



**National
Earthworm
Recording
Scheme**

Earthworm Recorder's Handbook



**Produced by Keiron Derek Brown on behalf of
the Earthworm Society of Britain**



This Handbook was produced for the earthworm recorders that enable the Earthworm Society of Britain to develop the current understanding of the distribution of earthworms in the British Isles.

The author would like to thank Frank Ashwood, Rich Burkmar, Kerry Calloway, Dan Carpenter and Emma Sherlock for volunteering their time and expertise to provide guidance and feedback regarding this publication.



The Earthworm Society of Britain's website can be found at www.earthwormsoc.org.uk and the society can be contacted by email at ESBenquiries@gmail.com.

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1 An Introduction to Earthworm Recording



1.1 The importance of recording earthworms

Earthworms are recognised as an ecologically important group of invertebrates that are crucial to the delivery of many ecosystem services. They facilitate the decomposition of plant and animal materials and break down soil, releasing nutrients and making them available for plants. Their burrows help to allow air and water to permeate into the soil, improving soil fertility and drainage. Furthermore, they are a vital food source for many vertebrates and other invertebrates.

However, despite being widely recognised by most people (such as gardeners and farmers) as ecologically important, earthworms are hugely under-recorded in the British Isles and we know relatively little about these organisms.

Many questions still remain unanswered:

- How is each earthworm species distributed across the British Isles?
- What specific conditions and habitats does each earthworm species require to survive?
- Are any of our earthworm species experiencing population declines and require intervention to ensure their conservation?

Biological records are very useful for answering these questions and many others. Every biological record must contain four core pieces of information:

- **Who** – The name of the recorder or determiner.
- **What** – The name of the organism or group of organisms that you are recording.
- **Where** – The location where the organism was observed.
- **When** – The date the organism was observed.

Combining these four pieces of data produces a biological record: **the presence of an organism at a specified time and place by a named individual.**

This Handbook was designed to provide guidance to individuals that are interested in generating earthworm biological records and contributing to our understanding of British earthworm species distribution and ecology.

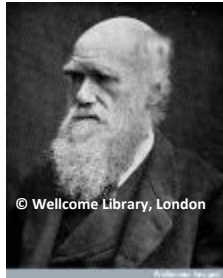


The Biological Records Centre (BRC), established in 1964, is a national focus in the UK for terrestrial and freshwater species recording.

The Earthworm Society of Britain (ESB) is registered with the BRC as the organisation responsible for recording earthworms in the United Kingdom.



1.2 A brief history of earthworm recording



Vegetable Mould Through the Action of Worms by Charles Darwin published



Earthworm Society of Britain (ESB) formed

Mapping of earthworm distribution for the British Isles and Eire highlights the under-recording of an ecologically important group (Carpenter et al.) journal paper published

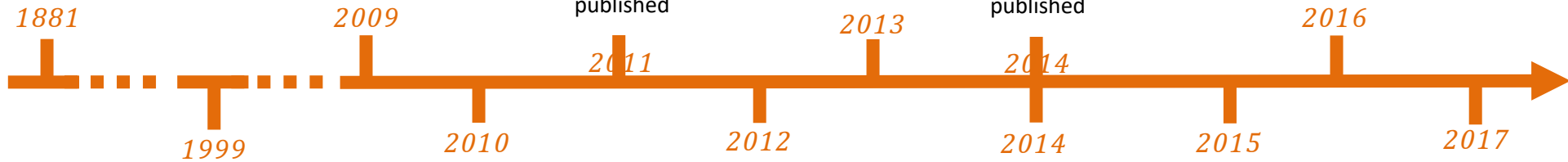


recorder packs to training courses

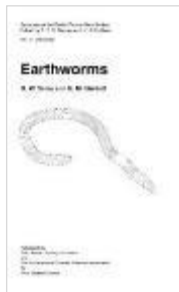
Earthworms in England: distribution, abundance and habitats (Jones) Natural England report published



NERS begins sharing data with Local Environmental Records Centres, NBN Gateway and Global Biodiversity Information Facility



Synopses of the British Fauna: Earthworms (Sims & Gerard) published



ESB begins running identification training courses for recorders



FSC Key to the Earthworms of the UK & Ireland (Sherlock) published



National Earthworm Recording Scheme (NERS) launched



ESB begins partnership with FSC Tomorrow's Biodiversity project

NERS Earthworm Recorder's Handbook (Brown) published





1.3 National Earthworm Recording Scheme



The Earthworm Society of Britain (ESB) is a non-profit organisation that was set up in 2009 to ensure that earthworms are represented in the biological recording community and wider biodiversity sector. The society is run entirely by volunteers and funded through grants, membership subscriptions and donations.

The ESB aims to promote and support scientific research so that earthworms and their environment can be better understood. Through its work the society aims to encourage the conservation of earthworms and their habitats and to educate and inspire people so that these fascinating creatures may continue to be enjoyed in the future.

The only society of its kind, the specific aims of the society are:

1. To conduct research into earthworms in the UK
2. To promote knowledge and appreciation of earthworms within the non-scientific community
3. To educate the non-scientific community in earthworm biology and ecology

The National Earthworm Recording Scheme (NERS) was officially launched in 2014 by the ESB to:

- undertake sampling of areas for earthworms
- train and support earthworm recorders (see **Training and events** section)
- create guidance for earthworm recording
- collate all earthworm records of the British Isles
- share ESB earthworm records through NBN (see **Open Data Agreement for Earthworm Records**)

These aims all revolve around the creation, collation and dissemination of earthworm biological records (species occurrence records).

Prior to the launch of the NERS, the ESB began seeking out earthworm records resulting from research institutions (such as government agencies, universities and natural history museums). These records focused on specific research questions and, as a result, the existing data may be biased towards earthworms found using certain sampling techniques and/or found in specific habitats favoured in academic research.

Therefore, the NERS encourages recorders to record by both:

Undertaking casual recording of earthworms By encouraging 'ad hoc' recording those earthworm species found outside of the soil and difficult to detect with standardised sampling techniques are also recorded.

Undertaking standardised sampling of earthworms This allows standardised data to be collected in a way that can help answer ecological questions by allowing comparison between sites or habitats. See **The NERS 5 Pit Protocol** and the **Earthworm Site Surveys** sections for more details.

Different sampling methods target different ecotypes of earthworm. More than one sampling method can be used at a single location and the sampling method should always be recorded with the biological records for earthworms. If a single species was recorded with two different sampling methods at the same location, then two records for that species would need to be made.



1.4 Training and events

The ESB hosts, and partners with other biodiversity training providers, to deliver a range of courses and events to help develop the skills of earthworm recorders. Check out the ESB website for details of upcoming training and events: <http://www.earthwormsoc.org.uk/upcoming-events>

Learn To Love Earthworms

1 day - Suitable for all

A general interest course covering earthworm biology and ecology, and undertaking an Earthworm Watch survey. Suitable for all, from gardeners to recorders and students to farmers. This course does not include earthworm identification training,

Earthworm Field Recorder Day

1 day - Suitable for all

Sampling events held within the field (therefore requiring a reasonable level of physical fitness). These events demonstrate to participants how to undertake earthworm sampling methods and the resulting records are used to generate site species lists for the sites that are surveyed.

Earthworm Identification Using Microscopes

1 day - Suitable for beginners

Workshops designed to give participants an introduction to earthworm identification using microscopes. Sampling methods may also be taught where a suitable venue is used. Upon completion of this course participants are considered qualified ESB Earthworm Recorders.



Identifying & Recording Earthworms

2 night/2 day residential - Suitable for all

A one-stop residential course covering all of the content contained within the following training courses:

- Learn To Love Earthworms – earthworm biology and ecology
- Earthworm Field Recorder Day – earthworm sampling methods and preservation techniques
- Earthworm Identification Using Microscopes – earthworm identification using microscopes and identification keys.



Advanced Earthworm ID Workshops

1 day - Some experience of earthworm ID required

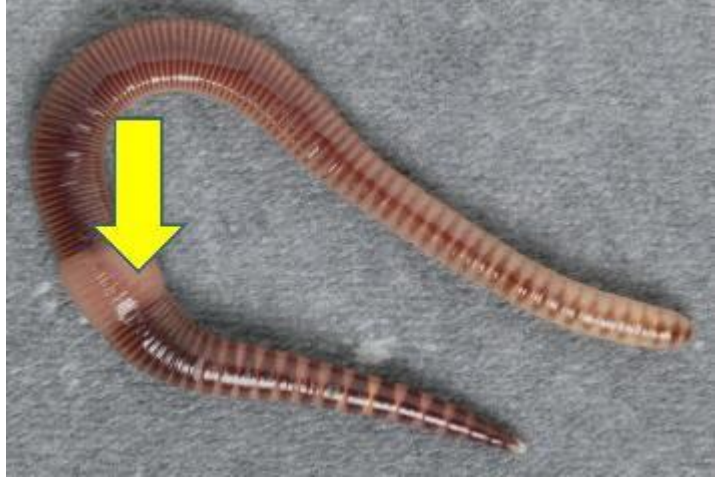
Workshops covering earthworm internal anatomy and dissection. This course is necessary for any recorders interested in sampling and identifying earthworms found in artificial environments in the UK (such as hothouses in botanical gardens).

1.5 Earthworm anatomy

There are a couple of basic anatomy lessons that should be learned before you continue on your journey to become an earthworm recorder. Importantly, earthworms often have a 'swelling' of fused segments known as the clitellum (or saddle) - indicated by the yellow arrow in the photo below.

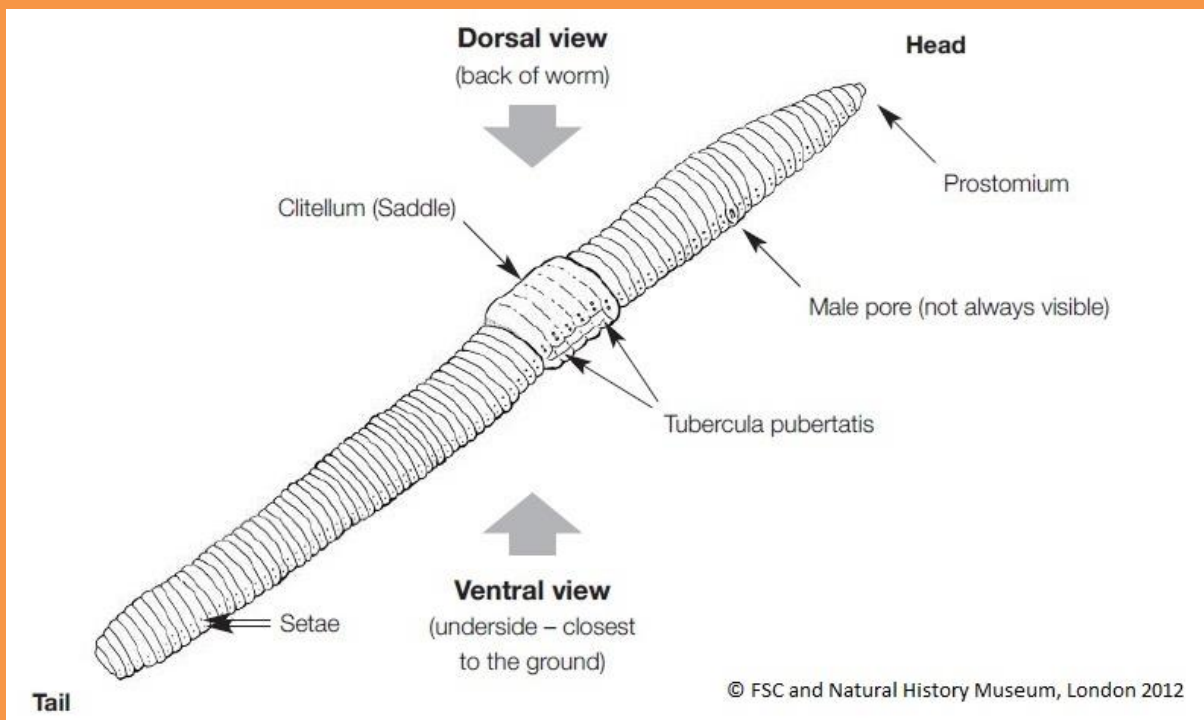
The clitellum tells us two things:

- (i) The presence of the clitellum on an earthworm tells us that it is an **adult**. Earthworms without a clitellum are juveniles. It is usually not possible to identify juvenile earthworms so these should not be collected and preserved.
- (ii) The clitellum is always found **nearest the head** end of an intact earthworm, making it simple to establish which end of the earthworm is the head.



More detail regarding earthworm anatomy, including the use of external characters used to identify earthworms can be found in the Field Studies Council's Key to the Earthworms of the UK & Ireland (2nd edition) (2018) by Emma Sherlock. The book is available from the FSC website:

<https://www.field-studies-council.org/publications/pubs/earthworms-2nd-edition.aspx>



External earthworm features used for identification diagram from Key to the Earthworms of the UK & Ireland (2012) by Emma Sherlock.

1.6 Earthworm ecology

Earthworms can be divided into four groups, called **ecotypes**, each of which describes a different grouping of earthworm species based on their ecology.

Anecic earthworms make permanent vertical burrows in the soil. They feed on leaves on the soil surface that they drag into their burrows. They also produce worm casts (a convoluted mass of soil, mud, or sand thrown up by an earthworm on the surface after passing through the worm's body) and these can quite often be seen on the surface in grasslands. Some species, such as *Lumbricus terrestris*, also make middens (piles of casts) around the entrance to their burrows. Anecic species include the largest species of earthworms in the British Isles. They are darkly coloured at the head end (red or brown) and have paler tails.

Endogeic earthworms live in and feed on the soil. They make horizontal burrows through the soil to move around and to feed and they will reuse these burrows to a certain extent. Endogeic earthworms are often pale colours (such as grey, pale pink, green or blue). Most species are found in the top layers of the soil, though some can burrow very deeply in the soil.

Epigeic earthworms live on the surface of the soil in leaf litter. These species tend not to make burrows but live in and feed on the leaf litter. Epigeic earthworms are also often bright red or reddy-brown, but they are not stripy.

Compost earthworms are really a subset of epigeic earthworms that contain the earthworm species that are most likely to be found in compost, areas very rich in rotting vegetation or dung. They prefer warm and moist environments with a ready supply of fresh compost material. They can very rapidly consume this material and also reproduce very quickly. Compost earthworms tend to be bright red in colour and stripy- some people call the stripy species 'tiger worms'. Compost worms are often used to help dispose of waste as they can also remove contaminants from soil.



2 Earthworm Sampling Techniques

2.1 The basics

Regardless of how you are sampling earthworms, whether it's a standardised sampling method for scientific research used or ad hoc earthworm searches under plant pots, there are some basic considerations that we recommend:

Preparation A map of your sample site is useful to mark where you will take your samples, or for identifying different habitats in to sample. New records on sites that have been previously sampled are still useful as you may get different results. Remember that if you do not own the land where you are sampling permission may be required from the landowner first. See the **Field Work Assessment**.



Equipment ("The basics") Consider the following equipment for collecting earthworms:

- **Plastic tubes of alcohol-based preservative** (to store and preserve earthworms).
- **Labels and pencil/alcohol resistant pen** (to label your samples and ensure they don't get mixed up).
- **Notebook and map/GPS/smartphone** (to make note of the location, habitat and other important factors).
- **Gloves** (to keep your hands clean).
- **Pointed non-serrated forceps** (optional but can be useful).



Details regarding the equipment to consider for specific sampling techniques are provided in the following sections.

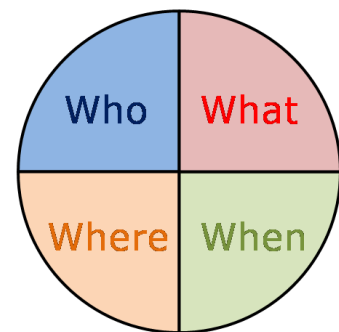
Preservation and Labelling In the majority of cases live earthworms can't be identified accurately. Therefore, adult earthworms should be collected (juveniles should be released), and preserved so they can be examined under a microscope. The collected earthworms should be placed in a tube of preservative, which will also act as a killing agent. Please see the **Earthworm Preservation** section.



Recording In order to make a record (as a minimum), the following information will need to be recorded in the field:

- **Who** – the recorder.
- **Where** - OS grid reference, which can be obtained using GPS or taken directly from an OS map or using online tools/apps.
- **When** – the date the earthworms are collected.

Other information, such as **sampling method** and **habitat** are also useful. Please see the **Recording Earthworms** section.





2.2 Microhabitat searches

Earthworms inhabit substrates other than soil so it is good practice to search any microhabitats present at each site. This will improve the likelihood of recording species that are less likely to be encountered in soil pits. Only adult earthworms should be collected as juveniles cannot be identified to species.

<i>Pros</i>	<i>Cons</i>
Detects all types of earthworm (anecic, compost, endogeic and epigeic), rather than only soil-dwelling species.	Non-quantitative method, meaning records have limited use when it comes to comparing sites or looking at abundance.

Equipment & Method

There is no exhaustive list of habitats and microhabitats that earthworms may be present in and equipment/search methods will vary depending on the nature of the microhabitat, but some examples are provided below:

Deadwood – contains several microhabitats, including under deadwood, under the bark and within rotting deadwood. When sampling deadwood destructively please ensure a minimal amount of deadwood is destroyed to maintain the microhabitat within the ecosystem.



Dung – dung contains rich organic matter and earthworms may be found within/beneath the dung or in the top layer of soil beneath the dung. Don't forget your gloves!

Under stones and other items – turning over items can often yield earthworms. Example objects to turnover include any item resting on soil and items such as plant pots, wooden boards and bin bags on any substrate.



Leaf Litter – leaf litter can be searched by hand or sieved. Some earthworms may be found within the very top layer of the soil, whereas others may be found on the surface amongst the litter.

Hedgerows – some earthworms are thought to be associated with hedgerows and may be found in the top layer of soil beneath them.

Compost – compost heaps/bins are often home to dense populations of earthworms. They can usually be found by simply searching the top layer of the compost. Don't forget your gloves!



Other interesting microhabitats include woodchip piles, shingle, stream beds, tree holes, molehills and many more...

Please record the earthworms you find in different microhabitats separately (even if a species occurs in multiple microhabitats at the same site). Recording the presence of a species in multiple habitats or microhabitats helps us learn more about the ecology of different earthworm species and their associations with specific conditions.



2.3 Mustard sampling

A vermifuge is a solution that causes earthworms to emerge from their burrows. Traditionally, vermifuges used for sampling earthworms consisted of using a formalin or potassium permanganate solution. Neither of these solutions is ideal to work with as formalin is carcinogenic and both solutions are thought to be detrimental to the environment. Scientific studies have shown that a mustard solution (made from English mustard powder and water) is effective at extracting earthworms and has little effect on the environment in comparison to formalin and potassium permanganate.

<i>Pros</i>	<i>Cons</i>
Effective for extracting soil-dwelling species (particularly deep-burrowing anecic species).	Sampling method biased towards soil-dwelling species. Less effective than soil pit sampling for extracting endogeic species from top layers of soil.
Relatively non-destructive technique. Useful for sampling soil-dwelling species on sites where digging is prohibited.	Success rate dependent on soil qualities and weather.
Relatively quick and simple to undertake. Great for engaging with the general public at relevant events/activities.	Solution is one time use and adds cost and weight to equipment.

Equipment

In addition to the equipment described in in **section 2.1**, you will need:

- **A bottle of water**
- **Mustard powder**

Method

- Mix mustard powder with still or tap water. It has been shown that the success rate of mustard-based vermifuge increases with increasing concentration until the point at which the solution thickness affects the viscosity of the liquid. We recommend mixing a solution of a few heaped teaspoons per 1.5 litres of water.
- Pour the vermifuge solution on approximately **1 square meter** of the ground (in long grass it can be useful to trim the grass first). As it soaks into the ground and flows down the burrows of anecic earthworm species, it will act as an irritant to any earthworms it reaches and will cause them to emerge on the surface. If the solution does not soak into the ground, conditions may be unsuitable for this sampling method.
- Any adult earthworms that surface should be removed and collected into a container/sample tubes. Allow earthworms to exit their burrows as completely as possible as they may retreat into their burrows if you try to collect them prematurely. Earthworms may surface outside of the area where the solution was poured and the area should be watched for a **minimum of 5 minutes**. Juvenile earthworms should be washed with water to remove mustard solution and returned to fresh soil as it is unlikely that these can be successfully identified.



2.4 Soil pit sampling

Digging soil pits and hand-sorting the excavated contents has been a standard earthworm sampling technique for scientific researchers for many years.

<i>Pros</i>	<i>Cons</i>
Effective for extracting soil-dwelling species, particularly endogeic species from the top layers of soil.	Sampling method biased towards soil-dwelling species. Less effective than mustard sampling for extracting deep-burrowing anecic species.
Effective sampling technique in most weather conditions (except where the ground is frozen).	Destructive sampling method that damages the soil and surface vegetation, and disturbs other soil organisms. Time consuming to hand-sort through contents of soil pits (even more so in wet soils).
Can easily be standardised and used to gain good qualitative data for research.	Can be difficult to get permission to dig on some sites due to destructive nature of sampling.

Equipment

In addition to the equipment described in in **section 2.1**, you will need:

- **A spade** (to dig the pits).
- **A sorting tray** (to place the soil on in order to sort through and look for earthworms, a pot or bin bag can be used as an alternative).
- **A bin bag or plastic sheet** (to sit on and prevent you getting wet and/or dirty while sorting your soil pits).



Method

- Dig a soil pit and remove the contents using a spade. The standard pit size for the National Earthworm Recording Scheme is approximately **25cm by 25cm, to a depth of 10cm**. Always check the empty pit to make sure no earthworms are in the bottom or sides!
- The soil from the pit should be placed on the sorting tray/bin bag/pot and sort through it with your hands.
- Any adult earthworms that are found in the soil should be removed and collected into a container/sample tubes.
- The soil should be returned to the pit once the contents has been sorted. This should be compacted down to avoid leaving a hole or uneven surface that people could trip over. Where possible, surface vegetation should be retained and returned to avoid leaving patches of bare earth that would be vulnerable to erosion. Juvenile earthworms should be counted and returned to the soil as it is unlikely that these can be successfully identified.
- Record number and size (dimensions) of soil pits sampled.





2.5 The NERS 5 Pit Protocol

The NERS 5 Pit Protocol is a standardised methodology for conducting soil pit sampling of a site for earthworms. This generates data that can be used to calculate the species composition and abundance of a site, making it useful for monitoring trends in earthworm populations. The standardised nature of the data allows different sites to be directly compared to one another.

Equipment

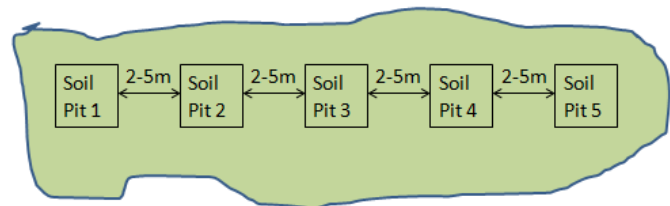
- In addition to the equipment outlined in the **Soil pit sampling** section, you will also need an **Earthworm Site Survey Form** to record your findings on.

Method

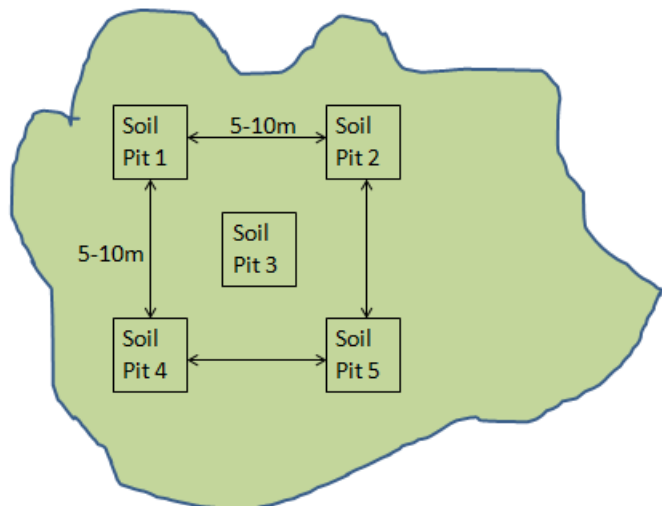
- Follow the method outlined in the **Soil pit sampling** section, with pits measuring approximately **25cm by 25cm, to a depth of 10cm**.
- Count and record the number of juveniles** returned to the soil on the **Earthworm Site Survey Form**.
- Repeat the process 5 times by digging **5 soil pits per site**.

Planning your soil pits is important so that all five soil pits fall within the habitat you are sampling. Please note that the distances provided in the following examples do not need to be exact and are given to provide approximate guidance so it is clear that soil pits should not be spaced a great distance apart.

Linear Habitats Some habitats are linear, and in these cases, a linear transect should be used with pits spaced evenly apart (for example between 2 and 5 metres). Linear transects may not necessarily be in a straight line and may be curved. Examples of this type of habitat may include hedgerows, riverbanks, pond edges and tree lines.



Large patches of habitat If you are sampling a habitat that covers a big enough area the soil pits can be arranged approximately in a square formation, with one pit in each corner (for example between 5 and 10 metres apart) and one in the centre. Examples of this type of habitat may include open fields, gardens, woodlands and parks.



Other Habitats In some cases neither of these arrangements will be suitable and the arrangement will need to be adapted to suit the habitat you are sampling. If the habitat is patchy, soil pits should be planned in patches of the same habitat (remembering that they should not be great distances apart).

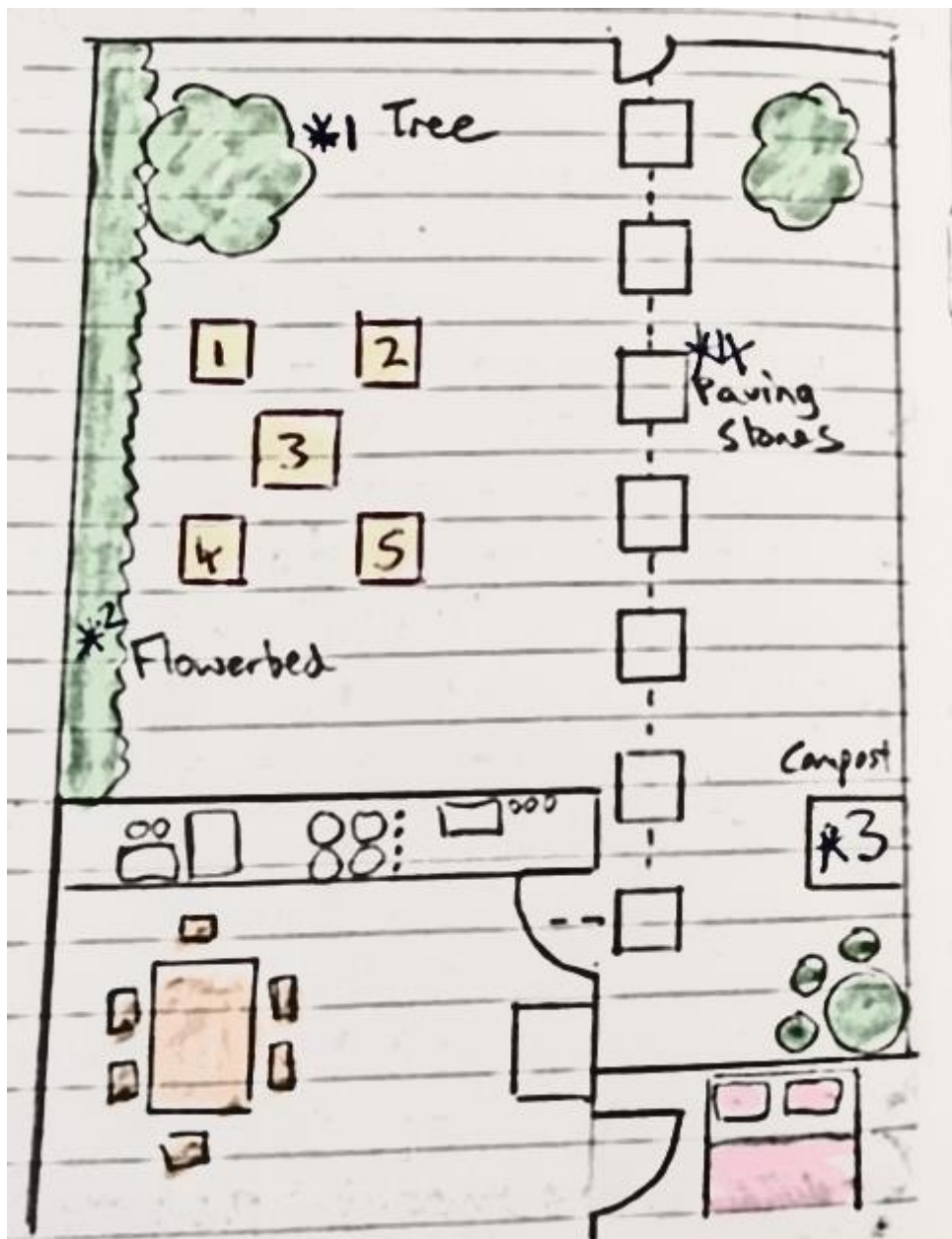


2.6 Earthworm Site Surveys

The Earthworm Society of Britain is currently reviewing the standard protocol for surveying sites, particularly gardens, and aims to launch an Earthworm Garden Survey in the near future.

The first phase of the review involved supporting a MSc dissertation looking at garden survey methods for earthworms and will inform the next stage of the review: a review of the existing scientific literature.

Later review stages will involve undertaking sampling projects to fill any survey method evidence gaps and consultation with biological recording and ecology professionals regarding the proposed survey methods.





3 Earthworm Preservation

3.1 Why is preserving necessary for earthworm recording?

The majority of earthworm species can't be identified in the field. Despite best efforts, no accurate identification key to live specimens currently exists and most specimens require observation under a microscope in order to reach reliable species identifications.

The Earthworm Society of Britain supports the collection of earthworm specimens for scientific purposes that further our understanding of earthworm ecology and biology. This involves includes the collection and killing of earthworms for the purpose of identifying the species and generating a biological record of species occurrence. It is recommended that earthworm sampling techniques are undertaken in a manner that ensures any impact to local earthworm populations is negligible.



This can be achieved by:

- Only taking adult specimens (identifiable through the presence of the clitellum or “saddle”). Juvenile earthworms cannot usually be identified and should therefore be returned to their environment to prevent the unnecessary killing of earthworms. Where quantitative methods are being used to gather abundance data, juveniles should be counted and released where possible.
- Following the NERS guidance regarding sampling techniques as these methods are unlikely to have a significant impact on local populations due to the low proportion of individuals that would be collected from any one habitat.
- Taking representative specimens when undertaking non-quantitative sampling techniques to ensure numerous specimens of a single species are not taken when this would add no value to the data.

Code of Conduct for Collecting Earthworms

We refer our recorders to the British Entomological & Natural History Society Code of Conduct for Collecting Insects and Other Invertebrates at www.benhs.org.uk/resources/collecting for further information regarding good practice when collecting invertebrates for scientific or educational purposes.

Preserved specimens can also be beneficial for future studies and identifications. The ESB encourages the building of personal reference collections and use of previously identified or verified specimens, to assist in the identification of future earthworm specimens. Where earthworm recorders do not have the capacity or willingness to build and maintain a personal reference collection, we encourage earthworm recorders to contact local natural history curators to discuss the possibility of accessing and contributing to those collections (though please note that many local natural history collections are under-funded and may be unable to accept new specimens or any specimens stored in alcohol).



3.2 Collecting specimens

Collected earthworms should be stored in a tube of 70-80% preservative (see the table in **Preserving specimens** on the following page for more details). The size/number of tubes used will depend on how many earthworms were collected, tubes should never be more than half full of specimens. The 70-80% preservative will also act as a fixing agent while preserving the earthworms. Earthworms contain a lot of fluid and this is released into the preservative, diluting the solution and causing the specimens to deteriorate. Therefore, if you have large specimens or a number of specimens within one tube, the preservative can be changed following sampling (preferably within 48 hours).

Do I always need to preserve earthworms in the field?

The simple answer is no. We recommend preserving earthworms in the field when you are planning to go and undertake earthworm sampling methods such as soil pit sampling or mustard sampling. However, there may be times when you happen upon earthworms or don't want to carry bottles of preservative with you. To collect earthworms in the field you will need a container that is aerated (such as a plastic take-away container with some breathing holes in the lid). When collecting earthworms in this way ensure that you take some of the substrate you found the earthworm in (such as soil, moss or leaf litter) and add a few drops of water to ensure the conditions remain damp enough for the earthworm to survive. Specimens should be able to survive in these conditions for a few days provided you regularly check the environment remains damp and add a few drops of water whenever necessary.

3.3 Relaxing/setting specimens

Earthworms can be relaxed and straightened. This is a completely optional step but can make identification of the specimens much easier as earthworms can stiffen in awkward-to-identify positions. It also acts as an anaesthetising agent so we would encourage people to use this step where possible.

- (i) Place the earthworms in a container of 20-30% preservative (if you dilute stronger preservative to 30% ensure you use distilled water, otherwise the solution will be cloudy)
- (ii) Leave for a few minutes
- (iii) Straighten out the earthworms in the grooves of the lid, as illustrated in the picture (forceps can be useful when doing this).
- (iv) Pour 70-80% preservative onto the straight earthworms.
- (v) Leave for 5-10 minutes before placing the earthworms in the plastic tube containing a label and 70-80% preservative.





3.4 Preserving specimens

Recorders preserve earthworms for a number of reasons, depending on their intended uses for the preserved specimen. The reasons for preservation will determine the required:

- (i) **Concentration of preservative** – dilution of alcohol-based preservatives can be achieved with deionized or distilled water (not tap water) which is easily purchased from any high-street chemist. Dilution rates can be calculated using this online tool: https://homedistiller.org/wiki/calcs/calcs_dilute.htm
- (ii) **Type of preservative** - details of the different types of preservative and how to source them can be found in the **Sourcing preservatives** section.

The ESB recommends the following preservative types and concentrations:

<i>Reason for preservation</i>	<i>Recommended preservative</i>
Identification only – when specimens need only be preserved for a short period of time until identified, and will be disposed of once a species determination is reached.	70% ethanol, IMS or IPA is acceptable. The earthworm will deteriorate more quickly than in 80% so only use 70% when you are planning to identify your specimens in the near future. Using 70% has the advantage of reducing cost as less volume of preservative is used per specimen tube than with 80%.
Verification – where a specimen will need to be stored until it can be verified by an ESB tutor or earthworm expert.	80% ethanol, IMS or IPA is recommended if a specimen is to be stored for more than a couple of weeks.
Collections – where a specimen will be stored for a long period of time and used as part of a museum natural history or personal reference collection.	80% ethanol is a requirement for museum collections and recommended for personal collections. The specimen will decay rapidly in <80% and go brittle in >80%.
DNA research – where a specimen is being stored with the intention of extracting genetic material.	96% ethanol is required to preserve genetic material. IMS and IPA are not suitable for preserving genetic material.

3.5 Labelling specimens

A label should also be placed in the tube to identify the pit and site that the sample belongs to. The label should contain as much information about the specimen as possible, and at the very least should indicate the four core fields (**who, what, where** and **when**). It should be on good quality paper if planning to keep the specimens for reference collections. Regular ink will dissolve in alcohol so use a lead pencil, or an alcohol-resistant pen to write your labels.

To the right is an example of good labelling in the field, as it contains all of the information gathered during the sampling. You may notice that it does not contain the species name. This is because it is rarely possible to identify the specimen in the field.



When storing specimens within a collection, good practice would be to separate specimens within a sample by species and add the species determination to the label alongside the name of the determiner (see example to the right). Alternatively, a second label could be added with this information.





3.6 Sourcing preservatives

Obtaining preservatives is not always the easiest of tasks as preservatives are alcohol-based flammable liquids, and the sale of these is strictly controlled by various regulations. Throughout our guidance we refer to 70-80% preservative, and the table below discusses the options that you may want to consider. *Although formalin is long considered the best preservative for earthworms (at 4% the colour is kept better, and the worm is well preserved) we do not recommend the use of this for earthworm recorders as it is a carcinogen and very dangerous to work with.*

<i>Preservative</i>	<i>Description</i>	<i>Where to source</i>
Ethanol	Ethanol is pure alcohol and is widely used to preserve invertebrates in institutions such as museums and universities. The standard concentration for these organisations is often 80%. It's also a necessity for DNA work, as 96% ethanol provides the best available preservation down to the molecular level.	Pure ethanol is very difficult to source as its sale is strictly controlled, usually requiring a licence. Amateur naturalists can sometimes get hold of pure ethanol if they have contacts with institutions that are licensed to use it and supply it to associates for legitimate purposes. However, 98% bio-ethanol has recently become available in garden centres for burners (though may not be suitable for DNA work).
IMS or IDA (Industrial Methylated Spirits or Industrial Denatured Alcohol)	IMS/IDA is excellent for preserving invertebrates and a suitable alternative to ethanol. However, it is not suitable for DNA work.	Educational establishments, such as field centres and schools, can purchase up to 5 litres of IMS/IDA each year without a license, but individual amateur naturalists need a license from HM Revenue & Customs to buy it. However, 70% IMS can be purchased without a licence from some online suppliers of cleaning products.
Isopropyl, Isopropanol or IPA (Isopropyl Alcohol)	Isopropyl has a tendency to dehydrate specimens and can make them brittle. To mitigate this, you can add a little glycerol (which is available without a license!). It is suggested that 20ml of glycerol is added to each litre of 70% Isopropyl.	Isopropyl can be bought without a license over the internet or from many high street chemists.
CDA (Completely Denatured Alcohol)	CDA is made by adding chemicals to pure ethanol to make it unfit for human consumption. There are many different formulations for CDA. Until recently it was required that a dye (usually blue, pink or purple) was part of these formulations, but this requirement has now been dropped so CDA may become available as a clear liquid.	CDA is not suitable for preserving invertebrates. There was often an assumption that this was because of the dye - which would certainly have made it less suitable - but in fact there are other ingredients in the formulations, such as wood naphtha, which make them unsuitable, possibly causing a milky suspension when diluted with water.

Please note that you should always check the safety information on any preservatives that you purchase and ensure that you follow any guidelines that the manufacturers provide for using these products safely.



4 Recording Earthworms

Records can be submitted to the National Earthworm Recording Scheme using our online **iRecord Earthworm Survey Form** or the **Excel Earthworm Records Submission Form** (see Section 1.1).

4.1 Who, what, where and when

Making a biological record requires four pieces of compulsory information: **who**, **what**, **where** and **when**. If any of these pieces of information are missing the record cannot be accepted.

These squares indicate the compulsory fields for the National Earthworm Recording Scheme.

There is a wealth of additional information that can be provided that may will add to the usefulness of the record by expanding on the four core fields (**who**, **what**, **where** and **when**). To make recording simpler, our submission forms have drop down menus for some of these additional fields. The options available are provided alongside the field descriptions in the guide below.

Who

Recorder Please provide the name of the individual who collected the specimen.

Determiner Please provide the name of the individual who identified the specimen. This may be the same individual as the recorder.

(If your identifications have been verified by another earthworm recorder or scientists, their name should be recorded in the comments field. This can't be the same individual as the determiner).

What

Species Each species should be recorded using its scientific name. A separate record should be created for each species found at a location and for each microhabitat/sampling method (so three species within a single microhabitat at one location would count as three records). UK species are listed in the **UK & Ireland Species Checklist (Natural Environments)** section below.

Number Abundance can be recorded by specifying the number of individuals found in the 'Number' column and is particularly useful when comparing standardised sampling between sites.

Where

Grid Reference Grid references allow the record to be pin-pointed to a location. We request a 6 figure grid reference (or 8 figure where possible). These can be attained using ordinance survey maps, GPS (such as a smartphone app or a handheld GPS device) or online grid reference tools (such as <http://gridreferencefinder.com>). Latitude/longitude is acceptable as an alternative to a grid reference. For a better understanding of how grid references work please check out <https://getoutside.ordnancesurvey.co.uk/guides/beginners-guide-to-grid-references/>

Site Name The site name should be recorded wherever possible. This can be the name of the site (e.g. Clints Quarry) or the address (e.g. King Street) and should include the county.

When

Date The date of specimen collection should be recorded in the standard dd/mm/yyyy format.



4.2 Additional fields

Habitat Pick the habitat that best describes the location. Options in upper case describe general habitats and options in lower case describe more specific habitats. If you feel the location does not fit into any of the categories below, please record it as 'other' and specify in the comments box.

010 WETLAND	034 upland grassland	070 WOODLAND
011 fen	040 URBAN	071 deciduous woodland
012 carr	041 park	072 coniferous woodland
013 bog	042 orchard	073 mixed deciduous/ coniferous woodland
020 HEATHLAND/MOORLAND	043 churchyard	090 BUILDING
021 lowland wet heath	044 garden	091 glasshouse (heated)
022 lowland dry heath	045 compost bin	092 glasshouse (heated)
023 valley mire	050 FARMLAND	100 CAVE/TUNNEL/WALL
024 upland heath/moor	051 arable	110 WASTE GROUND
030 GRASSLAND	052 pasture	120 OTHER (please specify)
031 acid grassland	060 SCRUBLAND	
032 neutral grassland	061 dense scrub	
033 calcareous grassland	062 scrub with open areas	

Sampling method Different sampling methods will often yield different species as they may target different substrates or microhabitats.

401 Soil pit sampling	438 Shingle/gravel search
402 NERS 5 Soil Pit Protocol	441 Leaf litter search
411 Molehill search	451 Compost search
412 Mustard sampling	455 Dung search
421 Under deadwood bark	456 Carrion search
422 Inside deadwood	462 Under moss (stone surface)
423 Inside tree hole	462 Under moss (wooden surface)
424 Under deadwood (turnover)	465 Hedgerow base search
432 Under rock/stone (turnover)	471 River/stream bed search
433 Under other item (turnover)	491 Found by chance (specify microhabitat)
435 In the open on natural substrate	495 Microhabitat search (unspecified)
436 In the open on artificial substrate	496 Other microhabitat (specify)
437 Woodchip pile search	499 Other sampling method

Comments field The comments field should be used to record any data or information it was not possible to record in the other fields. Where you have chosen an option that states 'specify', please enter the relevant details in the comments field. Some earthworms exist in different morphs (for example *Allolobophora chlorotica* occurs in a pink and a green form) and this should be recorded here where possible. Any additional fields can also be recorded here such as species of plant present, soil texture, soil pH, soil moisture, soil temperature, aspect and any site designation afforded to the site (many sites across the UK are designated due to their importance to biodiversity, geology or natural beauty). **You can never provide too much information in the comments box!**



4.3 Record submission

There are two methods of submitting records to the ESB:

1) *Excel Earthworm Records Submission Form* This is a Microsoft Excel spreadsheet that is available to download at www.earthwormsoc.org.uk/further-information/downloads

This can be completed and submitted to the National Earthworm Recording Scheme at ESBenquiries@gmail.com with the subject heading 'Earthworm Records (Your Name, Date of submission)' e.g. Earthworm Records (John Smith, 01/01/2000)

2) *iRecord Earthworm Survey Form* This online form can be accessed by any registered user of iRecord (an online recording portal created by the Biological Records Centre). *Registering is free and very easy at www.brc.ac.uk/irecord/user/register*

1. Log in to iRecord at www.brc.ac.uk/irecord/

Please note that you must have an iRecord account in order to submit records through the iRecord system.

2. Click on **Record** on the menu bar.

3. Select the option **Activities**.

Please note that you can also submit earthworm species records through other general iRecord forms, though this is not ideal as it does not gather some of the specific data we ask for with regards to earthworm records.



4. Click on the **Browse all activities** tab.

5. Enter **Earthworm** into the search bar and click **Go**.



6. Click on **Enter an earthworm record** to begin using the form.



The form will allow you to enter multiple records for the same site and has a great map function for finding the location data.

4.4 The journey of an earthworm record

It is the aim of the Earthworm Society of Britain to increase our understanding of earthworms in the UK and the ecological impact that these animals have on their environment. This involves ensuring that earthworm records are shared widely and are available for other potential data users to put the data collected by earthworm recorders and research institutions to good use. So, exactly what happens to earthworm records after they have been submitted to the ESB or iRecord?



Processing Records are processed and subjected to NERS verification protocols. Where necessary, queries are sent to recorders.

Records that are processed through iRecord are then available for both the Earthworm Society of Britain and the relevant Local Environmental Records Centre to download.

Collation Records are added to the relevant dataset. Currently there are two NERS datasets and three research datasets managed by the ESB:

- National Earthworm Recording Scheme records (Great Britain)
- National Earthworm Recording Scheme records (Channel Islands)
- Soil Biodiversity Group (NHM) earthworm records (Great Britain)
- Environment Agency *Eiseniella tetraedra* records (England)
- Earthworm Research Group (UCLan) earthworm records (Great Britain)

Dissemination The ESB then shares these records:

- **Locally** by emailing all earthworm records to all of the Local Environmental Records Centres in the UK on an annual basis.
- **Nationally** through bi-annual uploads of ESB datasets to the NBN Atlas: <https://registry.nbnatlas.org/public/show/dp88>
- **Internationally** by allowing the NBN to also make our earthworm datasets available through the Global Biodiversity Information Facility at www.gbif.org/publisher/0b8171d0-6b32-4ccc-bf3d-bf34b56c36d3



4.5 Open Data Agreement for Earthworm Records

The Earthworm Society of Britain (ESB) actively encourages the use of our data and hope that it can be used to further the current understanding of earthworms, both nationally and internationally. We are always interested to hear about how others have used our data (whether for use in science, sociology, art or anything else) and are glad to have produced a resource that is being put to use.

We ask all our data suppliers to read this document and only submit records to the ESB if they are happy with the policy stated below.

Access to ESB earthworm records

The ESB has an open data policy, allowing **open access** to our earthworm records with **no constraints** to the use of the data and ensuring records are available at the **full resolution** they are accepted at.

This is achieved through the submission of our databases to the **National Biodiversity Network (NBN) Atlas**. As a Data Sharing Partner of the NBN, the ESB is committed to ensuring this data set is updated on a regular basis (and no less than twice per year).

Datasets that are managed by the ESB can be found through the Data Partner webpage for the ESB on the NBN Atlas: <https://registry.nbnatlas.org/public/show/dp88>



Furthermore, we allow our records to be made available through:

- **Global Biodiversity Information Facility** (an international open data infrastructure, funded by governments) in accordance with their vision: "A world in which biodiversity information is freely and universally available for science, society and a sustainable future."
- **Local Environmental Records Centres (LERCs)** (regional not-for-profit organisations that collect, collate and manage information on the natural environment for a defined geographic area). ESB data is submitted to LERCs annually, though no formal data sharing agreements exist.

Licences and attribution

All data submitted to the Earthworm Society of Britain is assigned a **Creative Commons Attribution 4.0 International licence** as it is recommended for maximum dissemination and use of licensed materials.



It allows others to:

Share — copy and redistribute the material in any medium or format for any purpose, even commercially.

Adapt — remix, transform, and build upon the material for any purpose, even commercially.

(The licensor cannot revoke these freedoms as long as the user follows the license terms)

Under the following terms:

Attribution — Users must give **appropriate credit**, provide a link to the license, and **indicate if changes were made**. Users may do so in any reasonable manner, but not in any way that suggests the licensor endorses the user or their use of the data.

No additional restrictions — Users may not apply legal terms or **technological measures** that legally restrict others from doing anything the license permits.



5 Identifying Earthworms

5.1 Printed identification keys

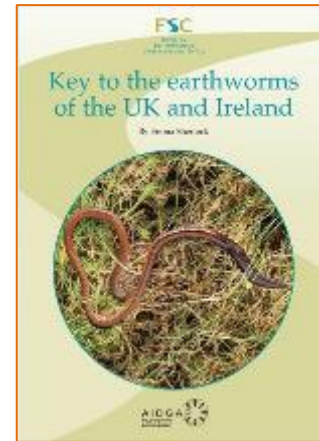
Key to the Earthworms of the UK & Ireland (2nd edition) (2018)

E. Sherlock

Produced by the Field studies Council as part of their AIDGAP series. The second edition expands on the ecology and biology sections of the first edition, and briefly summarises the global picture. The dichotomous key has been updated with current taxonomic names and includes 2 additional species now known to occur in the British Isles. The species pages have also been expanded to include more information and photos, including some photos of live earthworms. Finally, a guide to identifying 8 of the non-native earthworm species that are found in artificial environments, such as heated glasshouses, is also included.

The book is available from the FSC website:

<https://www.field-studies-council.org/publications/pubs/earthworms-2nd-edition.aspx>



Key to the Earthworms of the UK & Ireland (1st edition) (2012)

E. Sherlock

Produced by the Field Studies Council as part of the AIDGAP series. This key provides a basic background in earthworm biology and ecology, as well as information on sampling, recording and preserving earthworms. In addition to a dichotomous key, there is a quick earthworm comparison chart and species accounts. This resource is still suitable for identifying British and Irish earthworms but does have some limitations as some species names have changed since this publication, 1 species has been split into 2 species and our ecological understanding of some earthworm species has since been updated.

THIS PUBLICATION IS NOW OUT OF PRINT.



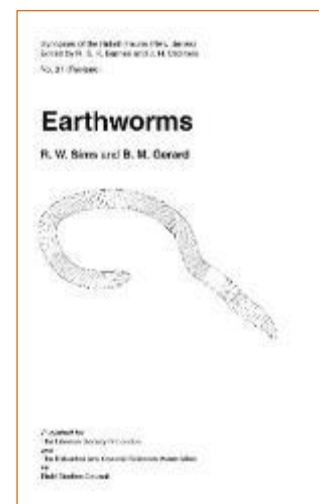
Earthworms (Synopsises of the British Fauna) (1985)

R.W. Sims & B.M. Gerard

This publication is part of the Synopsises of the British Fauna and provides a much more detailed account of UK earthworm biology and taxonomy. The technical detail contained within the dichotomous key and diagrams make this key suitable for more experienced users. It is also available from the FSC. This resource is still suitable for identifying British and Irish earthworms but does have some limitations as some species names have changed since this publication, 1 species has been split into 2 species and our ecological understanding of some earthworm species has since been updated.

The book is available from the FSC website:

www.field-studies-council.org/publications/pubs/earthworms-synopsis.aspx





5.2 Limitations of the OPAL Earthworm Guide

D.T. Jones & C. N. Lowe

The OPAL Earthworm Guide is a key to the common species of UK earthworms only and covers less than half of UK earthworm species. It is a fantastic resource for looking at earthworms in more depth with children and individuals not experienced in biological recording. However, it is not a sufficiently detailed identification key for the purpose of the National Earthworm Recording Scheme. Currently it is not possible to reliably identify live British earthworm species without the observation of morphological features under a microscope (or alternatively the use of sufficiently detailed high photos). The limitations associated with the OPAL Earthworm Guide are outlined in the following section.

Limitation 1 – Accuracy rate

As part of the OPAL project, an analysis was conducted by Imperial College London:

<http://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/opal-soil/Soil-Steering-Group-OPAL-Data-Analysis-National-Survey-Report.pdf>

Page 104 (page 39 of the earthworm section) indicates a list of UK & Ireland earthworm species and how it was selected which species would be included in the key. The list of UK & Ireland earthworm species in the report contains 26 species so please note that the true number of species at this point in time is 31 species in the UK and Ireland (or 29 in Great Britain).

It was found that the key only resulted in correct species identifications 66.2% of the time for adults (children were only correct 53.3% of the time). The worst example was one species (*Dendrobaena octaedra*) that was found to be correct 0% of the time when the OPAL key was used. The most commonly submitted records from the OPAL key to iRecord are for *Eisenia fetida* (60% accuracy from adults), *Lumbricus terrestris* (50% accuracy from adults) and *Octolasion cyaneum* (27% accuracy from adults). The table below is taken from the report and indicates the accuracy rates for the species included in the OPAL Earthworm Guide.

Table 6.2 Percentages of earthworms correctly identified by adults and children using the OPAL field guide.

	Adults	Children
All specimens	66.2%**	53.3%
Black-headed worm <i>Aporrectodea longa</i>	98%***	64%
Grey worm <i>Aporrectodea caliginosa</i>	73% ^{NS}	64%
Green worm <i>Allolobophora chlorotica</i>	78% ^{NS}	84%
Chestnut worm <i>Lumbricus castaneus</i>	54% ^{NS}	17%
Brandling worm <i>Eisenia fetida</i>	60% ^{NS}	36%
Redhead worm <i>Lumbricus rubellus</i>	56% ^{NS}	60%
Rosy-tipped worm <i>Aporrectodea rosea</i>	93%*	50%
Lob worm <i>Lumbricus terrestris</i>	50% ^{NS}	55%
Little tree worm <i>Satchellius mammalis</i>	75% ^{NS}	0%
Blue-grey worm <i>Octolasion cyaneum</i>	27% ^{NS}	9%
Compost worm <i>Eisenia veneta</i>	50% ^{NS}	11%
Octagonal-tailed worm <i>Dendrobaena octaedra</i>	0% ^{NS}	0%

Note: * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$; NS = not significant

Figure 1: Table 6.2 taken from The OPAL Soil and Earthworm Survey Report

Limitation 2 – The “Rare” Earthworms

Assuming the OPAL key was 100% effective when used on a species that is included in the key it would still be unsuitable for use in the National Earthworm Recording Scheme as it would inevitably result in the rarer species being misidentified as these were disregarded when the identification questions for the key was constructed. Some of the omitted species are closely related to the included species and it is not currently possible to tell live specimens apart as they require inspection under a microscope in order to identify the morphological features that separate them. Since the National Earthworm Recording Scheme was launched we have learned that some of the “common” species are less common than previously thought and some of the “rare” species are more common than we thought.

Limitation 3 – Some of the identification features don't work

One example of this is the use of a yellow tail to distinguish *Octolasion cyaneum* from other epigeic species of earthworms. *Octolasion lacteum* (a close relative of *O. cyaneum* and not included in the key) has been observed with a yellow tail (and this is evidenced in **Error! Reference source not found.** below). *Allolobophora chlorotica* and *Aporrectodea caliginosa* can also both have yellow tails, as can the compost earthworm *Eisenia fetida*. *O. cyaneum* has also been observed without the yellow tail in life.



Figure 2: *Octolasion lacteum* with a yellow tail. Photo (c) Emma Sherlock

Limitation 4 – False expectations

Finally, the key gives recorders false expectations that their record can be verified through provision of a photo. In reality we can only confirm the species if the photo(s) is of a high enough quality that the identification features that would normally be observed under a microscope can be clearly seen.



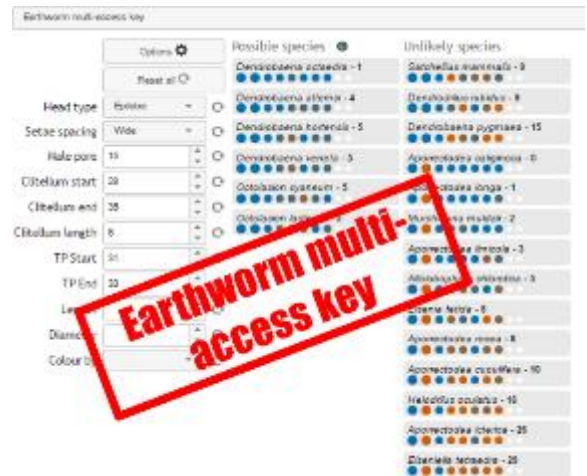
5.3 Digital identification resources

Earthworm identiKit

E. Sherlock & R. Burkmar

This online visualisation was created by R. Burkmar as part of the FSC Tomorrow's Biodiversity project using the knowledge base of Sherlock (2012). Please note that not all characteristics are considered (TP shape is omitted) and the printed key is often still required to verify identification.

This tool is a great aid to the printed key and is available to use for free from the Earthworm Society of Britain website. A future update is planned to update the taxonomy and add in the two additional species in line with Sherlock (2018). This update will also make better use of the image features.



www.earthwormsoc.org.uk/fullscreen/earthwormkey

Earthworm Images Website

B. Crabb

This online gallery of images is a collection of photos of various species of earthworm native to the UK. The photographs were taken using a USB microscope and have been labelled to indicate the location and appearance of identification features.

The resource was created by an earthworm recorder in order to assist other earthworm recorders with their identifications, and is not intended to be used as the sole method of identification for UK earthworms. The labels which appear on some of the images refer to that specimen only, they are not intended as a general description of the species.



<https://bjc792.wixsite.com/earthworm-images>

Earthworms UK Facebook Group

A. Marsh

A Facebook group set up to allow those interested in earthworm identification to give support to others and pose identification queries to others. The group was created to allow people to discuss earthworm identification regardless of their ability level and is a useful resource for both new and experienced recorders.

www.facebook.com/groups/1059301190824485/





5.4 Microscopes and lab work

In order to identify earthworms, you will need access to a microscope and some basic lab equipment.

Microscopes

British earthworms vary from under 2cm to 40cm in length so you'll need to consider this when selecting a suitable microscope. We recommend the use of a **stereo microscope with zoom magnification from X10 (for bigger earthworms) through to X30 (for smaller earthworms)**.

In addition, you should also consider:

- **A light source** – if your microscope doesn't come with lighting you may need to purchase a lamp as you will need to illuminate earthworms from above to be able to clearly see their identification features.
- **Stage plates** – These are the discs that sit beneath the petri dish when examining an earthworm specimen. Traditionally, they are white, black or transparent. When observing earthworms, some features on specimens may be clearer with a black stage plate and some clearer with a white stage plate (this can even differ between features on the same specimen). Most features are less clear when using a transparent stage plate. If your microscope does not have white or black stage plates you can make your own using black or white paper/card or purchase reversible black-white stage plates online.

Microscope suppliers that sell suitable equipment for earthworm recorders

- Brunel Microscopes
New microscopes: <http://www.brunelmicroscopes.co.uk/stereo-tour.html>
Used microscopes: <http://www.usedmicroscopes.co.uk/>
- Mazurek Optical services
<http://mazurekopticalservices.co.uk/microscopes/type/stereo/>
- Severn Sales (laboratory Equipment)
<http://www.severnsaleslabequip.com/index.php/metallurgy-and-microscopy/stereo-microscopes.html?limit=all>
- Fullerscope services
<http://www.fullerscopeservices.co.uk/products?cat=23>
- GT Vision
http://www.gtvision.co.uk/epages/es141397.sf/en_GB/?ObjectPath=/Shops/es141397/Categories/Stereo_Microscopes

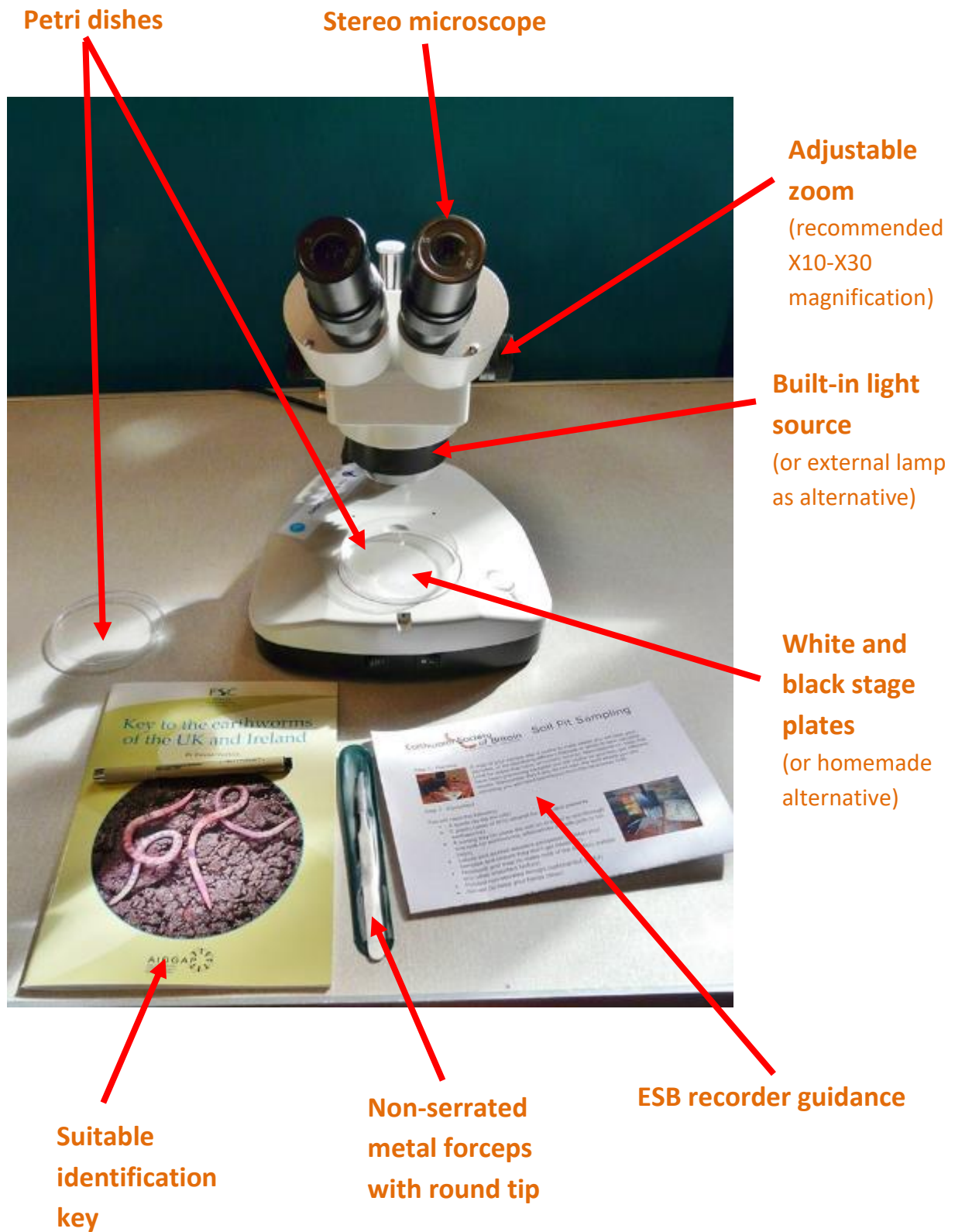
In addition to traditional microscopes, more digital microscopes are becoming available on the market (including very reasonably-priced USB microscopes). If you are considering purchasing a digital or USB microscope you should consider all of the above plus the stability of the model.

Forceps

Earthworms are soft-bodied animals and easy to damage if suitable forceps are not used to manipulate specimens. We advise using **non-serrated forceps with a rounded tip**, as both serrated edges and pointed tips can easily damage specimens and make it more difficult to identify your specimen. In general metal forceps are also better than plastic alternatives when manipulating earthworms under a microscope.

When identifying earthworms, you may find our **Earthworm Identification Features Sheet** useful to record the different features of your earthworms.

Earthworm identification lab set up



5.5 Photographing earthworms

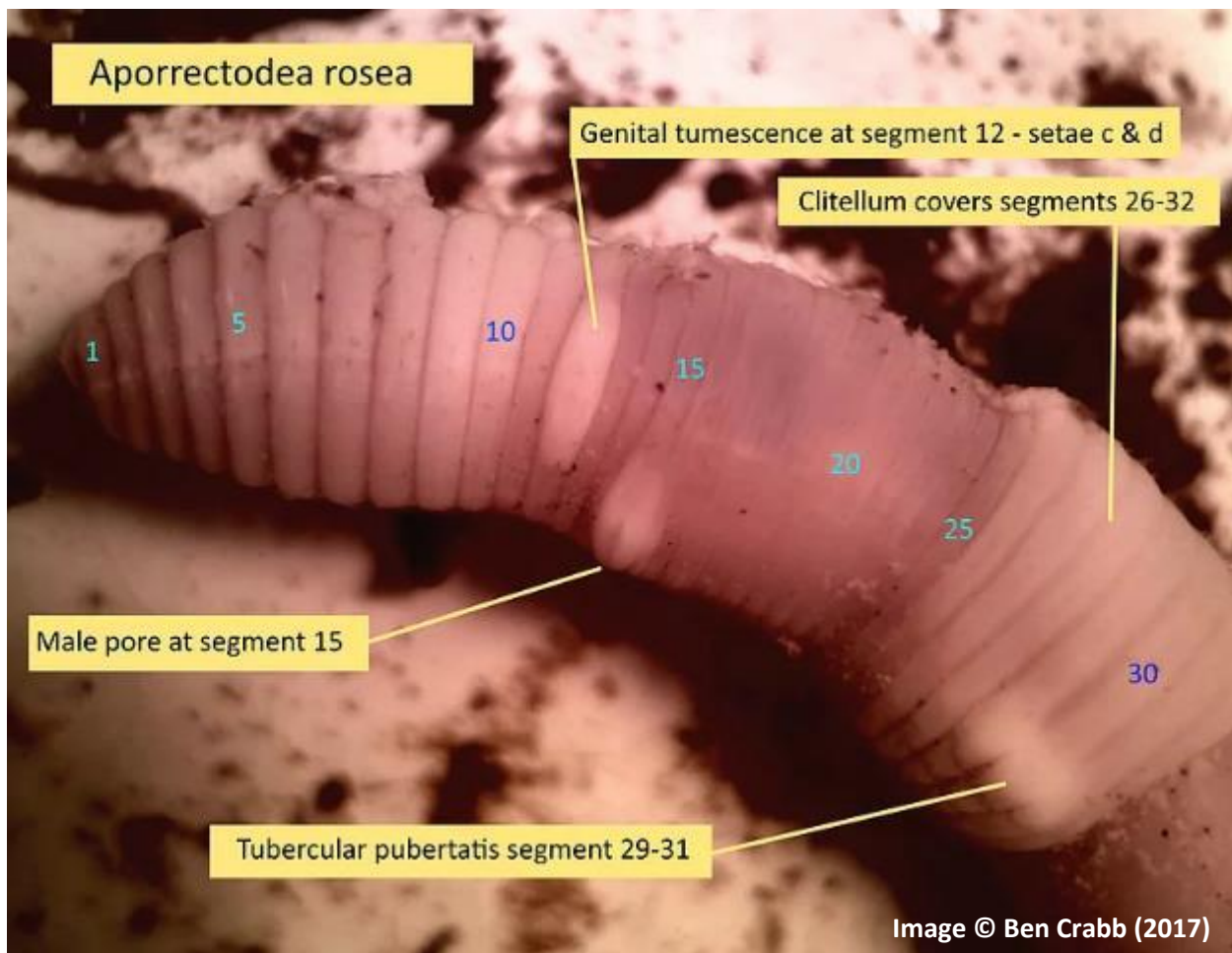
Identifying earthworms from photographs can be extremely difficult. This is particularly true if the photos are of live specimens, as it can be very difficult to see the features needed to make a reliable species determination. However, if you are submitting photos to the Earthworm Society of Britain for identification or verification purposes here are a few tips:

Provide several photos – for many specimens it is extremely difficult (if not impossible) to capture all the identification features in one photo. By taking several images you can capture a specimen from different angles and positions.

Provide close-up photos - the identification features of earthworms are often small and difficult to see on photographs of an entire specimen. Close-up photos of the saddle are particularly useful as they give insight into the location and shape of the TP – a key identification feature.



Label your photos – don't be afraid to add labels and notes to your photos. Numbering the segments (such as every fifth segment) can be useful, particularly on close up photos as there would otherwise be no reference with regards to segment numbers.



Examples of well-labelled photographs suitable for the identification of earthworms can be found on the Earthworm Images Website at <https://bjc792.wixsite.com/earthworm-images>



5.6 British Isles Earthworm Species Checklist (Natural Environments)

This checklist includes all species of earthworm known to occur in natural environments (i.e. in the wild) in the British Isles and was compiled by Keiron Derek Brown, Chris Raper and Emma Sherlock on 3rd March 2018. The checklist notes can be found on the following page.

CLASS CLITELLATA

SUBCLASS OLIGOCHAETA

ORDER CRASSCLITELLATA

		Rarity	Checklist notes
Family ACANTHRODRILIDAE	Claus, 1880		
<i>Microscolex phosphoreus</i>	(Duges, 1837)	Very rare	*1
Family LUMBRICIDAE	Rafinesque-Schmatz, 1815		
<i>Allolobophora chlorotica</i>	(Savigny, 1826)	Very common	*2
<i>Aporrectodea caliginosa</i>	(Savigny, 1826)	Very common	*3
<i>Aporrectodea cupulifera</i>	(Tétry, 1937)	Very rare	*4
<i>Aporrectodea icterica</i>	(Savigny, 1826)	Rare	
<i>Aporrectodea limicola</i>	(Michaelsen, 1890)	Rare	
<i>Aporrectodea longa</i>	(Ude, 1885)	Common	
<i>Aporrectodea nocturna</i>	Evans, 1946	Rare	*3
<i>Aporrectodea rosea</i>	(Savigny, 1826)	Common	
<i>Bimastos eiseni</i>	(Levinsen, 1884)	Common	*5
<i>Bimastos rubidus</i>	(Savigny, 1826)	Common	*5
<i>Dendrobaena attemsi</i>	(Michaelsen, 1902)	Uncommon	
<i>Dendrobaena hortensis</i>	(Michaelsen, 1890)	Rare	
<i>Dendrobaena octaedra</i>	(Savigny, 1826)	Uncommon	
<i>Dendrobaena pygmaea</i>	(Savigny, 1826)	Very rare	
<i>Dendrobaena veneta</i>	(Rosa, 1886)	Common	
<i>Eisenia andrei</i>	Bouché, 1972	Unknown	*6
<i>Eisenia fetida</i>	(Savigny, 1826)	Common	*6
<i>Eiseniella tetraedra</i>	(Savigny, 1826)	Common	
<i>Helodrilus oculatus</i>	Hoffmeister, 1845	Very rare	
<i>Kenleenus armadas</i>	Blakemore, 2012	Very rare	*4
<i>Lumbricus castaneus</i>	(Savigny, 1826)	Common	
<i>Lumbricus festivus</i>	(Savigny, 1826)	Rare	
<i>Lumbricus friendi</i>	Cognetti, 1904	Very rare	*7
<i>Lumbricus rubellus</i>	Hoffmeister, 1843	Very common	
<i>Lumbricus terrestris</i>	Linnaeus, 1758	Common	
<i>Murchieona muldali</i>	(Omodeo, 1956)	Rare	
<i>Octolasion cyaneum</i>	(Savigny, 1826)	Common	
<i>Octolasion lacteum</i>	(Örley, 1881)	Common	
<i>Satchellius mammalis</i>	(Savigny, 1826)	Uncommon	
Family SPARGANOPHILIDAE	Michaelsen, 1928		
<i>Sparganophilus tamesis</i>	Benham, 1892	Very rare	*8



5.7 British Isles Earthworm Species Checklist (Natural Environments) notes

1. *Microscolex phosphoreus* is an earthworm known to occur in the UK and thought to originate from South America. It is believed to occur very rarely in the UK and therefore a voucher specimen is required to confirm any records of this species.
2. *Allolobophora chlorotica* exists in two distinct morphs: green and pale (or pink). These morphs are recognised to differ in their ecological preferences, though both are relatively common and widespread. Where possible, the colour morph should be recorded as it is possible that these morphs may be re-determined as distinct species in the near future. Once preserved, it is not possible to tell the colour morphs apart so the colour must be recorded when observing a live specimen in order for the morph to be recorded.
3. *Aporrectodea caliginosa* was previously known to exist as a distinctly different morph: *nocturna*. This morph is an anecic earthworm, whereas *A. caliginosa* is typically an endogeic earthworm. Research that is due to be published in 2018 has demonstrated through both molecular and morphological work that the *nocturna* morph is in fact a distinct species: *Aporrectodea nocturna*. *A. nocturna* can be distinguished relatively easily as it is generally larger than *A. caliginosa* and has a deep red colour, but records of both species should be accompanied by a photograph where possible.
4. *Aporrectodea cupulifera* and *Kenleenus armadas* are known only from Ireland, and not from mainland Britain. Both species are thought to be very rare and a voucher specimen is required to confirm any records of either species.
5. *Bimastos eiseni* and *Bimastos rubidus* were previously named *Allolobophoridella eiseni* and *Dendrodrilus rubidus*, respectively, until 2017. They were re-classified according to molecular work into the genus *Bimastos* and are now thought to originate from North America.
6. *Eisenia andrei* is extremely difficult to separate from *Eisenia fetida*, and possibly only distinguishable through molecular work. Some earthworm taxonomists believe that *E. andrei* and *E. fetida* belong to a single species. All *Eisenia* species records are currently recorded as *Eisenia fetida*, as an aggregate species until a reliable method for distinguishing between the two species is established.
7. *Lumbricus friendi* is a very rare species and a voucher specimen is required to confirm any records of this species.
8. *Sparganophilus tamesis* is an earthworm known to occur in the UK and thought to originate from North America. In response to two unverified records of *S. tamesis* the Earthworm Society of Britain undertook a site survey of the River Thames close to Goring-on-Thames (the type locality) in 2016 but no specimens of *S. tamesis* were observed. It is thought likely that the species is still present in the UK and a voucher specimen is required to confirm any records of this species.



5.8 British Isles Earthworm Species Checklist (Artificial Environments)

Numerous non-native earthworm species have been recorded in artificial environments across the British Isles. Any non-native species found in the UK should be verified by an expert through examination of the preserved voucher specimen is likely to require dissection of the specimen. This checklist was compiled by Keiron Derek Brown, Chris Raper and Emma Sherlock on 3rd March 2018.

CLASS CLITELLATA

SUBCLASS OLIGOCHAETA

ORDER CRASSCLITELLATA

Family ACANTHODRILIDAE

<i>Dichogaster affinis</i>	(Michaelson, 1890)
<i>Dichogaster bolau</i>	(Michaelsen, 1891)
<i>Dichogaster saliens</i>	(Beddard, 1892)

Family EUDRILIDAE

<i>Eudriloides durbanensis</i>	Beddard, 1893
<i>Eudrilus eugeniae</i>	(Kinberg, 1867)
<i>Heliodrilus lagosensis</i>	Beddard, 1890
<i>Hyperiodrilus africanus</i>	Beddard, 1891
<i>Iridodrilus roseus</i>	Beddard, 1897

Family MEGASCOLECIDAE

<i>Amyntas alexandri alexandri</i>	(Beddard, 1900)
<i>Amyntas corticis</i>	(Kinberg, 1867)
<i>Amyntas gracilis</i>	(Kinberg, 1867)
<i>Amyntas morrisi</i>	(Beddard, 1892)
<i>Amyntas rodericensis</i>	(Grube, 1879)
<i>Anisochaeta celmisiae</i>	Blakemore, 2000
<i>Duplodicrodrilus schmardae schmardae</i>	(Horst, 1883)
<i>Metaphire californica</i>	(Kinberg, 1867)
<i>Metaphire posthuma</i>	(Vaillant, 1868)
<i>Perionyx excavatus</i>	Perrier, 1872
<i>Pithemera bictincta</i>	(Perrier, 1875)
<i>Polypheretima taprobanae</i>	(Beddard, 1892)

Family MONILIGASTRIDAE

<i>Drawida barwelli</i>	(Beddard, 1886)
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Family OCNERODRILIDAE

<i>Eukerria rubra</i>	(Friend, 1916)
<i>Eutyphoeus nicholsoni</i>	
<i>Gordiodrilus ditheca</i>	Beddard, 1892
<i>Gordiodrilus dominicensis</i>	Beddard, 1892
<i>Gordiodrilus elegans</i>	Beddard, 1892
<i>Gordiodrilus robustus</i>	Beddard, 1892
<i>Gordiodrilus tenuis</i>	Beddard, 1892
<i>Nannodrilus africanus</i>	Beddard, 1894
<i>Nematogenia lacuum</i>	(Beddard, 1893)
<i>Ocnerodrilus occidentalis</i>	Eisen, 1878
<i>Trigaster minima</i>	Friend, 1911

Family GLOSSOSCOLECIDAE

<i>Diachaeta barbadensis</i>	(Beddard, 1892)
<i>Diachaeta hesperidum</i>	(Beddard, 1893)
<i>Pontoscolex corethrurus</i>	(Muller, 1857)



5.9 Verification

All earthworm records submitted to the ESB are submitted to a verification protocol that allows ESB verifiers to determine if a record can be accepted into the ESB database. This verification protocol is important to prevent potentially unreliable or erroneous data entering ESB datasets.

Records submitted to the ESB belong to one of three categories:



Unconfirmed – the record/dataset has not yet been subjected to the verification protocol and is awaiting review by a verifier, or the verifier is awaiting further information from the recorder.



Accepted – the verifier has determined that the record/dataset can be considered trustworthy and is added to the relevant ESB dataset.



Not accepted – the verifier was unable to determine that the record/dataset can be considered trustworthy; it is therefore rejected and not added to any ESB dataset.

In order to determine if a record/dataset can be **Accepted**, a number of considerations are taken into account by the verifier to determine the verification status of the record. These include:

- **Recorder experience level** – such as attendance of earthworm identification training courses (i.e. ESB earthworm recorders) or previous demonstrated experience in earthworm identification (i.e. trusted non-ESB earthworm recorder). Verifiers consist of ESB tutors or earthworm experts (such as earthworm taxonomists).
- **Species determination methods** – such as the observation of a preserved specimen's external features, use of a microscope/hand lens and observation of colour of live specimen.
- **Identification resource used** – records are only ✓ accepted when determined from an ESB-approved identification resource, such as Sims & Gerard (1999), Sherlock (2012) and the online Earthworm Multi-Access Key (www.earthwormsoc.org.uk/fullscreen/earthwormkey). Species determinations reached using the OPAL earthworm key (and the iSpot key derived from it) will not be accepted.
- **Suspected errors** – such as the presence of a species outside of its known range or habitat and discrepancies in the geographical or temporal data.
- **Species rarity** – 'Rare' and 'Very Rare' earthworm species determinations may require the checking of a voucher specimen or suitable photo by an ESB tutor or earthworm expert.

<i>Rare species</i>	<i>Very rare species</i>
<i>Aporrectodea icterica</i>	<i>Aporrectodea cupulifera</i>
<i>Aporrectodea limicola</i>	<i>Dendrobaena pygmaea</i>
<i>Aporrectodea nocturna</i>	<i>Helodrilus oculatus</i>
<i>Dendrobaena attemsi</i>	<i>Kenleenus armadus</i>
<i>Dendrobaena hortensis</i>	<i>Lumbricus friendi</i>
<i>Dendrobaena octaedra</i>	<i>Microscoplex phosphoreus</i>
<i>Dendrobaena veneta</i>	<i>Sparganophilus tamesis</i>
<i>Lumbricus festivus</i>	
<i>Murchieona muldali</i>	



The verifier may require further information from the recorder in order to make their assessment or may determine that a voucher specimen or suitable photo is required in order to accept the record.

Following this assessment, a verification status is applied to the record to determine if the record can be accepted (see table on the following page). Only records that are assessed as **Correct** and **Considered correct** are **Accepted** and added to the ESB database.

<i>Verification Status</i>		
Accepted	Correct	Verifier is able to confirm that the species has been identified correctly, usually on the basis of a voucher specimen or, in some cases, a photo of the distinguishing characteristics.
	Considered correct	Verifier has not seen a specimen or a photo that can be used to confirm the identification but has a high degree of confidence that the record is likely to be correct, based on difficulty of ID, the ID resources used (e.g. an accepted identification key and observation of characteristics of specimen using a microscope) and recorder's level of experience and skill.
Not Accepted	Incorrect	Verifier is able to confirm that the species has been identified incorrectly, usually on the basis of a voucher specimen or, in some cases, a photo of the distinguishing characteristics.
	Unable to verify	Verifier has a high degree of confidence that the record is likely to be incorrect based on information provided by recorder (such as photos, identifications resources used and a lack of recorder experience and skill). All species determinations reached using the OPAL Earthworm Key should be classed as 'Unable to verify', unless a verifier can determine the species themselves from a photo or voucher specimen.
	Plausible	Verification term status used in iRecord as an alternative to 'Unable to verify' for all unconfirmed identifications and any confirmed juvenile records (i.e. there is not enough supporting evidence for the possibility of misidentification to be ruled out). This term allows unconfirmed records from inexperienced recorders to be dealt with, without putting the recorder off by giving an outright rejection.

How can I get my record verified by a tutor or an expert?

Please submit your record as per the usual submission pathways and the ESB will get in touch. **Please note that a tutor or expert may need to inspect the voucher specimen** so it's always useful to retain the preserved specimen for any determinations that you believe may require verification.

If you have any questions relating to the identification of British or Irish earthworms, please contact the Earthworm Society of Britain at ESBenquiries@gmail.com.



6 Field Work Assessment

We recommend that recorders carry out a field work assessment in advance of any earthworm sampling. The Earthworm Society of Britain (ESB) recommends you should consider the following:

6.1 Permissions

You should contact the land owner or site manager to ensure you have the necessary permission to undertake your sampling. It is good practice to request permission for the following:

- Access to the site.
- Destructive sampling methods (such as digging or searching through deadwood).
- Collection and removal of specimens from the site.
- Submission of the records to the National Earthworm Recording Scheme (NERS) and refer them to the **Open Data Agreement for Earthworm Records** contained in this document.

Furthermore, the land owner/site manager may be interested in what was found so we recommend you always share your results with them in the form of the records or a site species list.

6.2 Health and safety

Consider carrying out your own risk assessment before doing fieldwork with the following considerations:

- Avoid doing fieldwork on your own, if you do ensure you tell someone exactly where you will be and when you expect to return.
- Always ask permission from the owner before entering land.
- Always tell a responsible adult where you are going and what time you expect to return.
- Check the weather forecast before doing fieldwork, and take appropriate clothing.
- Be aware of local hazards such as dangerous wildlife or hazardous terrain.
- Watch out for dangers such as sharp objects and broken glass in soil.
- Take care to avoid injuries to your hands and soil borne diseases by wearing gloves.
- Always take a mobile phone and a map of the area.
- Know who to contact in the event of an emergency and check where the nearest source of help is in case your mobile phone does not work.
- Carry out a risk assessment for the planned field work.





6.3 Risk assessment

An example risk assessment is given below that is used by the ESB when conducting field work for collecting earthworm records for ESB events to give earthworm recorders an idea regarding some of the risks that should be considered. Different sites and weather conditions will require specific considerations so earthworm recorders are responsible for conducting their own risk assessments and ensuring they operate within any parameters outlined by site managers/land owners (e.g. site-specific risk assessments) when permission is granted to sample a site for earthworms.

<i>Hazard</i>	<i>Risk</i>	<i>Precautions/action</i>	<i>Likelihood</i>
Natural hazards (e.g. open or moving water, cliff or quarry edges, steep slopes)	Drowning, injuries or falls, exposure,	Exercise caution near water, keep away from cliff edges and quarries, be aware of steep slopes.	Low
Adverse weather	Hypothermia, exposure, sunburn, heat stroke	Ensure you have the correct clothing for the conditions. If the weather is too extreme abandon the sampling or seek shelter. Ensure you have something to eat and drink with you.	Low
Tools (e.g. spade, trowel etc...)	Injuries, bruises, cuts, muscle injuries	Transport tools safely, use only for intended purpose, seek training if required, be aware of others during use.	Low
Holes dug during sampling	Trips, breaks, falls	Never leave holes unattended, ensure they are filled in at the end of sampling.	Low
Soil/earthworm borne bacteria or pathogens	Infection	Wear gloves if appropriate, wash hands before eating.	Low

The Earthworm Society of Britain shall not, in any circumstances, have any liability whatsoever for any injury, losses or damages which may be suffered by any participants carrying out earthworm sampling, recording and related activities, whether in contract, tort or otherwise. By participating in any Recording Activities, all participants agree, acknowledge and accept the foregoing.

New Zealand Flatworm

The New Zealand Flatworm (*Arthurdendyus triangulates*) is a non-native flatworm species that is known to have colonised the UK, and is now common in Scotland and Northern Ireland. The NZ Flatworm is known to eat earthworms and is dark brown with pale, spotted margins and underside. It grows up to 15cm in length and has a flattened body. **NZ Flatworms should only be handled wearing gloves as they can cause irritation to the skin.**

Please note that it is illegal to release non-native flatworms, such as the NZ Flatworm, or allow them to escape into the wild in the UK. More information about non-native invertebrate species can be found on the Buglife website: www.buglife.org.uk



7 References

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Earthworm Site Survey Form

For use when undertaking the National Earthworm Recording Scheme 5-Pit Protocol or a full Earthworm Site Survey.

Site Name:	Date (dd/mm/yyyy):	
Grid reference	Recorder Name(s):	
Vice county:	Habitat:	
<p style="text-align: center;">Soil Pits</p> <p>Soil pit sampling undertaken?</p> <p style="text-align: center;">Yes No</p> <p style="text-align: center;"> <input type="checkbox"/> <input type="checkbox"/> </p> <p>Number of soil pits:</p> <p>No. of juveniles returned to soil:</p>	<p style="text-align: center;">Mustard Sampling</p> <p>Mustard sampling undertaken?</p> <p style="text-align: center;">Yes No</p> <p style="text-align: center;"> <input type="checkbox"/> <input type="checkbox"/> </p> <p>Number of mustard sampling points:</p> <p>No. of juveniles returned to soil:</p>	<p style="text-align: center;">Microhabitat Searches</p> <p>Microhabitat searches undertaken?</p> <p style="text-align: center;">Yes No</p> <p style="text-align: center;"> <input type="checkbox"/> <input type="checkbox"/> </p> <p>Microhabitat 1 details:</p> <p>Microhabitat 2 details:</p> <p>Microhabitat 3 details:</p>
Comments:		

