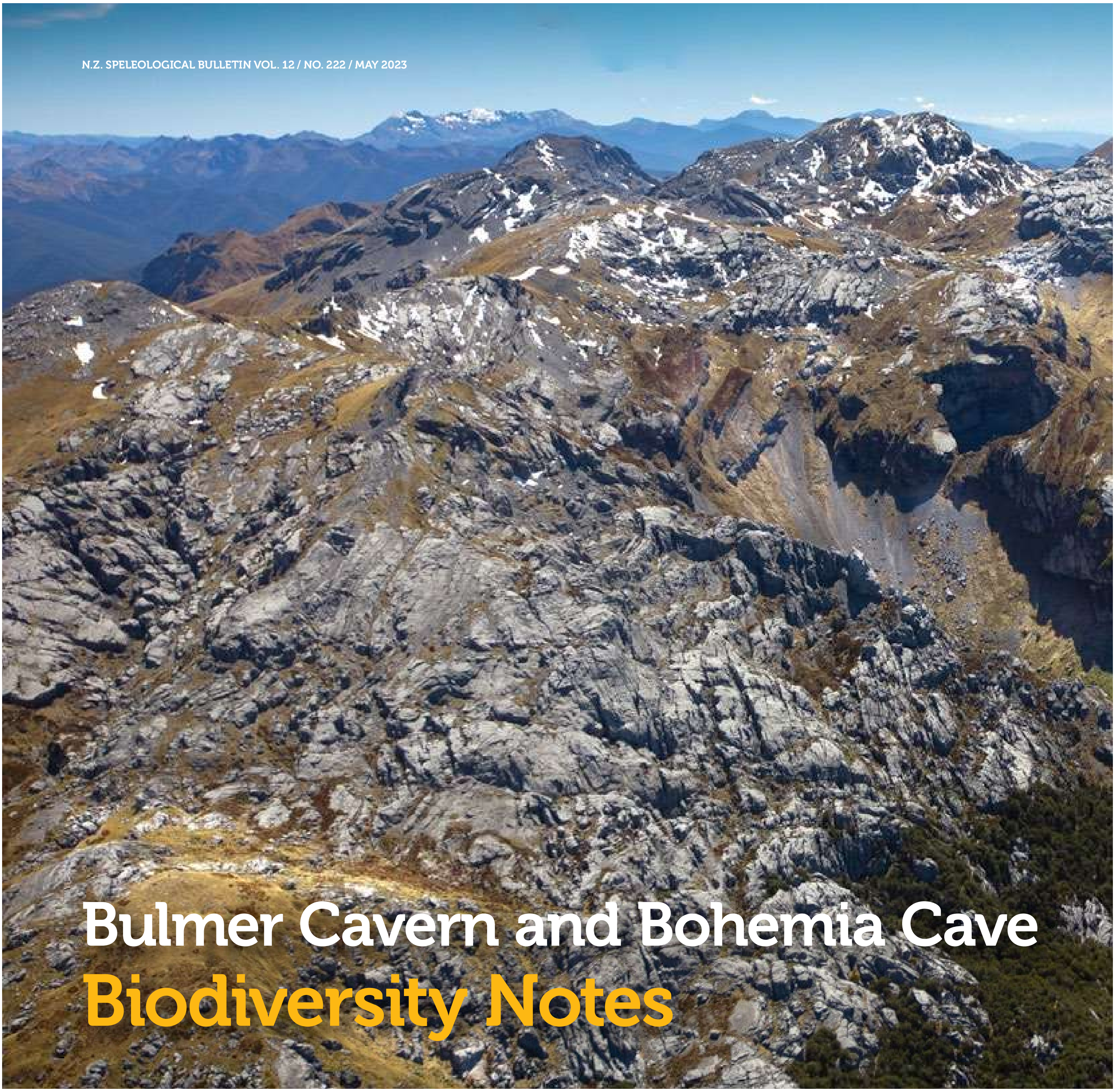


Bulmer Cavern and Bohemia Cave
Biodiversity Notes

By Anna Stewart

https://adventure360.co.nz/underground

Karst landscapes can be found worldwide with varying degrees of protection and conservation (Gillieson 2022). These landscapes include within them subterranean biodiversity systems. These ecosystems are home to a variety of different groups of species at different stages of adaptation to underground environments. Generally, they are stable long-term environments for their inhabitants, compared to shorter term surface systems such as forests, rivers and wetlands. These systems are poorly understood, making it difficult to give good information to landowners, councils, and government departments on methods for conservation and protection.

As a repository of our country's biohistory, they need careful management and conservation. Recording cave life gives a snapshot of New Zealand's unique subterrain biodiversity.

Introduction

The Mt Owen glaciated karst area, situated in Kahurangi National Park, New Zealand, is home to some of the oldest and longest caves in New Zealand. In summer the temperatures can range from -1 to 30 degrees. And in winter can drop as low as -10 degrees.

The Mt. Owen massif is a block of alpine marble that sits between two faults and has a total area of approximately 77km^2, of which approximately 35km^2 is above the present-day treeline.

The South Owen karst field looking towards the north. Bohemia Cave lies under the marble in the left foreground. Bulmer Cavern runs beneath the karst field on the righthand side of the page. Photo : Marcus Thomas

It is bounded to the south by the Owen and Fyfe rivers, which are tributaries of the Buller River, and to the north by Nuggety and Granity creeks, which are tributaries of the Wangapeka River. The highest point of the massif is Mt. Owen. Sediment burial dating indicates that there were well-developed cave systems by the mid-Pliocene (approximately 2.8 million years ago), and the oldest passages may have started forming in the latest Miocene (approximately 5 million years ago) (Holden, 2019).

Te Ana O Ngakea was discovered and explored on the 2022 expedition. Its only known entrance is located above the treeline at the base of a bluff above the head of Bulmer Lake. It has a surveyed length of 762m and a depth of 168m, and is expected to connect to the top end of Bohemia Cave (Holden & McKay, 2022 pers. comm) *(Note: this has now been connected over the Annual Summer expedition 2023 – ed).* A small bird fossil was recorded from the new cave. Previously moa skeletons have been found in Bulmer, (Cooper 1992).

> ***"The highest point of the massif is Mt. Owen. Sediment burial dating indicates that there were well developed cave systems by the mid-Pliocene (approximately 2.8 million years ago)...***

Biodiversity Notes

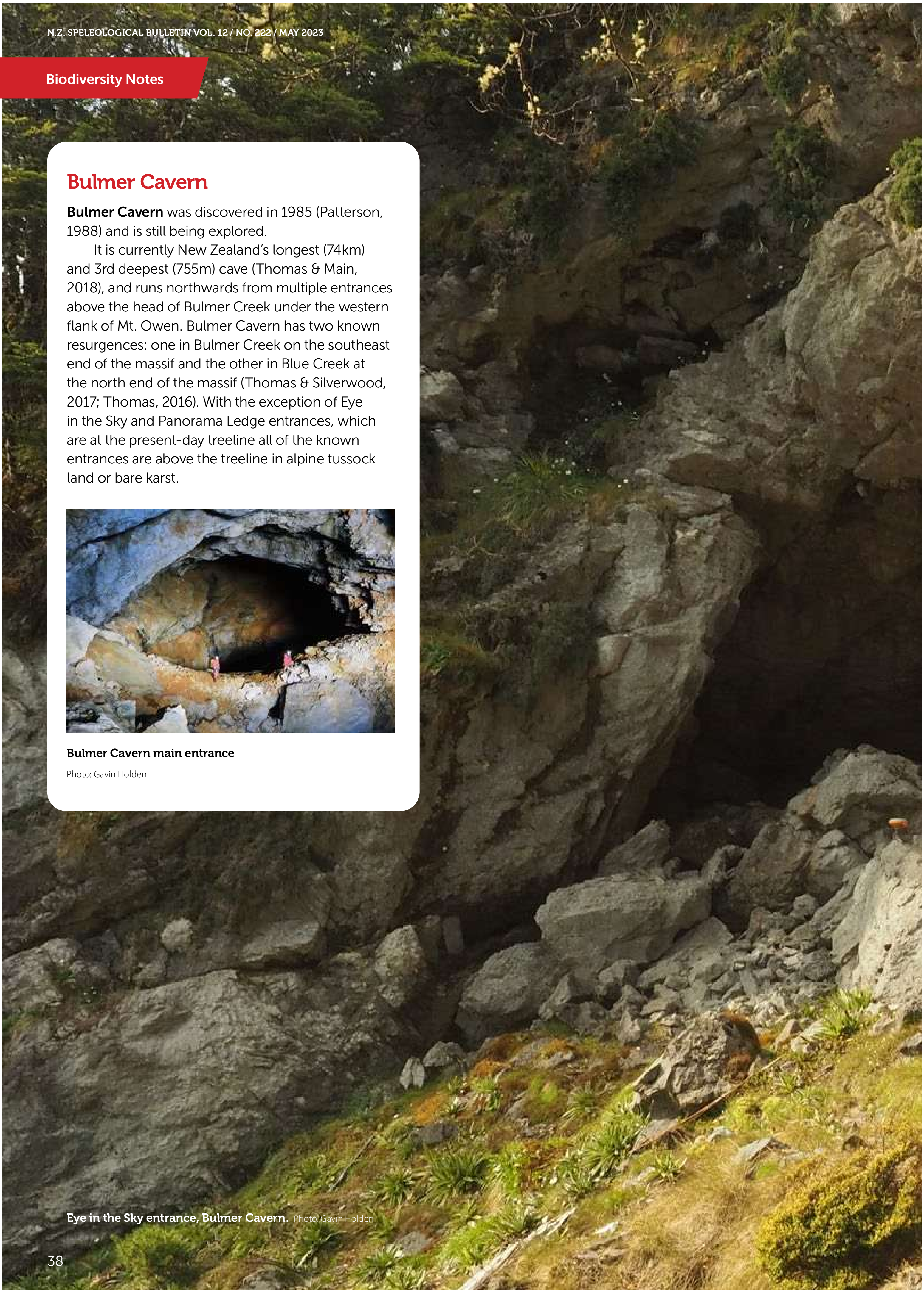
Bohemia Cave

Bohemia Cave is currently New Zealand's 8th longest (11 km) and 4th deepest (733m) cave, and was discovered and explored in the 1990s by visiting Czech caving expeditions (Tasler et al,1997). Its main entrance sits just on the beech forest tree line. It is famous for its world class aragonite speleothems (Tasler, 1998). The main streamway resurges in the Fyfe River valley, and the air temperature is around 4 degrees in the cave (Holden, 2021 pers. comm)

A small bird fossil from Te Ana O NgaKea

Photos Gavin Holden

Aragonite speleothems in Bohemia Cave. Photo: Gavin Holden



Bulmer Cavern

Bulmer Cavern was discovered in 1985 (Patterson, 1988) and is still being explored.

It is currently New Zealand's longest (74km) and 3rd deepest (755m) cave (Thomas & Main, 2018), and runs northwards from multiple entrances above the head of Bulmer Creek under the western flank of Mt. Owen. Bulmer Cavern has two known resurgences: one in Bulmer Creek on the southeast end of the massif and the other in Blue Creek at the north end of the massif (Thomas & Silverwood, 2017; Thomas, 2016). With the exception of Eye in the Sky and Panorama Ledge entrances, which are at the present-day treeline all of the known entrances are above the treeline in alpine tussock land or bare karst.

Bulmer Cavern main entrance

Photo: Gavin Holden

Eye in the Sky entrance, Bulmer Cavern. Photo: Gavin Holden

Chamois in Castle Basin, Mt Owen. Photo: Gavin Holden

Cave ecosystems

Cave habitats have distinct features that can affect the ability of species to survive in them. For example, without light, no photosynthesis occurs and therefore most nutrients enter from the surface – either washed in by streamways or falling into the cave from tomos. However species can, over time, adapt to cave conditions. The degree of physical (troglomorphies) adaptation can be used to group inhabitants and often there is overlap between groups.

Cave organisms can also have their own ecological niches in caves depending upon their degrees of adaptation and modes of life. Generally these zones are divided in terms of temperature range and location.

Table 1: Classification of cave communities (Sket 2008) (Choi 2011)

Group	Key features
Troglobiont or troglobites	These species are fully adapted to living in caves. And have the morphological, physiological, and behavioral adaptations for underground life. These features include adaptations such as loss of pigmentation, reduced eyesight, longer appendages, and smaller bodies. They will also have a slower metabolism (even with limited food sources, they can survive for a long time) and have lost the ability to cope successfully with large changes in temperature, (caves tend to have fairly stable temperatures year round).(Culver 2015). This group is unable to survive outside of cave systems and in some cases may only be found in a single cave. All have small habitat ranges and are endemic species. Examples of troglobites in New Zealand caves include cave beetles, short legged harvestmen, snails and spiders.
Eutroglophile	Essentially terrestrial species able to maintain a permanent subterranean population and could be referred as future troglobites. For example, glowworms.
Subtroglophile	Species which may temporarily inhabit a subterranean habitat but is intimately associated with surface habitats for some biological functions on a daily (e.g., feeding) or seasonal (e.g., reproduction) basis. For example, cave wēta.
Trogloxene	Species only occur sporadically in a cave habitat and are unable to establish a sustainable subterranean population. e.g nursery spiders and flatworms.
Scotophile (subdivided from Trogloxene, Choi 2011)	Species which have a natural affinity for darkness, but not necessarily a cave adapted species. For example, Neanops (beetle species).

Table 2: Ecological zones in the cave (Vermeulen and Whitten 1999)

Zone	Description
Twilight	Near the cave entrance where light, humidity and temperature vary. This zone is occupied by a variety of fauna, particularly by surface (trogloxene) species
Transition	The zone of almost complete darkness with variable humidity and temperature.
Deep zone	Complete darkness with almost 100% humidity and constant temperature. Generally this zone is occupied by troglobites.
Stagnant zone	The of complete darkness with 100% humidity and where there is little air exchange, and carbon dioxide concentration may become high.

Objectives and Method:

The aim of the project was to search for, and record any cave inhabitants present and their locations in Bohemia and Bulmer caves over six days. This study was primarily focused on the air (vadose) zones of the cave; aquatic subterranean animals were not included in the project. The investigation was carried out by visual searching on cave walls, boulders and under rocks. Recording was done by photography and occasional video with an Olympus Tough TG-6 Digital Camera .

Results and Discussion:

Over the time period a variety of animals were observed in the caves.

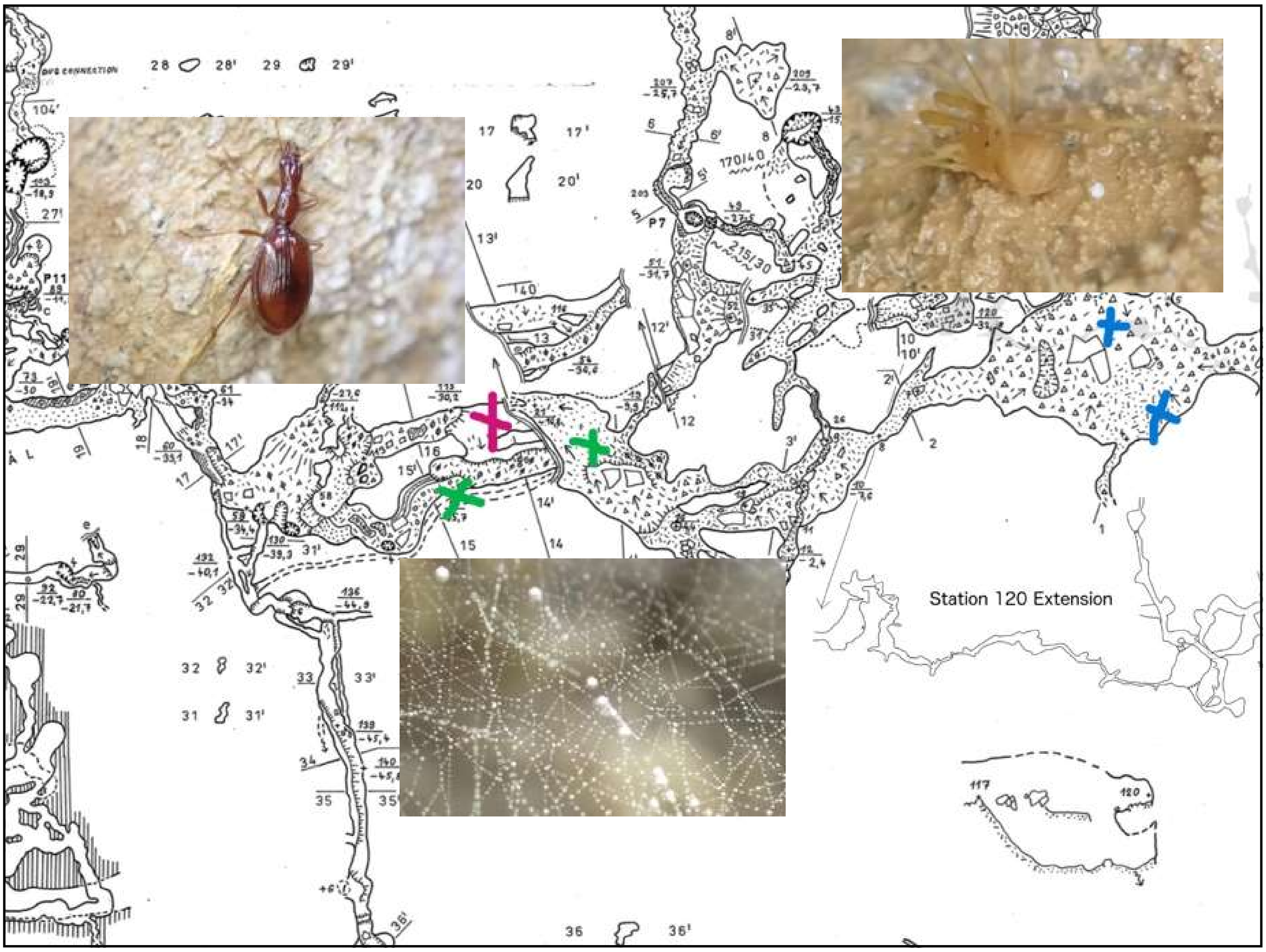
Table 3: Animal groups sighted in the caves

Higher group	Family	RTU	Common Name
Opiliones	Synthetonychidae	Synthetonychia	short legged cave harvestmen
Opiliones	Triaenonychidae	Hendea myersi assimilis	short legged cave harvestmen
Araneae	Theridiidae	Theridiidae	cave spider
Araneae	Cycloctenidae	Cycloctenus	nursery web spider
Coleoptera	Carabidae	Trechini	cave beetle
Orthoptera	Rhaphidophoridae	Macropathinae	cave wētā
Gastropoda	Charopidae	Charopinae	dot snail
Nemertea	Prosorhochmidae	Antiponemertes pantini	ribbon worm

RTU= recognisable taxonomic unit

Table 4: Zone-wise occurrence of the cave species with respect to their cave adapted status

RTU/Common Name	Community	Twilight	Transition Zone	Dark Zone
Synthetonychia (short legged cave harvestmen)	Troglobite	seen	seen	not seen
Hendea myersi assimilis (short legged harvestmen)	Trogloxene	seen	not seen	not seen
Theridiidae (cave spider)	Troglobite	seen	seen	seen
Cycloctenus (nursery web spider)	Trogloxene	seen	not seen	not seen
Trechini (cave beetle)	Troglobite	not seen	not seen	seen
Macropathinae (cave wētā)	Eutroglophile	seen	seen	seen
Charopinae (air breathing land snail)	Subtroglophile	seen	seen	not seen
Antiponemertes pantini (ribbon worm)	Trogloxene	seen	not seen	not seen



Map 1: Location of troglobitic species in Bohemia cave (Troglobite species were only sighted in Bohemia Cave).

The location within the cave where invertebrates were found, in general, matched to their amount of cave adaptation, i.e. the more cave-adapted, the further into the cave they could be found. Synthetonychia cave sp. was not seen in the dark zone of the cave. This might be due to poor search techniques rather than not occurring in these areas.

Undescribed troglobite species accounts:

Synthetonychia cave species

(Figure 1)

Common name: short legged cave harvestmen

Distribution: This family currently consists of one genus with 14 species (Forster 1954). (Giribet 2014) (Fernández 2017) According to the recent divergence dating analyses (Derkarabetian et al 2021), the family Synthetonychiidae diverged from its closest relatives about 250 MYA. They are endemic to New Zealand and have been here for the entire time. The family is distributed across New Zealand, generally reclusive although common. This new species has only been found in Bohemia Cave.

Habitat: They were sighted in the large cave entrance chamber (twilight zone) of Bohemia. Either on boulders or under small stones. Extensive searching over four days in the cave, only resulted in 4 being found. They were in pairs.

Behaviour: In contrast to other Opiliones, the pedipalps are more raised. Those observed tended to move slowly around in fairly straight lines, away from light and sound/vibrations. There was no obvious food source nor were any of the ones observed feeding. Cave microbes as a possible food source would require further investigation.

Video: https://youtu.be/5YdbXV8stDQ

Araneae: Theridiidae cave sp.

(Figure 2)

Theridiidae sp. (undescribed)

Common name: cave cobweb spider

Distribution: cobweb spiders are distributed worldwide. This new species has only been found in Bohemia cave. Making its current known distribution very small.

Appearance: A very small (3-4mm) pale spider. Currently at TePapa for taxonomic description.

Habitat: Webs were relatively common through the cave; often in small recesses in the cave walls.. There did not seem to be a relationship between streamways and web locations. Most webs had water droplets attached to them. Further investigation into whether the webs

Figure 1; Long limbs, pale colouring, reduced eyes and small size, compared to surfaces species, show how they have become physically cave adapted. Photos (top left) Synthetonychia cave sp in situ; (top right) Synthetonychia cave sp microscope; (lower left) Synthetonychia cave sp in situ; (lower right) Surface Synthetonychia species. Photos: Top and bottom left: Anna Stewart. Top right photo: S. Derkarabetian, Harvard University. Bottom right: Gonazalo Giribet, Harvard University

Figure 2; (top left) Web with centrifuge tube for scale; (top right) Under the microscope Photo: P.Sirvid, TePapa; **(lower left) Cave spider on web in cave; (lower right) Cave spider in-situ on cave wall.** Photo: Gavin Holden are constructed of water attracting properties could be worthwhile. The webs seemed to be individually unique, very small and intricate. Some webs were flat and lay on the floor in tiny cracks in the wall, while others were somewhat similar to glowworm strands from walls, and others again a crisscross pattern. Glowworms are not present at this altitude. Overseas studies have found troglobite cave spiders also inhabit the dark zones of caves, (Cuff 2021).

Behaviour: The spiders could be seen on the webs and also on walls away from webs. Those on webs were sensitive to movement (possibly air current changes) and less sensitive to light, as they remained stationary when light was shone on them. None were observed feeding, or were any obvious prey in the webs.

Possibly, one food source could be from moonmilk. Moonmilk is a whitish, porous speleothem characterised by a soft texture (Hill & Forti 1997) that is usually permanently covered by percolating water and has a rich microbial biomass. Moonmilk can occur on aragonite formations.

Video: A Video of one in a traditional downwards hunting pose: https://youtu.be/qFuVUG7gGyE

Described troglobite species account:

Carabidae: Trechini (Figure 3)

Kupetrechus sp

Common name: Cave beetle

Distribution: Cave beetles have been previously recorded from this area (Townsend, 1963). *Kupetrechus larsoni* (Townsend 2010) have been collected from traps in alpine scree and are only known from Mt Owen caves. Two further cave beetle species known from the Mt Owen area are *Kupetrechus lamberti* (Townsend 2010) and *Erebotrechus infernus* (Britton 1964).

Appearance: Species showed signs of cave adaptation, with pale colouring, smaller, narrow body and longer limbs. Length approximately 1cm.

Habitat: Beetles were sighted on cave boulders near active streamways and in smaller, muddy areas away from water sources. Small snails were seen nearby during the observation of one cave beetle. Snails as a possible food source for the beetles would require further investigation.

Figure 3; Cave beetles in-situ Bohemia Cave. Photos: Anna Stewart

Behaviour: The beetles were very active, moving quickly around the local area. When they were caught and observed in petri dishes in the cave, they continued this pattern of moving. A total of 3 cave beetles were seen in the Bohemia Cave system during the search period. Possibly there are food sources in the muddy banks and this is foraging behaviour. A closer investigation of the digestive tract contents and mouthpart morphology could offer suggestions around food sources.

Video: https://youtu.be/o86VBt0s2NM.

Other non-troglobitic species accounts:

Bulmer Cavern:

Two days were spent investigating Bulmer main entrance and Panorama

Montage of non-troglobitic species (ID by iNaturalist)(top left) Macropathinae (cave weta); (top right) *Hendea myersi ssp. assimilis* (short legged harvestmen); (mid left) *Antiponemertes pantini* (ribbon worm); (mid right) Genus Cycloctenus (spider); (lower left) Subfamily Charopinae (snail); (lower right) weevil. Photos: Anna Stewart

entrance. No troglobitic species were observed in the cave. This is most likely due to time constraints and area searched. Various non-troglobitic invertebrates were observed. (Fig4)

Conclusions

These caves are viable ecosystems with a mix of invertebrate inhabitants that range from permanent cave dwellers to occasional visitors. Cave flora was not investigated, however overseas studies have found that unique plant species can inhabitat cave entrances (Monro 2018) and play a part in cave ecosystems.

The finding of two new species of troglobitic arachnids in Bohemia over a short search period by a single person, is suggestive that more troglobitic animals could be present in the caves.

It would also seem plausible that all of the cave entrances would have once been within forested settings. As conditions outside of the caves deteriorated, animals could have migrated into these stable environments, with their steady year round temperature and humidity. It would seem unlikely that animals only entered Bohemia and not Bulmer.

Many juvenile species of terrestrial invertebrates were observed in the cave entrances, this perhaps may be part of a lifecycle system that could allow for vulnerable young to develop in the safety of a cave. Similar terrestrial spiders can be found in sub-alpine caves. These animals could also be a source of food for cave obligate species.

An interesting feature was the degraded tape in Bohemia Cave. It could also be worthwhile to account for this occurrence; alongside conservation measures of removing and replacing it.

Long term studies of cave biota could provide more information and possible new species. For example, systematic long term research on three caves in Korea has provided substantial data on their cave life (Chang 2021).

Overall, the caves showed an existence of active ecosystems and highly endemic biodiversity.

Currently, in New Zealand, cave biodiversity is not fully recognised as a biodiversity system. This makes research and data collection patchy and difficult. For any inroads into cave obligate species and their dispersal, habitat and ecology, much more work needs to be done. In particular for conservation and preservation of these highly endemic and rare species. ▪

Author relaxing at the exit of 'Eye in the Sky', Bulmer Cavern. Photo: Nicole Miller

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New Zealand's longest caves

Compiled by Lindsay Main

	Cave	*Location*	*Length (m)*
1.	**Bulmer Cavern**	Mt Owen	74319
2.	**Greenlink-Middle Earth**	Tākaka Hill	40156
3.	**Nettlebed-Stormy Pot**	Mt Arthur	38252
4.	**Ellis Basin System**	Mt Arthur	33400
5.	**Megamania**	Heaphy Valley	15077
6.	**Honeycomb Hill Cave**	Ōpārara	13712
7.	**Gardner's Gut**	Waitomo	12296
8.	**Bohemia Cave**	Mt Owen	11230
9.	**Tōtara Cave**	Golden Bay	10000
10.	**Mangawhitikau**	Waitomo	8054
11.	**The Metro/Te Ananui**	Charleston	8000
12.	**Te Mana Nui Cave**	Mt Arthur	6490
13.	**Aurora-Te Ana-au**	Te Anau	6400
14.	**Mangaone Cave**	Gisborne	6300
15.	**Moonsilver Cave**	Upper Tākaka	5900
16.	**Waitomo Headwaters**	Waitomo	5618
17.	**Millars Waterfall**	Waitomo	5150
18.	**Xanadu System**	Punakaiki	5010
19.	**Spittle Springs**	Tākaka Valley	5006
20.	**Waipu Caves System**	Waipu	5000
21.	**Beyond Words**	Heaphy	4970
22.	**Fred Cave**	Waitomo	4760
23.	**Thunderer Cave**	Puketiti	4726
24.	**Stinkpot Cave**	Mahoenui	4548
25.	**Windrift**	Mt Arthur	4410

New Zealand's deepest caves

	Cave	*Location*	*Depth (m)*	*Date*
1.	**Nettlebed-Stormy Pot**	Mt Arthur	1174	2014
2.	**Ellis Basin System**	Mt Arthur	993	2010
3.	**Bulmer Cavern**	Mt Owen	755	1988
4.	**Bohemia Cave**	Mt Owen	733	2023
5.	**HH Cave**	Mt Arthur	721	1989
6.	**Incognito/Falcon System**	Mt Arthur	551	1991
7.	**Ajax Cave /Turk's Torrent**	Mt Owen	450	2020
8.	**Viceroy Shaft**	Mt Owen	415	1999*
9.	**Greenlink-Middle Earth**	Tākaka Hill	404	2020
10.	**Deep Thought**	Mt Owen	403	2007
11.	**Twin Traverse Tomo**	Mt Arthur	400	2001
12.	**Ironstone Cave**	Tākaka Hill	396	2017
13.	**Windrift**	Mt Arthur	362	1985
14.	**Legless**	Tākaka Hill	362	2000
15.	**Harwood Hole**	Tākaka Hill	357	1959
16.	**Gorgoroth**	Mt Arthur	354	1972
17.	**Rotapot**	Mt Owen	341	2001
18.	**Spanish Parrot Cave**	Mt Arthur	336	2015
19.	**Blackbird Hole**	Mt Arthur	317	1972
20.	**Perseverance Cave**	Tākaka Hill	315	1987
21.	**Giants Staircase**	Mt Owen	301	2017
22.	**Hector Cave**	Mt Owen	300	2021
23.	**Odyssey: The Cave**	Mt Owen	296	2001
24.	**Aurora Cave**	Te Anau	267	1961
25.	**Laghu Cave**	Mt Arthur	261	1980

* Viceroy Shaft was pushed to an estimated depth of 600m in December 2022. Actual depth yet to be confirmed.