

The Natural History of Read's Cave.

BY G. A. WALTON, M.B., CH.B., F.R.E.S.

Read's Cave, or Keltic Cavern, lies in the Northern foothills of Blackdown, near Burrington, on the junction line of the limestone shales and the massive limestone.

It was first entered by members of the Society in September, 1919, after the excavation of over twenty tons of rubble which blocked the entrance. This lies at the base of a small cliff, in an excavation about 10 ft. deep, and faces South; it is quite small, about 1 ft. 6 in. square. The stream runs off the peaty surface of Blackdown in a well marked valley, and disappears in a swallet about 20 yards from the foot of the cliff.

An irregular rift passes inwards and downwards from the entrance at an angle of 60° to a depth of 45 ft. and is choked on either side to form a passage, which leads into the Main Chamber. This is 175 ft. long, and has an average height of 27 ft. and an average width of 33 ft. The walls and rocks are in many places covered by a layer of stalagmite deposit, and several passages are found leading out of the chamber.

The most important of these begins opposite the entrance to the Main Chamber, and leads, through a hole in floor, a distance of 47 ft. to a squeeze, known as Zed Alley. Beyond this point the character of the cave changes abruptly, and the way on lies through a maze of boulders past a waterfall to a depth of 200 ft.

The rocks are everywhere wet, and much eroded, displaying a jagged array of fossils, such as *Zaphrentis*, *Syringothyris*, *Michelinia*, and *Spirifera*.

At the far end of the cavern, the Western end, small passages lead down to a fair sized cavity called the Boulder Chamber, and a small series of stalagmite passages and chambers leads back up toward the surface from the Eastern end of the Main Chamber.

The sketch-map (*Fig. 8*) is drawn from the actual survey, and indicates the points enumerated above; excavations make it clear that the original entrance was gained lower down than at present, and led by way of a gentle descent to a chamber of greater dimensions than the one we now know.

Large numbers of bones, iron implements, and some pottery were excavated from the floor of the cavern when it was first entered. The material was found mostly mixed within a stratum of black mud, 1 to

8 in. thick, and covered over by a layer of stalagmite $\frac{1}{4}$ to 1 in. thick; the extent of this black layer showed that fires were scattered all over the floor.

These remains indicate that Read's Cave was once inhabited by people known as Brythons, of late Keltic culture, who were retreating Westwards and Northwards before the invading Belgæ, somewhere

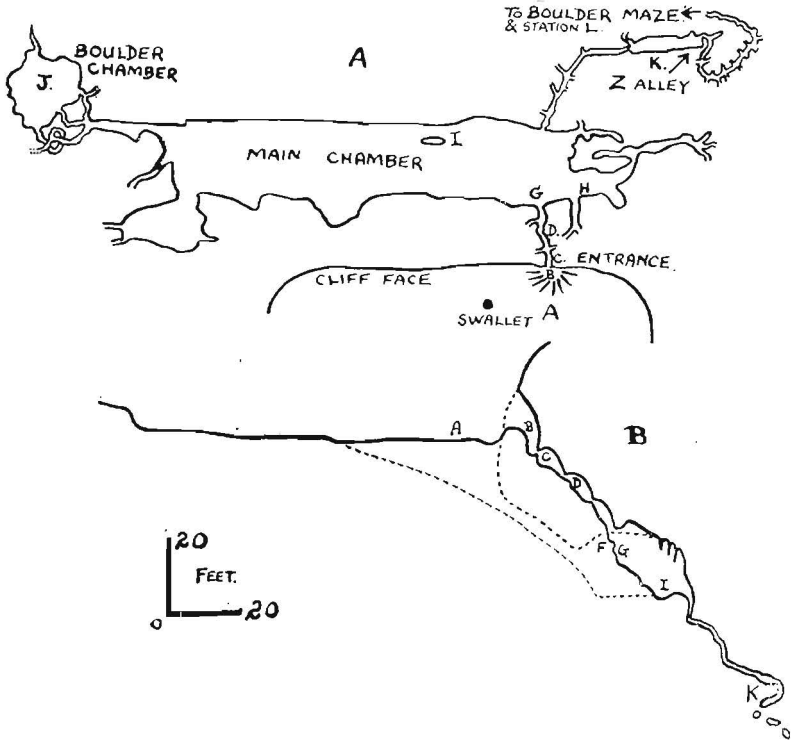


FIG. 8.—Plan (A) and Elevation (B) of Read's Cave, showing the location of the stations A-K. The dotted section in B represents the original outline of the Cave. Survey by U.B.S.S.

between 50 B.C. and 50 A.D. It is estimated that the roof of the cavern fell in and sealed the entrance some time after 500 A.D., and presumably the cave had not been entered by any animal bigger than a rabbit since that time, until the cave was opened up by the Society.

The significance of these facts is that, although we do not know what the fauna of the cave was like at the time when the entrance became sealed, we do know that it contained a large amount of decayed organic matter, and since the re-opening in 1919, has been open to

invasion by various animals, and to contamination by parties of cave explorers, leaving behind candle grease, and numerous foreign organisms, both from the ground outside and conveyed on their boots and clothes from other caves.

Having described the general topography of the cave, I will now briefly indicate the position of the stations at which observations were made each time the cave was descended. Each station is given a reference letter (*Fig. 8*), by means of which the site of collection of the animals listed on p. 130 may be identified.

For comparison with the fauna of the cave itself a collection was made of the collembola from various places within 25 yards of the cave entrance, from beneath stones and from the sides of the stream where it disappears into the swallet (Station A).

Station B is in the depression about 10 ft. deep outside the cave entrance. The floor of the hole is composed of dry crumbling earth, scanty green algæ, and fallen leaves from surrounding vegetation and the cliff above.

The humidity at all stations was measured by means of an unstandardised atmometer, and the light intensity with the aid of a selenium photoelectric cell, on a bright summer day. At the lip of the depression the humidity was 0.15 of the saturation value inside the cave at 48° F.; in the bottom of the depression it was 0.5 of that value. The light intensity in the depression, facing South, was 500 ft. candles, and the temperature 65° F.

Immediately inside the entrance there is just enough room to stand upright, on a steep slope of moist clay, which becomes dry at the sides. The rock roof is covered in places by lichens and green algæ. Light intensity 14 ft. candles. Temperature 55° F., and humidity 0.65 of the saturation value of the Main Chamber. This is Station C.

At a distance of 14 ft. from the entrance and at a depth of 9 ft. Station D is situated, round a corner of rock where the floor is composed of dry earth and the roof of irregular rocks. The light intensity is reduced to 1 ft. candle and the temperature reading 52.7° F.; humidity as at Station C. At this point the algæ and lichens are replaced by moulds, chiefly *Penicillium*.

Six feet from Station D, and somewhat deeper there is a damp patch of earth caused by a permanent drip from the roof, which here comes down to within 1 ft. 6 in. of the floor. A colony of springtails gathered round a concentration of moulds is the most obvious feature of Station E.

At a depth of 23 ft. from the cave entrance there is a collection of steep rocks covered with damp clay and small patches of mould. This

is Station F, and is at the entrance to the Main Chamber, where at a temperature of 50° F. the atmosphere is saturated.

Station G is inside the main chamber at a depth of 30 ft., and 30 ft. from the entrance. It consists of damp boulders covered with candle droppings, often overgrown with moulds.

Station H is a discarded shirt, situated in a narrow rift 33 ft. from the cave entrance; it contained a rich fauna of collembola.

Station I is a small permanent pool, roughly 3 ft. by 1 ft., in the centre of the clay floor of the Main Chamber.

Atmospheric conditions in the Main Chamber are uniform—the temperature being 48° F., and the air saturated with water vapour, as it is, in fact, throughout the remainder of the cave system from here onwards.

The Boulder Chamber, in which lies Station J, is 200 ft. from the entrance, and about 50 ft. below the surface. Its floor consists of large rocks covered with moist cave mud and extensive areas of mould.

Station K is a small grotto just before Zed Alley, about 100 ft. from the entrance and 70 ft. down. At this station all the rocks are wet, and every hollow filled with water. Moulds are much less evident here than in the Main Chamber, and *Pilobelas* is most frequently encountered.

Station L is in the Boulder Maze a further 70 ft. below Zed Alley; the rocks are very jagged and wet, and animal life is scarce. Below this level the only living creatures seen were occasional Collembola (*Isotoma Bipunctata*) and occasional patches of mould.

LIST OF CAVE FAUNA.

<i>Species</i>	<i>Station</i>
ARTHROPODA.—	
Crustacea.—	
ISOPODA.—	
Oniscus Murarius	E
Myriapoda.—	
DIPLOPODA.—	
Brachydesmus superus mosellanus (Verhoeff)	F, G, I, J
Glomeris perplexa var. marginata (Latzel)	E
Insecta.—	
COLLEMBOLA.—	
PODUROIDEA.—	
Hypogastrura armata (Nic.)	A
Hypogastrura octoculata (Wom.)	L, B, F, G, H, I, J, K
Anurida granaria (Nic.)	E, F, G, H, I
Onychiurus fimetarius (L.)	A, F, G, H, I, J, K
Onychiurus armatus (Tullb.)	A
Onychiurus ambulans (L.)	G, I
Falsomia quodrioculata (Tullb.)	A
Falsomia fimetaria (L.)	A

ENTOMOBROIDEA.—				
Isotoma bipunctata (Axels)	-	-	-	H, J, K, L
Isotoma notabilis (Schäff)	-	-	-	A
Isotoma minor (Schäff)	-	-	-	A, H
Isotomurus palustris (Müll.)	-	-	-	A
Heteromurus nitidus (Templ.)	-	-	-	D, E, F, G, H, J
Entomobrya nivalis (L.) maculata (Schäff)	-	-	-	B
Orchesella cincta (L.)	-	-	-	B
Tomocerus minor (Lubb.)	-	-	-	K, B, C, D, E, F
Tomocerus (Pogognathus) longicornis (Müll.)	-	-	-	E
Lepidocyrtus lanuginosus (Gunal)	-	-	-	A
Lepidocyrtus cyaneus (Tullb.)	-	-	-	B, C, F, H
Lepidocyrtus curvicolis (Bourl.)	-	-	-	B, C, E, F, H
SYMPHYOPLEONA.—				
Megalothorax minimus	-	-	-	K, L
Arrhopalites pygmaeus (Wank)	-	-	-	H, I, K, L
COLEOPTERA.—				
CRYPTOPHAGIDÆ.—				
Cryptophagus distinguendus (Sta.)	-	-	-	D
SILPHIDÆ.—				
Catops chrysomeloides	-	-	-	I
STAPHYLINIDÆ.—				
Quedius mesomelinus (Marsh.)	-	-	-	D
Lestera longelytrata (Gz.)	-	-	-	D
Lestera pubescens (Mann.)	-	-	-	L
Proteinus brachypterum (Fab.)	-	-	-	D
LEPTINIDÆ.—				
Leptinus testaceus (Müll.)	-	-	-	D, E
CLAMBIDÆ.—				
Clambus pubescens Redt.	-	-	-	D
DIPTERA.—				
TIPULIDÆ.—				
Trichocera annulata (Mg.)	-	-	-	G
Limonia nubeculosa (Mg.)	-	-	-	C
CULICIDÆ.—				
Culex pipiens (L.)	-	-	-	C, E, G
Theobaldia annulata (Mg.)	-	-	-	C, E
MYCETOPHILIDÆ.—				
Rhymosia fasciata (Mg.)	-	-	-	C, E
Sciara (sp.)	-	-	-	G, I
Exechia (sp.)	-	-	-	C, E
SPHÆROCERIDÆ.—				
Leptocera silvatica (Mg.)	-	-	-	D
Leptocera palmata (Richards)	-	-	-	D
MUSCIDÆ.—				
Calliphora erythrocephala (Mg.)	-	-	-	G, J
NYCTERIBIDÆ.—				
Nycteribia (Celeripes) biarticulata (Hermann)	-	-	-	On Bats
LEPIDOPTERA.—				
Triphosa dubitata (L.)	-	-	-	C
SIPHONAPTERA.—				
Dasypsyllus gallinulæ (Dale)	-	-	-	C
Arachnida.—				
PSEUDOSCORPIONIDA.—				
Chthonius rayii (L. Koch)	-	-	-	C

ARANEIDA.—					
Meta merianæ (Scopoli)	-	-	-	C, D	
Meta menardi (Latreilla)	-	-	-	C, D	
ACARINA.—					
Veigaia sp. (Protonymph)	-	-	-	C	
Eugamasus oudemansi (Berlese)	-	-	-	C	
Eugamasus magnus (forma typica) (Kramer)	-	-	-		
PHALANGIDA.—					
Nemastoma chrysomelas (Hern)	-	-	-	G	
MOLLUSCA.—					
Gastropoda.—					
Oxychilus cellarius (Müller)	-	-	-	G, and Main Chamber	
Helix aspersa (Müller)	-	-	-	G	
CHORDATA.—					
Vertebrata.—					
EUTHERIA.—					
Rhinolophus hipposideros minutus	-	-	-	D, K, & Main Chamber	
Rhinolophus ferrum-equinum insularis	-	-	-	K, and Main Chamber	

By far the most obvious element of the cave fauna were the Collembola (Springtails), in some places they were to be found in incredible numbers. The first interesting observation concerns the effect upon them of the small entrance of the cave. From the list it will be seen that nine species which are found quite close to the entrance have never been met with inside the cavern, while six species found inside the cave have never been found outside. One of the species, *Falsomia fimetaria*, found only outside Read's Cavern was noted at Treack Cliff Cavern in Derbyshire by J. M. Brown, and was collected by Lieut.-Colonel E. A. Glennie. *Hypogastrura octoculata* is distributed through the cavern from the entrance right down to the deeper passages but becomes scarce where the cave shows erosion and is permanently covered by a film of water.

Onychiurus fimetarius is found in the soil outside the cave and again in the Main Chamber; it also extends for some distance only down the various side passages. Thus it abounds where the atmosphere is saturated with water vapour, but, in the deeper parts, where condensation is taking place, its numbers rapidly drop off. *Lepidocyrtus curvicolis* and *Lepidocyrtus cyaneus*, pigmented forms possessing eyes, occur in about equal numbers in the depression at the entrance to the cave.

However, immediately the cave was entered many more *Lepidocyrtus curvicolis* were found than *Lepidocyrtus cyaneus*, as may be seen from the accompanying histogram (Fig. 9), based on actual counts of the springtails at various stations, and showing clearly the distribution of the various species throughout the cave.

The first true cavernicolous species to be met with is the white *Heteromurus nitidus*. This is an active species possessing eyes, and somewhat resembling *Lepidocyrtus*.

It makes its first appearance at Station D, where there is just a glimmer of light on a bright day, and its numbers gradually increase

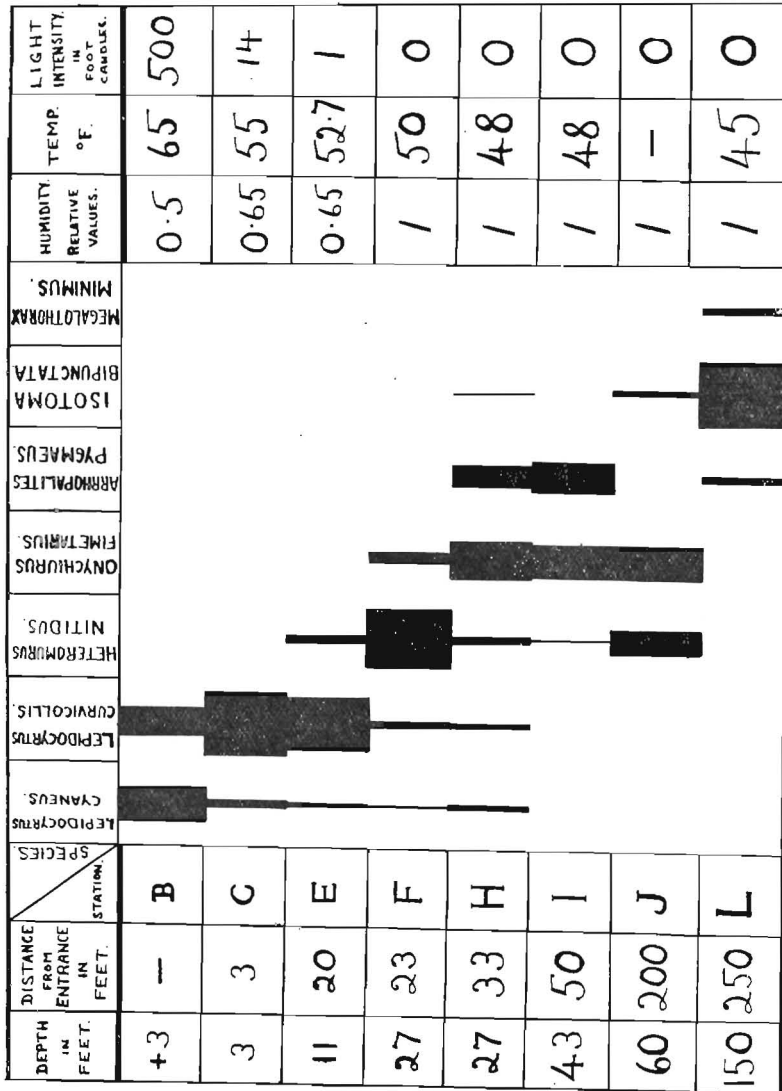


FIG. 9.—Histogram showing the frequency of the species of collembola in Read's Cave in relation to each other and to the environmental factors present.

until at Station F it is the dominant species. It then decreases in number in inverse ratio to the numbers of the blind, white, *Onychiurus fimetarius*, until in the Boulder Chamber the incidence of the two species is about the same. *H. nitidus* has never been found in the wet passages below Zed Alley, where its place is taken by *Isotoma bipunctata*.

Onychiurus fimetarius is a common species of springtail living in soil, under stones and logs, etc., and has been incriminated as responsible for devouring the root hairs of plants.

In Read's Cave this springtail lives in great numbers on the surface of the mud, where the only forms of food available are moulds (Mycophagia) and Bacteria.

Experiments were carried out in the laboratory upon some of the commoner species in the cave. Pure cultures of the moulds growing in the cave were produced in the Department of Botany at Bristol University, and to these were added series of *Onychiurus fimetarius* and *Heteromurus nitidus* and some *Tomocerus minor*.

Examination of the gut contents of *Onychiurus fimetarius* and *Heteromurus nitidus* showed the presence of the brown spores of *Stemphylium botryosum* together with hyphal segments of the same colour and numbers of hyaline spores which appeared to be chiefly of *Penicillia* Spp. *Stemphylium* was difficult to find in the cave because it appears to be eaten down by the innumerable springtails, but flat brownish colonies could be found by careful examination of the mud.

In the laboratory cultures of *Stemphylium* and *Penicillium* containing springtails were kept at room temperature and at 42° F. and these showed that, when compared with control cultures, without springtails, both the hyphæ and the conidia of the moulds were eaten. *H. nitidus* appeared to show a preference for the hyphæ, and *O. fimetarius* for the conidia.

After two months at room-temperature, keeping the two petri dishes under a duster to produce a dim light all the *O. fimetarius* in the culture had died, but some of the *H. nitidus* were still alive, and numerous young specimens were present.

Of the cultures kept at 42° F. inside a refrigerator (a temperature 3° F. below the coldest temperature recorded in the cave) it was found that after three months there was a 30 per cent death rate amongst *H. nitidus* specimens, and of 50 *O. fimetarius* originally present 20 were still alive, although no breeding had taken place. A few *H. octoculata* survived three months at 42° F. An agar plate exposed in the Boulder Maze below Station K for fourteen months had a sparse growth of *Pilobelas* and a number of *Isotoma bipunctata* present on it when examined. It was transferred to the refrigerator on September 9th, 1940, and kept at 42° F. for eight months until April 10th, 1941, when it was found that the *Pilobelas* was still growing and 6 specimens of *Isotoma bipunctata* were observed alive. *Tomocerus minor* lived for over six months at 42° F. and ate large holes in the colonies of mould.

Perhaps the most interesting discovery in the cave was the springtail *Arrhopalites pygmaeus*. As reported by Mr. J. M. Brown, this specimen was previously unknown to Britain. First noted on the surface of the pool (Station I) it was later found to live in wet places over most of the floor of the Main Chamber, on a wet side passage leading from the Boulder Chamber, and in wet places near Zed Alley (Station K). The minute springtail *Megalothorax minimus* lives in small numbers on the surface of small pools in the rocks beyond Zed Alley where they show signs of active erosion.

An *Oligochaete* was to be found all over the cave, even at extreme depths, often, owing to the high humidity, crawling about freely over the damp clay. Specimens collected were, however, too immature to be identified.

The Isopod *Oniscus Murarius* only occurs near the entrance of the cave, rarely at a depth of more than 20 ft., which also applies to the Pill Mellipede *Glomeris*.

The other Diplopod, *Brachydesmus*, has very much the same distribution as the springtail *Onychiurus fimetarius*; both are sluggish white creatures found only in the complete absence of light where the conditions of humidity are exactly to their liking.

The Phalangid was found just inside the cave, within 10 ft. of the entrance.

None of the beetles are true cavernicolous forms and all are rather scarce. Larvæ of *Quedius* were found in the Main Chamber, and *Lestera pubescens* was found right down in the Boulder Maze where conditions are almost aquatic.

Of the Diptera evidence is only forthcoming that *Sciara* and *Nycteribia* actually breed in the cave. Larvæ of *Sciara* were found in small excavations made in the clay beneath bits of candle wax, which had been attacked by a mould.

Cultures were made, and a white monovorticillate *Penicillium* was isolated, which grew successfully on paraffin wax in the laboratory and which was readily eaten by the Collembola. Associated with these lumps of candle wax one therefore finds a growth of mould, and beneath it live numerous examples of the springtails *Hypogastrura octoculata* and *Onychiurus fimetarius* as well as larvæ of *Sciara* (proved by breeding out the flies) and occasionally larvæ of the Staphylinid beetle *Quedius*.

The Tipulid *Limonia nubeculosa*, the Mycetophilids *Rhymosia* and *Exechia*, the *Leptocera* and the mosquitoes obviously hibernate in considerable numbers in the upper part of the cave. It is possible that the mosquitoes feed upon the bats. The small "Daddy long legs" *Trichocera* was found deep down in the passages below Zed Alley, and

may breed in the cave. The extraordinary fly *Nycteriba* lives in the fur of the bats, and was found both on the Greater and Lesser Horse-shoe Bats.

Triphosa dubitata is a medium sized moth which lives on the wall and roof of the cave within about 20 ft. of the entrance. No bird has ever been seen in the cave so that it is difficult to account for the presence of large numbers of the bird flea *Dasyptyllus gallinulae*, found on the floor of the cave facing the light coming through the small square entrance.

The large spiders of the genus *Meta* spin their webs in the small passages close to the entrance to the cave, but are never found in the deeper parts. Mites are found throughout the cave system, running about amongst the springtails on the floor; occasional examples are met with below Zed Alley. The Harvest Man *Nemastoma*, although not a true cavi-colous form, is found in the Main Chamber.

Bats appear to live and feed in the cave, and can often be seen flying about in the Main Chamber, where the wings of *Triphosa* clearly indicate their source of food. Bluebottles, *Calliphora*, are occasionally met with in such remote places as the Boulder Chamber.

The temperature of the cave varies little with the seasons of the year, and the amount of water present does not follow the seasons. There is a considerable time-lag before conditions underground simulate those occurring outside the cave; thus the cave is wettest in the spring and driest in the autumn and early winter.

As the cave slowly dries, the moulds, and consequently the spring-tails, move further into the cave, and so it is that we find a species such as *Heteromurus nitidus*, normally occurring in large numbers at Station D, migrating in a dry phase to Station F, and under these conditions the zonation of the springtails becomes less obvious.

CONCLUSIONS

The fauna of a Mendip Cave has been thoroughly investigated, and a marked difference between this and a continental cave has been demonstrated by showing the complete absence of any truly cavernicolous elements.

The fauna consists of those animals found commonly living in soil, under stones, and beneath the bark of trees.

One species, *Arrhopalites pygmaeus*, was found to be new to Britain, and the zonation of the Collembola in the cave illustrated.

It was proved that the Collembola eat the moulds *Stemphylium* and *Penicillium*, devouring both the hyphal elements and conidia. Cultures of springtails were kept in a healthy condition for three months

on a diet of pure mould growing on a low nutrient agar medium. *Isotoma bipunctata* lived for eight months at a temperature of 42° F. on a culture of *Pilobelas*.

Lastly, an undetermined white monoverticillate *Pencillium* was discovered which could be grown successfully on paraffin wax, and which was readily eaten by the Collembola.

ACKNOWLEDGEMENTS

To all the authorities who so kindly identified the animals found in the cave I wish to express my most sincere thanks: To Mr. J. M. Brown for identifying over three hundred Collembola, Dr. A. H. Campbell for providing mycological apparatus and accommodation at Bristol University, and for identifying the *Stemphylium*, to Mr. Cox, of the British Museum, for naming the fleas; Mr. S. Gordon Smith, for naming the moth; Dr. Hugh Scott for examining the Nycteribiidae; and Dr. O. W. Richards for naming the flies. To Dr. K. G. Blair, for naming the beetles; Miss W. M. Kendall for identifying the Acarina; Dr. Graham Brade-Birks, for examining the Diplopoda; and Dr. A. R. Jackson, for naming the false scorpion and the Phalangid. To Mr. Bassindale, Miss P. M. Jenkin, and Dr. Gorvett, of the staff of Bristol University, for help in naming the Isopod, the Molluscs, and the Spiders, and for reference to cave fauna on the continent. Thanks are due also to Mr. M. A. C. Hinton, of the Natural History Museum, for naming the spiders; and to Mr. R. Winckworth and Mr. A. E. Ellis for naming the Molluscs.

Also I would like to express my gratitude for the help in collecting given by members of the Bristol University Spelæological Society, namely, Dr. F. J. Goddard, Dr. A. F. Rogers, who first drew attention to the presence of the Collembola, and R. A. J. Pearce, who also edited the paper and constructed the histogram.

REFERENCES

- University of Bristol Spelæological Society *Proceedings*, Vol. I, No. 1, pp. 9-20; No. 2, pp. 87-89; No. 3, pp. 135-143; Vol. II, No. 1, pp. 51, 55, 59; No. 2, pp. 125-127.
- Brown, J. M., "Collembola from Some Derbyshire Caverns," *Naturalist*, 1938, p. 306.
- Brown, J. M., "*Arrhopalites pygmaeus* (Wank) (Collembola-Sminthuridae) New to Britain," from the *Entomologists' Monthly Magazine*," Vol. LXXVIII, 1942, p. 135.
- Carpenter, George H., "The Collembola of Michelstown Cave," *Lisburn Naturalist's Journal*, Vol. VI, 1897, pp. 225-231.
- Womersley, H., "The Collembola of Ireland," *Proceedings Royal Irish Academy*, No. 39 (B11), 1930, pp. 160-202.