at the egg or larval stages of the pest. This is particularly important in pests with hard bodies and those with effective defensive behaviours, such as the jumping escape of cabbage stem flea beetles (see diagram below).

It is important to build a resilient community of carabids across your whole farm, so that they can provide a consistent regulation of pest populations.



FARM MANAGEMENT FOR CARABIDS: FIELD B

FEATURE	BEETLE BENEFIT	BEST FOR CARABIDS
HEDGEROWS	Connectivity, food resources, overwintering habitat, resting habitat, refuge.	Varied structure of tree species, with wildflowers, grasses and plants at the base - multiple micro-habitats.
CONSERVATION HEADLANDS IN ARABLE	Refuge from pesticides, alternative food resources (invertebrates and weed seeds)	At least one spray left unsprayed to allow wildflower and grass growth. No insecticide use. Limited herbicide use.
FIELD MARGINS AND CORNERS	Resting and breeding habitats, alternative food resources. Connection to other fields and foraging areas.	Varied structure of wildflowers and tufts. Mow perennial grass rotation of 2-3yrs, margins annually in summer.
DITCHES	Connection of habitats for migration, resting and breeding habitats, refuge.	Varied structure of wildflowers and tufts, grass. Gentler angles will aid beetle movement.
BROWNFIELD AREAS	Connectivity, refuge and breeding habitats. Alternative food resources.	Areas of rubble, old structures and disused tips etc. are good beetle habitats.

BOUNDARY AND SEMI-NATURAL AREAS

ABID BEETLES	FARMER BENEFIT	MAXIMISATION BY MANAGEMENT
<p>different dense es, and climbing – to provide bitats.</p>	<p>Persistence of beneficial beetles, pollinators, and farmland birds.</p> <p>Erosion reduction. Shelter. Carbon storage.</p>	<p>Pair with margins for habitat mosaic.</p> <p>Cut every second or third year for structure.</p> <p>Cut hedges across the farm in alternate years for resource continuity.</p>
<p>er's width allow native ss growth.</p>	<p>Persistence of beneficial beetles.</p> <p>Buffering of spray impacts on adjacent areas.</p>	<p>Spot treat or weed wipe invasive or troublesome vegetation. This may not be appropriate in fields with problem weeds.</p>
<p>native ssocky grasses. ss margins on a and wildflower n late autumn.</p>	<p>Least productive areas of fields used to boost beetle services in the adjacent productive area. Also good for pollinators and other pest regualting insects such as hoverflies, spiders and wasps.</p>	<p>Allow native wildflowers to colonise, or boost with seed mixes of local stock. Encourage a range of broadleaf plants to create a varied structure.</p>
<p>native ssocky ed sides ement.</p>	<p>Encourages abundance and migration of species that are better adapted to wet conditions.</p>	<p>Manage vegetation when necessary on only one bank at a time, alternating.</p> <p>Allow a buffer area when spraying.</p>
<p>d walls, c. can be ts.</p>	<p>Non-productive 'waste' areas can be used to benefit natural-enemy pest control</p>	<p>Areas left unmanaged with no pesticides.</p> <p>Allow natural weed/wildflower colonisation. Incorporate wood/compost and manure piles.</p> <p>Cut back scrub if necessary to keep open.</p>

FARM MANAGEMENT FOR CARABIDS: IN-FIELD

FEATURE	BEETLE BENEFIT	BEST FOR CARABIDS
REDUCED TILLAGE	Reduces mortality of adults, and particularly soil-dwelling larvae.	Zero till will avoid disruption to beetles, surface cover and structure beneficial for carabids in crop centres.
COVER CROPS	Retains vegetative cover and associated microclimates and shelter.	Legume cover crops improve soil and boost soil microclimate, benefitting resources for carabid larvae.
UNDERSOWING/ COMPANION CROPS	Improves habitat structure and resources for carabids in crop centres.	Undersown grass and legumes are beneficial for carabids in crop areas, due to ground structure and resources. Different species may be used in different crops.
BEETLE BANKS	Resting and breeding habitats, alternative food resources. Connectivity to field margin habitats.	Varied structure of wildflowers and tufts. Banked ridge of 2m. Small variations in structure are good for micro-habitats.
TUSSOCKY VARIED GRASS SWARD	Resting and breeding habitats, alternative food resources.	Varied structure of wildflowers and tufts. Limited herbicide use. Limited wormer use.
HERBAL LEYS	Resting and breeding habitats, alternative food resources.	Variety of legumes, wildflowers and grasses.

LD MEASURES

CARABID BEETLES	FARMER BENEFIT	MAXIMISATION BY MANAGEMENT
Most damage to chaff promotes beetles to encourage centres.	Enhanced survivorship of both spring and autumn breeding species for maximum potential predators in field. Particularly key for below-ground predation by larvae.	If some tillages necessary, reducing amount and keeping tillage timings different between fields will minimise impact on carabids.
Soils improve invertebrates, soil availability	Retention of species in field areas between productive crops. Soil improvement and nutrient cycling assisted by other soil invertebrates.	Consider the variety of crops in your farm landscape when choosing cover crop – more variety will encourage different carabid species.
Grass and clover mix carabid larvae to below ground resources. may be in crops	Enhancement of species inhabiting crop centres, particularly predatory larvae. Persistence of these crop to crop.	Having crops of different structures, particularly broadleaves within cereals provides a ranged structure and extra resources.
Native sedge grass. in width – bank are habitats.	Particularly useful in larger fields, to encourage penetration of predators to centre. Erosion control in sloped fields. Also good for pollinators and other pest-eating invertebrates.	Allow native wildflowers to colonise, or boost with seed mixes of local stock. Vary structure. Connect to field edges at one side.
Native sedge grass. use. in cattle.	Persistence and diversity of beneficial beetles in pasture areas. Control of pest flies in dung.	Lower stock densities or cell grazing. Mixed livestock grazing can achieve a variable sward height.
Grasses.	Improved soil structure, and soil invertebrates. Increased diversity of carabid species.	Consider placement in farm landscape to link to other grass areas, for species migration.

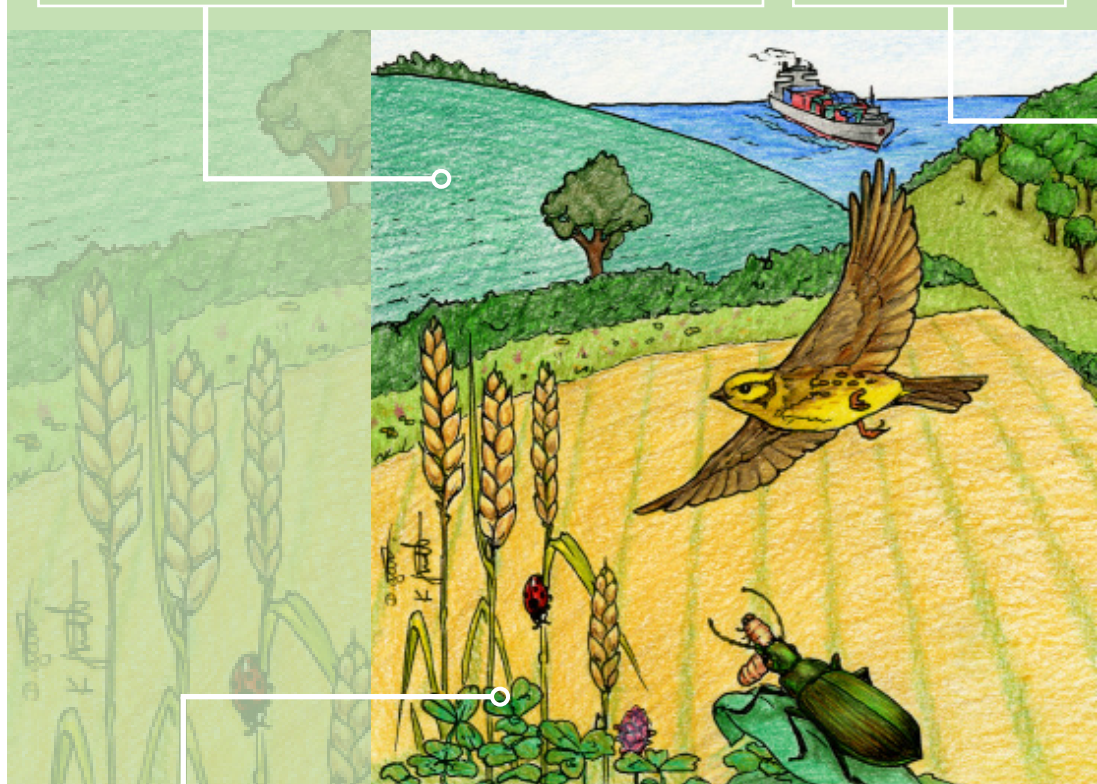
FARM MANAGEMENT FOR CARABIDS: HOW TO APPLY MEASURES IN THE FARM LAND

FALLOW AND SOWN FLOWER MIX

Areas of non productive land in rotations allows for carabids to breed and thrive in a large 'source area' and move across farm habitats. Siting these in central areas of the farm where possible will maximise the spread of beetles to cropped areas.

CROP JUXTAPOSITION

Having a variety of crops in proximity will encourage a variety of species.



FIELD CENTRE HABITATS

Carabids, particularly species that don't fly, move into crops from adjacent habitats. In larger fields, beetle banks or flower strips can help to improve penetration to crop centres. Infield management such as under-sowing with clover, intercropping, and reduced tillage, can improve habitat quality, meaning species will overwinter and breed successfully in crop centres.

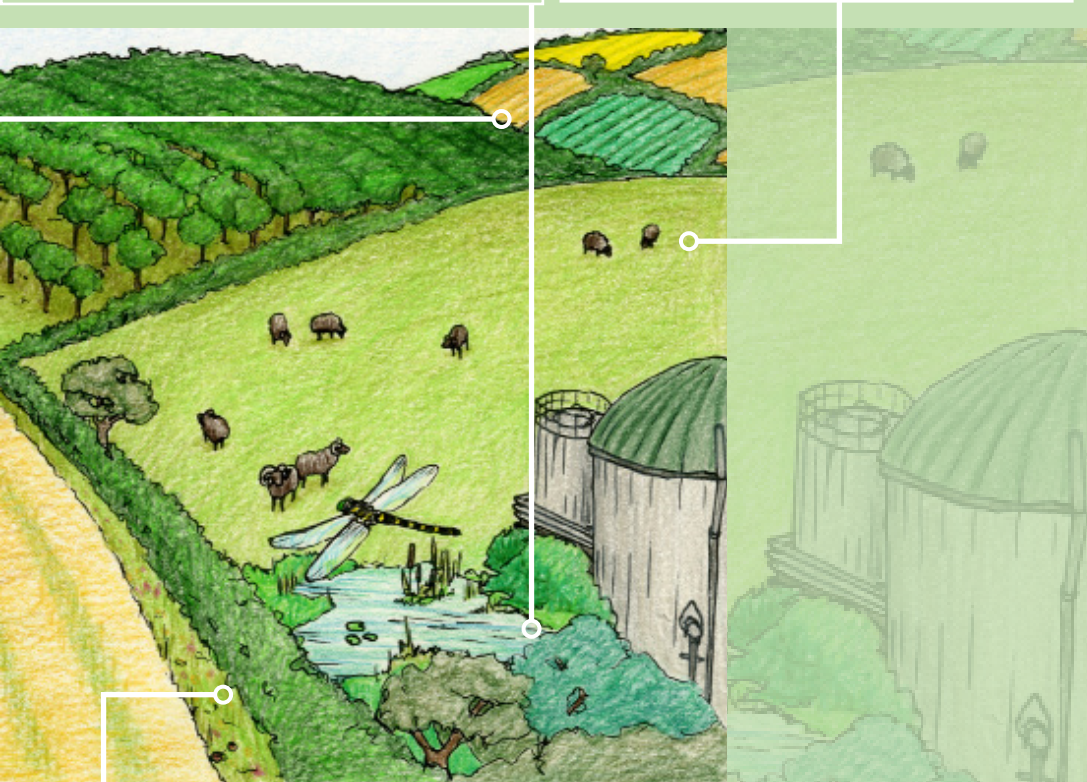
DSCAPE

PONDS AND WATERBODIES

Wet areas support carabid beetle diversity, and is especially important on farms prone to periodic flooding. Think about creating a network of wet areas, linked with ditches.

GRASSLAND MANAGEMENT

Periods of reduced grazing and taking field corners out of management create a tussocky sward. Join areas up to create 'stepping stones' of habitat across the farm.

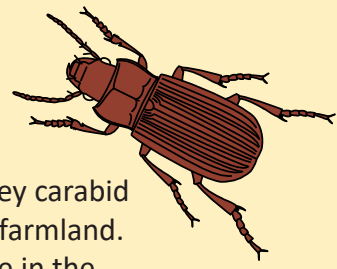


BUFFERING

Having larger margins and hedges at field edges next to urban areas, roads, or farm buildings can buffer negative effects of these areas that are less habitable by wildlife, and that do not support migration of beneficial insects into crops. Buffering can also be useful to minimise management affects, such as machinery disturbance and spray drift, on valuable habitats such as waterbodies.

Life sizes of species, in page order





This guide is to aid in the identification to key carabid species and functional groups found in UK farmland.

All ID features are designed to be useable in the field, by eye or with a 10x hand lens.

There are over 350 species of carabid in the UK. Some species cannot be identified without a microscope. Using this key, the most abundant and useful species or families of carabids in respect to agricultural productivity can be identified with a moderate degree of certainty.

For fully accurate and comprehensive carabid ID we recommend Luff, M.L., *The Carabidae (ground beetles) of Britain and Ireland*.

For more information on how to sample carabid beetles and conserve them on your land, contact us at comms@rothamsted.ac.uk

