

A STUDY OF THE PRESENT STATE OF AN IRISH COLONY OF THE SLOW WORM (*ANGUIS FRAGILIS* LINNAEUS, 1758) (SQUAMATA: ANGUIDAE) IN THE BURREN, COUNTIES CLARE AND GALWAY. ADDENDUM 2020 – 2023

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Abstract

In the glacial karst landscaped Burren region of Counties Clare and Galway in the west of Ireland there is a colony of slow worms, the legless lizard, *Anguis fragilis* Linnaeus, 1758 (Squamata: Anguidae). This is a continuation from the 2015 to 2019 report and covers the period 2020 to 2023. Data includes sex ratios, refugia preference, pertinent temperatures, female gravidity, observation of juveniles, optimum conditions, terrain preference, repeat sightings.

Key words: *Anguis fragilis*, slow worm, Ireland, Burren, distribution, sex ratio, gravidity, birth, habits, age, terrain, refugia.

Introduction

Parry (2020) reviewed the history and ecology of the slow worm (*Anguis fragilis* Linnaeus, 1758) in Ireland. The author reported on a five-year investigation (2015 to 2019) into the lifestyle, habits, age and sexual dimorphism, and terrain inhabited by the current population in the glacial karst landscaped Burren region of Counties Clare and Galway in the west of Ireland. From the total encounters of 743, the ratio of male, female and juvenile slow worms was monitored as was the possibility of a home range and repeated individual refugia preference by adult females compared to the transient habit of males. The variation of preferred habitat, the refugia employed and pertinent temperatures were also recorded. The present paper deals with a continuation of this research for the period 2020 – 2023. for further information on the Burren, see Anon. (2023a).

Methods

Recommencing the study in 2020 the number of covers employed and the distances travelled were reduced due to Covid-19, my age and health. The Covid restrictions also limited the meeting of new landowners to access their properties, therefore the use of the previously accessible sites was continued with many covers retained from previous years but with some additions. The covers were of a variety of materials mainly of dimensions 0.5m² and positioned

without considered orientation.

Locations

The divisions are townlands. These are small geographical divisions of land, historically and currently used in Ireland (Anon., 2023a).

2020. County Clare

Fahee North: corrugated tin and corrugated bitumen retained from previous year. Sundry items – traffic cone on road verge.

Keelhilla: steel sheet placed in 2015 remained. A corrugated tin 50cm² was added.

Quakerstown: retained from previous years corrugated tin, steel sheet, tin sheet and one bitumen mat plus various debris rubbish on site.

Rockvale: retained were corrugated bitumen and corrugated tin.

2020. County Galway

Cahererillan: steel sheet 2.5m x 1.5m and corrugated tin retained from previous years plus various debris items.

Cappacasheen 1: tin sheet retained since 2016 and one corrugated tin added.

Cappacasheen 2: corrugated tin x 4, one bitumen mat retained from previous years.

Cappacasheen JCs: retained were two of corrugated bitumen and one plywood.

Funshin More: corrugated bitumen and corrugated tin were retained.

Roo: with access previously granted a corrugated tin (Roo north side) and corrugated bitumen (Roo South side) were placed.

2021. County Clare

Keelhilla: two covers retained, steel sheet, corrugated tin.

Quakerstown: three covers retained from previous year, tin sheet, corrugated tin, steel sheet plus debris felt etc.

Rockvale: two covers retained corrugated bitumen and corrugated tin.

NEW. *Derreenatloghtan*: corrugated tin placed on roadside verge.

2021. County Galway

Cahererillan: one cover of corrugated tin retained plus various debris items.

Cappacasheen 1: retained one cover and one added. Tin sheet and corrugated tin.

Cappacasheen 2: retained 5 covers, one bitumen mat and 4 of corrugated tin.

Cappacasheen JCs: as for 2020, three covers, two corrugated bitumen and one plywood.

Roo South: one cover corrugated tin replaced corrugated bitumen.

NEW. *Ballybuck South*: corrugated tin placed on roadside verge.

Gortnaglogh: two covers placed corrugated bitumen and bitumen mat.

2022. County Clare

Quakerstown: three covers retained, corrugated tin, tin sheet, steel sheet, added corrugated tin

plus felt mat.

Quakerstown LR: two covers both corrugated bitumen.

Quakerstown OTR: steel sheet placed.

Rockvale: one corrugated bitumen cover abutting drystone wall.

Derreenatloghtan: roadside verge, corrugated tin retained.

Keelhilla RS: steel tin as previous years.

South Commons: two covers, one corrugated tin one corrugated bitumen.

2022. County Galway

Cappacasheen 1: two covers retained, tin sheet and corrugated tin. Further cover a large plywood sheet added.

Cappacasheen 2: five covers, four corrugated tin and one bitumen mat.

Cappacasheen JCs: three covers retained two corrugated bitumen and one of plywood. Plywood sheet added.

NEW: *Normangrove*: corrugated tin placed on roadside verge.

2023. County Clare

Derreenatloghtan: one cover, corrugated tin retained.

Keelhilla RS: steel sheet retained.

Quakerstown: four covers retained, two corrugated tin, tin sheet, steel sheet, plus bitumen felt amongst debris on site.

Quakerstown LR: two covers as before but now corrugated bitumen and one bitumen mat.

Quakerstown OTR: steel sheet retained, plywood sheet added.

Rockvale: one bitumen mat.

South Commons: two covers retained, corrugated tin and corrugated bitumen.

NEW: *Cloonselherny*: two covers introduced corrugated bitumen and bitumen mat.

2023. County Galway

Cappacasheen 1: three covers retained, plywood, tin sheet, and corrugated tin.

Cappacasheen 2: four covers, three corrugated tin and one bitumen mat. JCs: four covers retained being two plywood and two corrugated bitumen. Plywood cover added.

Procedure

The checking of the sites during 2020 began from the first week in March to the end of October. In 2021, checking began in late January and concluded during the last week of October. During 2022, sites were checked from mid-February until mid-September when illness caused a premature conclusion. In 2023, it was late February when site checks commenced and concluded on 28 October when hibernation was assumed.

The dates of the appearance of the slow worms in Spring and the last sightings in Autumn were noted along with the relevant meteorological details (Table 1). Recording weather

conditions and then attempting to relate encounter numbers of slow worms under refugia to any condition was considered important.

Each site visit followed the same principal whether a slow worm was encountered or not. The date and time would always be noted along with the air temperature, the minimum temperature of the previous night and the daily maximum temperature. Also recorded were the temperature of each cover surface and the weather conditions with particular emphasis on cloud levels.

Also noted were the sex and age class of the animal, length if measurable and any interesting features such as sloughing, mating marks or damage, and if it was a previously recorded animal. The behaviour of gravid females and appearance dates and growth rates of juveniles were also recorded. Young slow worms were allocated either adult or juvenile status dependant on their size, markings and colour, thus sub-adult classification was not implemented. Two townlands that have been surveyed over some years are Cappacasheen in County Galway and Quakerstown in County Clare. While both are within the limestone area of the Burren, visibly they are very different. A comparison of the two sites was made of which 2023 is a perfect example. Did the frequency of visits, at least twice, preferably three times weekly cause a noticeable disturbance? Times of visits to check covers were usually *ad hoc* but during one specific month in 2023 checks were restricted to those times and conditions my data suggested as optimum. Checks were not made during storms or seriously inclement weather.

Unusual behavioural occurrences were noted and analysed. As with previous years all manner of debris and miscellanea at sites and *en route* was investigated. Photographs were taken, when possible, with a Samsung Galaxy S7.

Results

2020

Cahererillan: two covers plus debris produced 130 encounters between 7 May and 21 September. Steel sheet 25, corrugated tin 37 with debris items, felt 23, plastic 5, slate 35, scrap tin 4, plus one openly basking animal.

Cappacasheen 1: one cover 25 encounters between 22 March and 21 September. Tin sheet 25.

Cappacasheen 2: five covers produced 156 encounters between 19 March and 5 October. Four corrugated tin 111, bitumen mat 44, plus 1 openly basking animal.

Cappacasheen JCs: three covers for 31 encounters between 19 March and 7 September. Corrugated bitumen 26, plywood 5.

Keelhilla: two covers produced 30 sightings from 25 May to 28 September. Steel sheet 5, corrugated tin 25.

Quakerstown: four covers plus various debris produced 158 encounters from 15 March to 18 October. Corrugated tin 107, tin sheet 27, steel sheet 10, bitumen mat 4, various debris concrete

and felt 10.

Roo: two covers for 5 encounters from 10 August to 14 September. Corrugated tin none, corrugated bitumen 5.

Sundry sightings: traffic cone, 3 encounters.

No slow worms were found at Rockvale, Funshin More and Fahee North.

2020: total 538. Females 213, Males 71 = ratio 3/1. Juveniles 254 being 47.2% of total. Covers were checked on 87 occasions for a total of 6.1 encounters per trip.

2021

Ballybuck South: one cover produced one encounter on 7 April. Corrugated tin 1.

Cahererillan: one corrugated tin plus debris produced 26 encounters from 18 May to 10 August. Corrugated tin 1, debris of tin/felt 25.

Cappacasheen 1: two covers housed 16 encounters between 19 March and 31 August. Tin sheet 15, corrugated tin 1.

Cappacasheen 2: five covers produced 36 sightings plus one openly basking animal between 19 March and 31 August. Four corrugated tin 30 encounters, bitumen mat 6.

Cappacasheen JCs: three covers produced 15 encounters between 30 March and 26 August. Two corrugated bitumen 8 and plywood 7.

Derreenatloghtan: one cover produced 17 encounters from 28 May until 8 October. Corrugated tin 17.

Keelhilla: two covers, for one slow worm on 31 May. Corrugated tin none, steel sheet one.

Quakerstown: three covers plus debris produced 156 encounters from 16 March to 22 October. Corrugated tin 116, tin sheet 30, steel sheet 7, debris felt 2, debris cardboard 1.

Roo South: one cover revealed one slow worm on 2 September. Corrugated tin one.

No slow worms were encountered at Gortnaglogh, Normangrove or Rockvale.

2021 total 269. Females 85, Males 53 = ratio 1.6/1. Juveniles 131 being 48.6% of total. Covers were checked on 74 occasions giving 3.6 encounters per trip.

2022

Cappacasheen 1: three covers produced 50 encounters. Tin sheet 16, corrugated tin 2, plywood 32. From 19 March to 15 September.

Cappacasheen 2: four corrugated tin 29 encounters, bitumen mat 18 encounters. From 14 April to 9 September.

Derreenatloghtan: one corrugated tin 34 encounters from 24 March to 2 September.

Cappacasheen JCs: two corrugated bitumen 5 encounters, two plywood 13 encounters. From 21 March to 31 August.

Keelhilla RS: one steel sheet. One encounter 29 June.

Quakertown: five covers plus debris item produced 133 encounters from 19 March to 15

September Corrugated tin x two 86, tin sheet 17, steel sheet 15, felt 15. Openly basking animal 1.

Quakerstown LR: two corrugated bitumen 10 encounters from 23 June to 15 September.

Quakerstown OTR: one steel sheet 14 encounters from 13 March to 16 August.

Sundry sightings: Leitra: 1 on concrete. *Cappacasheen*: traffic cone 4. *Fahee North*: paving stone, 1. *Under council signs lying on road verge*: 2. *Normangrove*: dead body on roadway.

No slow worms were found at Rockvale or South Commons.

2022 total 317. Females 145, Males 105 = ratio 1.38 /1. Juveniles 67 being 21.1% of total. Covers were checked on 77 occasions for 4.11 encounters per trip. Survey prematurely concluded on 15 September.

2023

Cappacasheen 1: 59 Encounters. Plywood 44, tin sheet 8, corrugated tin 7. From 25 March to 3 October.

Cappacasheen 2: total 138 encounters, three corrugated tin 96 encounters, bitumen mat 42. From 20 March to 16 October.

Cappacasheen JCs: three plywood 5 encounters, two corrugated bitumen produced 7 encounters from 29 June until 31 August.

Cloonselherny: one encounter on 25 July.

Derreenatloghtan: one corrugated tin produced 49 encounters from 16 March to 8 October.

Keelhilla RS: steel sheet 9 encounters. From 17 April to 17 August.

Quakerstown: 148 encounters. Two corrugated tin 77, tin sheet 4 encounters. Steel sheet 18 encounters. Debris felt mat 49. From 16 March to 19 October.

Quakerstown LR: 53 encounters being corrugated bitumen 29, bitumen mat 24 encounters. From 1 April to 24 October.

Quakerstown OTR: 8 encounters. Steel sheet 3, plywood 5 encounters. From 1 May to 25 August.

Rockvale: one encounter, bitumen mat on 23 August.

No slow worms were found at South Commons.

2023 total 482. Females 267, males 137, Juveniles 78. Ratio Female/male 1.95/1. Juvenile 78 being 16.18% of total. There were 92 cover checks producing an average of 5.3 encounters per trip until assumed hibernation.

Gravid females and growth of juveniles

In contrast to 2021 and 2022 when few female slow worms appeared to have been mated, 2020 saw at least one gravid female at each of the sites and similarly during 2023 many of the adult females encountered under refugia appeared to be gravid.

In both 2020 and 2023, it was noticeable in what appears to be normal behaviour, that those females remained in the usual refugia until just prior to birthing. Most returned later, obviously postnatal. While various refugia placed near the birth site may house one or two juveniles, it was fortuitous that in 2020 up to seven juveniles remained under a single corrugated tin, their recognizable head markings enabling me to follow their growth from first appearance and into subsequent years.

Most newborns at this site were of a size according to the accepted age/length scales. Beebee and Griffiths (2000) state that newborn slow worms measure between 70 and 100mm long. By the end of their first one year of age, immature slow worms have approximately doubled in length and by two years measure up to 230mm. Smith (1951) notes that at birth the young measure from 65 to 90mm. in length. At one year old, they are between 152 and 180mm. in length; at two years old between 219 and 230mm in length". Inns (2009) gives the size of hatchlings at 80mm, Frazer (1983) records that at birth the slow-worm is 65-90mm long and there are 4-28 in the litter (usually 6-12).

With a rigid piece of tape measure laid alongside and photographed from above, I was able to obtain fairly accurate lengths over time. Initially they were in the 80 to 90mm range, by October they were in the mid 90mm. The following spring, March into April 2021, they ranged between 103 to 115mm. At the end of year one they were 145 to 160mm and the single remaining animal after the tin was vandalized, measured, with tail partially in an ant tunnel, at more than 190mm on 18 August 2022, nearly two years old. At the same site, a steel sheet just 50m away also held newborns.

In late September 2020, an individual was measured at 73mm. On 9 October, another measured 78mm, one on 9 October at 78mm and a third on 18 October was 82mm. This seemed to be a clutch of smaller individuals than appeared under the corrugated tin. In late April 2021 that same steel sheet housed a juvenile at just 75mm, while a bitumen mat lying alongside contained a juvenile of 67mm, near the accepted minimum length of a newborn. These measurements perhaps lent some merit to the suggestion by Street (1979) that the young are normally born at the end of August or beginning of September, although they may appear as early as mid-July or after an unfavourable summer as late as October, November, or even the following spring. Both Frazer (1983) and Smith (1951) refer to Knight's report (1949) of a slow worm discovered hibernating near Deal in Kent on 29 February which, when killed, was found to contain fully developed embryos 75 to 80mm in length. Bebee (2013) states that "There's also some suggestion that slow-worms may retain their young and give birth the following spring. Does this really happen?" Gender and age ratios 2015 – 2023 are shown (Fig. 1).

Hibernation

From 2020 to 2023, the dates of initial sightings on emergence from hibernation, and those of the final sightings presuming that hibernation had occurred have been noted. It is reasonable to assume that being ectotherms, slow worms are temperature driven, or is it day length that affects their behaviour? A further likely factor is that their major food sources become inactive and or unavailable during cooler weather. The temperature has been noted for each of the five days prior to my first sighting of the year and the five days prior to my final sighting and presumed hibernation of each year (Table 1).

Roadside verges

If access to an unsurveyed townland was unavailable, a cover placed on a suitable stretch of nearby roadside verge often proved effective. Carefully positioned and concealed in the foliage, most were removed as soon as they produced or after a short trial period if they had not. These temporary placings, along with various discarded debris items were particularly productive for roaming males during March and April. At Derreenatloghtan townland, a corrugated tin cover was placed in a roadside verge in late August 2019 until October as a trial. One damaged slow worm was found in that period despite the site appearing unsuitable for slow worm habitation. That single encounter piqued my interest, and the cover was replaced in May 2021. With vehicles passing just two meters away on a busy 'L' road, the results were significant.

Through 2021 the cover was checked on 57 occasions with a single slow worms present 17 times, nine of which were a particular mature male (MM1). Remaining in place over winter the cover was checked on 79 occasions during 2022. On 32 occasions it was inhabited by a single animal and twice with two. MM1 was present on 29 visits.

From the first of 33 visits in 2023 beginning on 16 March to the last on 8 October MM1 was found with one other on four occasions, and at another time was one of six. (Plate 1). Over the three years, the cover was checked on 228 occasions. On 80 checks a single slow worm was present, on seven occasions there were two and once the six were present. MM1 was encountered 71 times.

Repeat sightings and disturbance effect

Female #58 was initially seen in August 2016 and each subsequent year. In 2020 she was present on 22 March and occasionally during the summer. On 13 July it was noted she had lost tail length. In 2021 she appeared initially on 19 March and again in March and April. She was last seen that year on 8 July. In 2022 for the seventh successive year female #58 was again present under the tin sheet, coincidentally again on 19 March. However, in 2023 she was not encountered.

Repeat sightings of individual slow worms over periods of three and four years became accepted as normal behaviour rather than noteworthy. Many of those individuals demonstrated personal characteristics to such an extent that I would know the response to expect when lifting particular covers. Some slow worms were very calm and took little notice when their roof was lifted, even in warm conditions, which enabled leisurely photography and measurement. Others, despite being exposed on numerous occasions rarely enabled a clear photograph with the best perhaps a blurred tail-end. My overall impression is that mature males were the least responsive to disturbance.

Among the slow worms which remained on site throughout the summer were those that were occasionally present over two or three years but with some years missed out completely. A casual passers-by was also seen once. A repeat sighting of interest occurred on 29 July 2016. This was male #52 at KY, the longest slow worm yet discovered and found under corrugated tin in the company of a female. The tin was removed at the end of that year but replaced on 20 March 2020 in the original position. On 14 September 2020, male #52 was discovered under the tin. Previously 43cm long, it was now showing a severely reduced tail and a length of just 31cm. According to Smith (1951) the tail is 55 per cent. of the total length of the adult male. Beebee and Griffiths (2000) state that the tail is between one and one and one-and-a-half times the body length but is proportionately longer in males than females. Accordingly, this male had lost at least 50% of its tail. Slow worms are able to shed a length of tail should they be in danger. This ability, autotomy, is effective when under attack from predators.

Cloud effect

My data offered a recurring factor present on days that resulted in multi-encounters, cloud. Cloud is frequently reported with the encountering of slow worms. (Fish, 2016) notes that slow worms and common lizards both appeared to be recorded in greater numbers during overcast or wet weather. Simms (1970) states that this is the reptile likely to be most active on cloudy but mild days or those days of alternating sun and shower so typical of an English spring.

Daily levels of cloud density can be measured using the Okta system, whereby cloud is measured at eight grades with 0 being clear sky and 8 being completely overcast (Anon., 2023c). Figure 2 shows the contrasting results of two occasions when covers were checked at the same time of day and with similar air temperatures of 18-20°C. The third data is a day at random and the fourth an example from August 2023.

The three extra covers on 10 August 2020 were serial non-producers but as they were checked, they were included. The air pressure and humidity levels in the chart were added as perhaps they play some part in slow worm activity and possibly a major part.

During August 2023, a month generally regarded as poor for encounters, rather than time my

trips for occasions when it was convenient or at those times recommended in the literature as preferable. Instead, I visited my sites in those conditions and times of day which I considered, *via* my data, as most likely to prove productive which were the presence of heavy cloud cover coupled with a temperature of around 20°C and in late afternoon. Luckily those conditions prevailed. The average monthly encounter numbers for 2023 were March, 1 per trip, April 6, May 5.4, during June 4.16, July 5.33, August 11 per trip, September 3.6, and October 4.18 per trip (Fig. 2).

Site comparison

As can be seen in the results, two townlands that have been surveyed regularly are Cappacasheen in County Galway and Quakerstown in County Clare. While both areas are within the limestone of the Burren area, visibly they are very different, and a curious pattern of encounters has occurred in the last few years of which 2023 is a perfect example (Fig. 3).

Cappacasheen is highly vegetated, much of it impenetrable with thick, long grasses and flora including, ling or common heather (*Calluna vulgaris*), common juniper (*Juniperus communis*), brambles (*Rubus fruticosus*) and common ivy (*Hedera helix*), and dense shrubbery of mainly blackthorn (*Prunus spinosa*), whitethorn or hawthorn (*Crataegus monogyna*), holly (*Ilex aquifolium*), ivy, and hazel (*Corylus avellana*) along with ash (*Fraxinus excelsior*) trees. Flanked by a roadside hedgerow obscuring a dry-stone wall, there are occasional areas open to the sun, intimate and sheltered from wind. The area has not been grazed for some years and the path to access my covers requires regular pruning.

Quakerstown is open, flat, windswept limestone pavement with some low, stunted scrub, sparse grass and ground foliage which is regularly grazed by cattle. There are occasional bushed areas, mainly whitethorn often swathed in brambles. The main structure available are dry stone walls ivy covered and vegetated at the base. Loose, flat limestone rocks abound creating limitless natural refugia for slow worms.

Both sites contain similar cover numbers and material types. It is peculiar that initially in the year the encounters in an open, cool windswept Quakerstown far outnumber those in the sheltered, highly vegetated Cappacasheen. In June and July, the encounters for both sites were comparable but during August and September Cappacasheen exceeded those of Quakerstown considerably. Subsequently, in October, a complete reversal of numbers of sightings is recorded. The final annual totals are not dissimilar.

Q. Mar 4. Apr 36. May 28. June 23. July 29. Aug 35. Sept 17. Oct 33

C. Mar 2. Apr 18. May 18. June 23. July 29. Aug 65. Sept 25. Oct 12

Discussion

After eight years of surveying the Burren slow worm colony, some thousands of data have been accumulated with the major goal to make some reasonable sense of the lifestyle and movement of slow worms. Their commonly used descriptive adjectives, enigmatic and cryptic are appropriate. There appear to be three categories of encounters, those regular inhabitants of a particular refugia often over years but also females during a summer, occasional inhabitants with perhaps a year or longer in between attendance, and those occasional visitors. The behaviour of slow worms is impossible to predict or comprehend and while each year brings more fascination, 2023 ranked highly with occasions of inexplicable behaviour. The finding of six slow worms, all adult, under a single cover was even more unusual as over a three-year period there were often none to be found, infrequently a single individual and rarely there maybe two. Gonzalo *et al.* (2004) states that *Anguis* being semi fossorial and spending much time subsurface or in dense undergrowth, use scent to locate prey and other slow worms. Having seen several gravid females together before during August and while these were healthy specimens (see plate 1), the females were not obviously gravid as one would expect in mid-August. Is it scent that for some reason impelled the hexad to assemble, and for what purpose? Were they a group or an aggregation?

Occasionally what appeared to be random behaviour has occurred. A site containing three covers in 2020 produced 31 encounters. That site produced 15 encounters in 2021. The same site with an added cover produced 18 encounters in 2022, but in 2023 with yet a further cover added, it was not until trip 46 on 29 June before the first encounter. No further encounters were made until 14 August when until 31 August eleven slow worms were found. There were no further sightings thereafter. In addition to the curiously brief appearance period the general attendance figures over the years hint at a decreasing population. Or was it disturbance? At JCs two identical corrugated bitumen mats are positioned up against a dry-stone wall. They face the same direction, are in the same vegetation, their cover surface temperatures vary by one degree at most and are 25 metres apart. Over three years JCL has produced 35 encounters, JCR just 4.

After a poor return of encounters during September 2023, on 1 October with sun and passing cloud and a temperature of 16°C rising to 17°C, I checked my circuit from mid-day until 13.30hrs. The result was just two covers inhabited, one with a single, the other with two. A partial re-run three hours later of fifteen covers produced a further six encounters including the single still present from the first trip. Five further slow worms had emerged in the interim period from covers that were initially vacant. With the air temperature up by one degree the surface differences of the newly inhabited covers were, with single occupancy, up 2°C from 21°C, up 5°C from 21°C and exact same at 22°C. A cover now with two inhabitants had

decreased by 8°C to 20°C from the initial circuit. The movement of the sun had affected the cover temperatures as those covers in shade/semi-shade became open and those that had been open to the sun become less so. From initially recording three slow worms I was able to record eight for the day. This raised the question of why two slow worms had appeared under a cover that had dropped in temperature so radically?

When I first noticed from data collected over many years that cloud cover may have a positive effect on slow worm numbers encountered under refugia, I assumed it was because of some element within those conditions, that it may be humidity levels or perhaps barometric pressure. I used the Okta system of cloud levels (Anon., 2023c) as did Raye (2021) although he appeared unconvinced commenting, “Since cloud cover does not seem to affect slow worms much, could a different weather variable be monitored?”

Comparing productive days with average results I have concluded that the reason is far simpler than any meteorological or other possible cause. The covers were roughly positioned but they would all receive at least some direct solar rays during the day, which could either enable or disable their suitability for habitation. At any one time some covers may be too hot while others are too cool so only a limited number of covers would be at an acceptable temperature. This situation changes with heavy cloud cover. The dense low cloud limiting direct rays hitting the ground is, in effect, causing all covers to be shaded whatever their position. Should the air temperature be sufficiently warm i.e 18°C or more then the covers are affected by convection rather than direct radiation. Consequently, rather than direct sunshine affecting some covers but not all which would cause a temperature range of too cold to too warm, the entire cover range then become low to mid-twenties, a perfect temperature for habitation. If the air temperature is low, no amount of cloud will be effective.

What impels an ectotherm into and out of hibernation is broadly assumed to be temperature influenced, but that is debatable. Beebee and Griffiths (2000) note that emergence from hibernation usually occurs in March in (southern England) but may be later in the north. Speybroeck *et al.* (2016) state that active between March and October in most of range, but this may be considerably shorter in N of range and longer in S. That slow worms are temperature driven does not accord with my data in the four-year chart (Fig. 2) showing the five days prior to emergence (my first sighting) each year and the five days prior to assumed hibernation (my last sighting) during those years. The air temperatures do not imply the need for immediate action. Perhaps it is the instinctual nature of their body clock or rhythm that they are impelled by rather than external factors such as meteorological, thermal or another possible factor. The Mean 10cm Soil Temperature data for September and October 2023 (Met Eireann, 2023) make interesting reading, the drop in soil temperature being steadier than the corresponding fluctuating air temperature and may affect a semi-fossorial animal. Presumably they hibernate

before it gets too cold, while there is still sufficient food available.

Most Citizen Science slow worm sighting in Ireland reported to the National Biodiversity Data Centre (2023) emanate from the Burren National Park where access is freely available. The major portion of the Burren remains unexplored as much of the land is privately owned and inaccessible to ramblers. According to Burrenbeo Trust (2023), the Burren stretches across roughly 560 km² of north Clare and south Galway. Of which, according to National Parks of Ireland (2023), the Burren National Park covers 1800 hectares (18km²).

Sightings reported from outside the National Park are often on public roadways, green roads or other tourist walks. The increase in reported sightings is due to a greater public interest and awareness of the animal coupled with the simplicity of reporting with personal technology *via* the National Biodiversity Data Centre app. Should a planned programme be implemented across the entirety of the Burren a greater area of occupancy would undoubtedly be revealed. During my study period conducted with an amateur though enthusiastic approach I met slow worms in seventeen townlands in both Clare and Galway for a total number of 2349 encounters and each one was as thrilling as the first.

Slowly but surely as slow worms gain publicity and interest, increased numbers will be recorded across the country. I am convinced that they are far more widespread than is currently known but then they are as enigmatic as they are cryptic. It is unfortunate that the slow worm in Ireland is largely ignored when the presence of these fascinating and beautiful animals should be cherished.

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TABLE 1. The temperature was noted for each of the five days prior to the first sighting of the year and the five days prior to the final sighting and presumed hibernation of each year. Some data used from Timeanddate (2023)

First sighting - previous 5 days high/low °C	
2020 15 March	12/6, 10/3, 9/3, 9/5, 13/6.
2021 16 March	13/8, 10/4, 9/4, 8/3, 11/6.
2022 19 March	11/4, 10/3, 11/0, 13/4, 16/4.
2023 16 March	12/3, 9/1, 13/8, 13/7, 12/1.
Final sighting - previous 5 days high/low °C	
2020 18 October	13/9, 14/5, 13/3, 13/4, 13/7.
2021 22 October	17/14, 19/15, 19/11, 13/9, 12/5.
2022 15 September	Illness prevented further checks.
2023 24 October	11/7, 12/8, 14/6, 12/11, 12/8.



PLATE 1. Six slow worms under the same cover, Derreenatloghtan townland, County Clare, 17 August 2023. Photograph: Nicholas Parry.

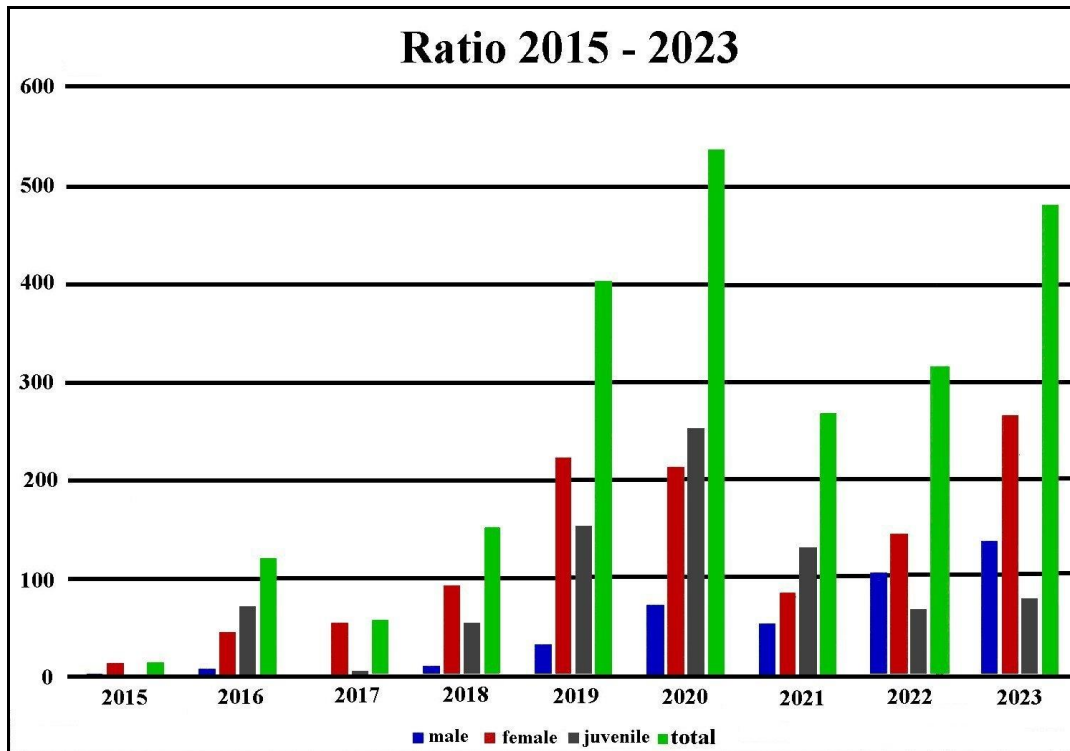


FIGURE 1. Gender and age ratios 2015 – 2023.

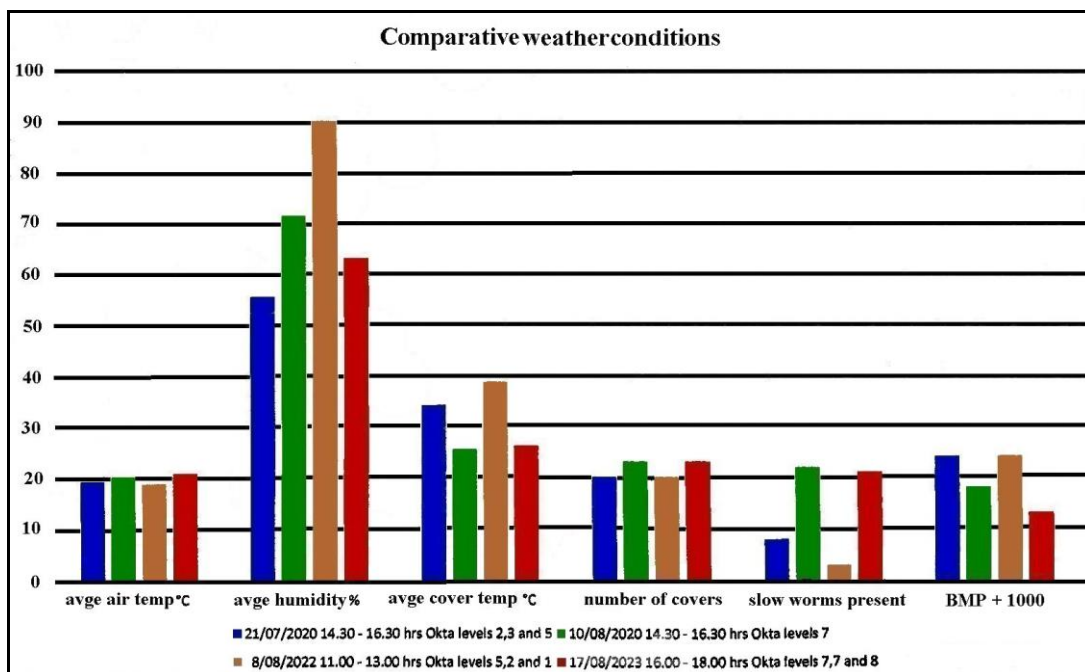


FIGURE 2. Comparative weather conditions.

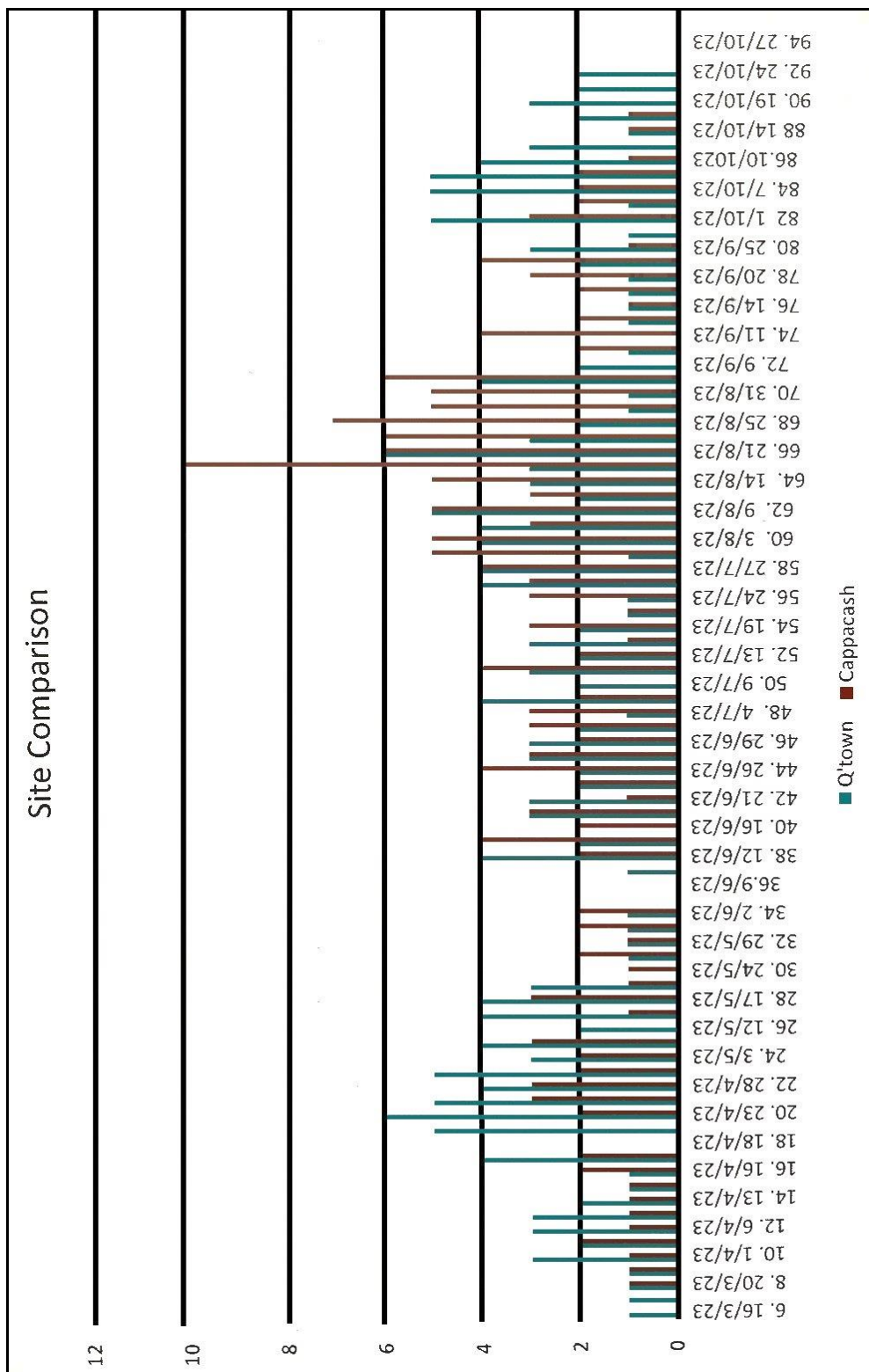


FIGURE 3. Comparison of the number of slow worms in Cappacash, County Galway and Quakerstown, County Clare, respectively.