

FASCINATING FAUNA OF SUBTERRANEAN RIVERS

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CHINA'S MYSTERIOUS CAVEFISHES

Field researcher and passionate conservationist Danté Fenolio reports on the little-known, highly adapted and currently endangered fauna of South China's karst





Cone Karst in Guangxi, China. At times the peaks in South China seem to compete for space and are densely bunched together (cone karst or *fengling*). At other times, the peaks are discrete entities and do not touch one another – falling into the tower karst or *fengcong* category. The two are related in that they represent different stages in the same process. Tower karst evolves from cone karst as water undercuts the limestone through time.



The Small-eyed Barbel *Sinocyclocheilus microphthalmus* photographed *in-situ*. The same species is featured on the opening page of our story.

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e headed into the field at dawn. The drive took us closer and closer to a dense cluster of high limestone peaks, ultimately following a road among them. This was an area of South China we had visited before. We were all excited – it is exceptionally remote and with few people. The region is riddled with caves. Unbelievably tangled clusters of vegetation grow on the nearly vertical slopes. Birds, infrequently encountered elsewhere, are commonplace again and small mammals occasionally dash across the road and into the thick roadside vegetation. As we climbed the steep terrain, the road began to twist back and forth – it was cut from a sheer cliff face and ultimately had drop-offs that were 800 to 1000 feet above the valley floor. The width of the road was hardly more than the width of our vehicle. Any mistake driving this route would end badly, but we have gained great confidence in our driver during the past five or so expeditions to South China. He is the real deal - a professional. After fifteen or so miles, the road turned into a muddy, rutted mess. A short distance farther and we arrived to an old house made of weathered adobe. The aged structure was sheltered from the sun by an even older looking roof of worn, handmade clay tiles.

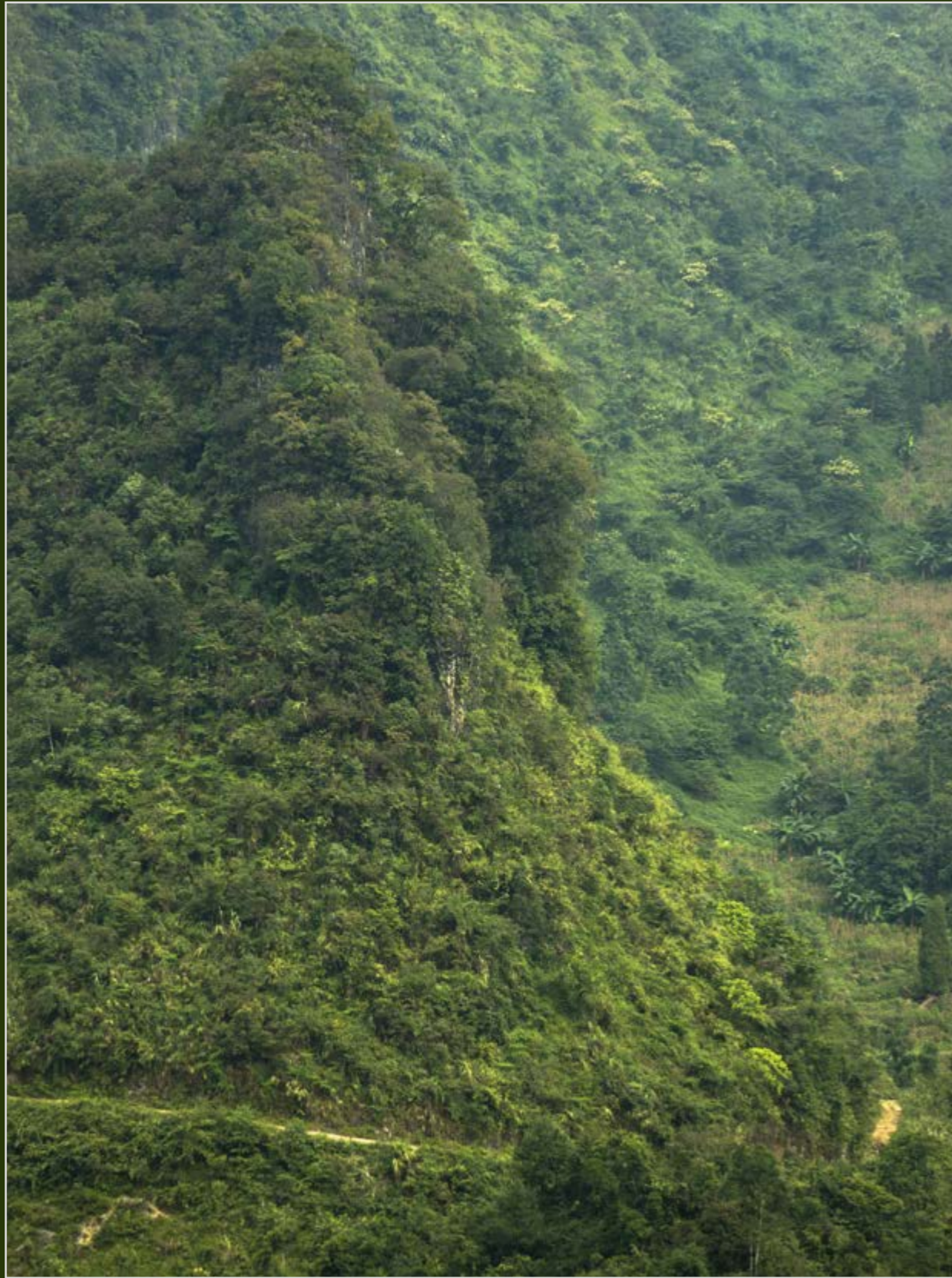
PHOTOS
 BY DANTÉ FENOLIO

We would traverse the rest of the route on foot. The locals greeted us warmly. A year ago, they had told us that there was a population of cavefish in nearby cave streams. On this visit they provided our colleague, Dr. Yhau Zhao, with a gift upon our arrival: a cavefish preserved in alcohol. We watched as Yhau held up the clear bottle of alcohol and stared at the slender, eyeless fish. He was amazed with the find and was overwhelmed with excitement. We prepared for a wet cave trip and started toward the massive karst tower in front of us. The trail was a steep one that wound its way into a carved valley. At the base of the valley, a cave mouth was visible through the vegetation as a dark, circular shadow. Cold air billowed from the cave mouth and we made our way down muddy and rocky slopes to a stream below. With an underwater housing and camera, we were able to photograph cavefish where they live...oh what a rush – to capture these animals in their element. (As an FYI and before we move on, the accepted ichthyological plural of fish is “fishes” when referring to multiple species). The term “cavefishes” conjures up visual images of pink and blind animals that almost defy reality in appearance and Southeast Asia has many species. In fact,

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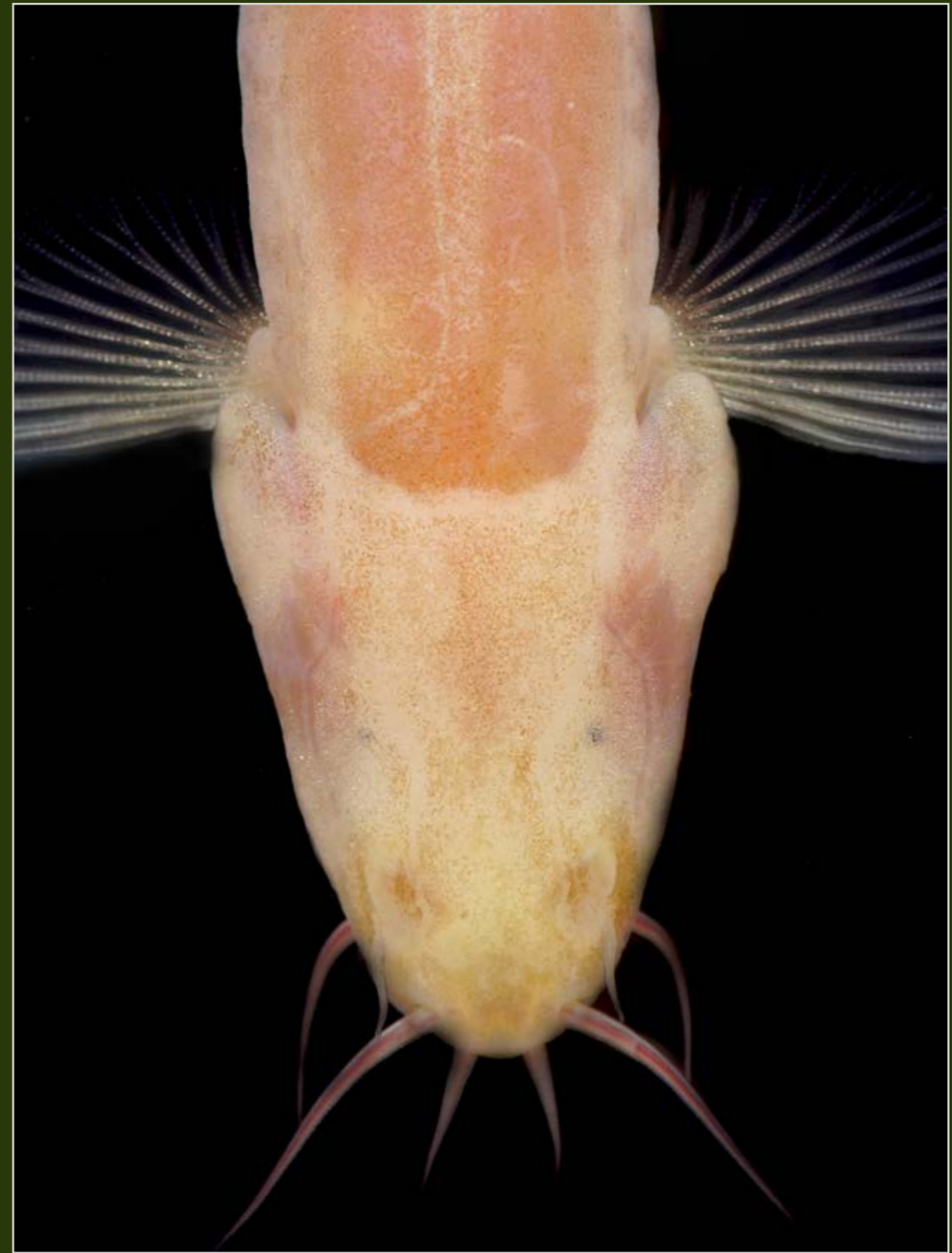
The Asiatic watersnake *Sinonatrix aequifasciata* can be found inside of caves, sometimes well beyond the twilight zone.



Many roads in China's karst region traverse steep and difficult terrain. Continued exploration of subterranean habitats in Southeast Asia is critical to protecting the species that live there. Documentation of the distribution and diversity of cave species identifies "biodiversity hotspots" which can then be targeted for protection.



The Taiji Cave Loach *Oreonectes anophthalmus* is seriously threatened by overcollection and agricultural runoff at the only known locality.



Oreonectes macrolepis retains vestigial eyes and some skin pigmentation.



The Golden Line Barbel *Sinocyclocheilus furcodorsalis* photographed *in-situ*.



Top, caving skills are required to work in many of the caves the CCWG has been investigating. Bottom, fish traps are often used to collect fish in caves.

defining cavefishes is something that requires explanation in a place as diverse as Southeast Asia. Some definitions will help here. Animals that live exclusively in caves or groundwater are known respectively as *troglobites* (or *troglobionts*) and *stygobites* (or *stygobionts*). Troglabionts live on the land, stygobionts in the water. The terms are associated with species that are highly adapted for life in subterranean habitats and are found no place else. The adaptations of cave-inhabiting species come in a variety of forms that are not expressed the same way in all species. Think of each character, like eye size, as a variable on a sliding scale. As a species evolves in conjunction with a subterranean existence, the size and degree of development of its eyes, for instance, tends to slide down the scale (again, not observed in every species). These changes happen over time and across generations, not in individuals. The same can be said of other key characters such as degree of pigmentation, body size, body length and girth, mouth shape and size, and forehead shape and size. Obligate subterranean fishes in China generally, but not always, show some modification in these characters. When these characters are expressed, they are considered *trogomorphic* characters, or characters associated with life below ground. Some subterranean species develop structures not found in their relatives that live in surface habitats, and scientists are not always certain of their function. The Chinese Barbels, for example, inhabit both surface streams and subterranean waters. The cave-inhabiting

species exhibit varying degrees of adaptation for that environment, and some have mysterious structures. For example, the Horned Golden Line Barbel, *Sinocyclocheilus tileihornes*, has a structure protruding from its forehead that looks very much like a horn. Other cave-inhabiting species have massive bumps on their foreheads and or a flattened, duck-billed mouth. We assume that the structures have something to do with life in the dark, but we do not know their exact function yet. Just as with the other characters mentioned above, these structures exist on a continuum; that is, they are expressed more strongly in some species than in others. There are many cavefishes in China that are only found in groundwater but that have differing expression of the characters mentioned above. The blind and pink fish found in the region are abundant and well represented. Loaches (families *Nemacheilidae* and *Cobitidae*) and barbels (family *Cyprinidae*) dominate the ichthyofauna of these subterranean waters – but there are exceptions. One is a blind and pink catfish, described only three years ago, SE Asia’s first “blindcat.” But back to defining cavefishes in SE Asia...the tricky part is how you describe the rest of the fishes that inhabit caves for at least part of their lives. For example, there is an assemblage of species that live in cave streams during the day but feed in productive surface waters under the cover of darkness, not unlike the ecology of cave inhabiting bats. These fishes typically have fully functional eyes and

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Hand netting of fishes is a preferred method when conditions are suitable.



Above, photography of subterranean species is a big part of the documentation process. The Chinese Cavefish Working Group has put a lot of effort into capturing images of cave organisms where they occur and *in-situ* (image by Daphne Soares). Right, cave formations are commonplace in South China's caves.



One of the oddly-shaped groundwater loaches, *Triplophysa huanjiangensis*, has an elongate head and face. This is *Triplophysa huanjiangensis* photographed *in-situ*.



The Tile-like Horned Barbel *Sinocyclocheilus tileihornes* has an interesting structure protruding from its head. No explanation for the function of this structure has been identified.



China is a complicated mosaic of ethnic groups with distinctive languages, customs and identities, and many of these groups retain their cultures today.

pigment; however, they depend on subterranean habitat for their survival. They are as tied to subterranean waters as their blind and depigmented relatives that never leave permanent darkness. Certainly, both groups qualify as cavefishes. The karst region (area that has an appropriate geology for cave formation) of SE Asia is larger than the state of Texas (USA) and boasts the greatest diversity of obligate subterranean fishes anywhere in the world. In China alone, there are no fewer than 130 species dependent on subterranean waters. There are also *troglophiles*, species that readily inhabit subterranean waters when they are available. This includes a host of catfishes and cyprinids not typically considered cavefishes because they also occur in surface water, far from caves. These species can complete their entire life cycles in surface habitats but a few might also be able to do so in subterranean habitats. Our drive home took us past the loud and unmistakable clanging of excavators breaking up limestone to be hauled off to concrete plants and tile factories. Even in the most remote corners of China, the harvest of limestone is big business and, in part, fuels the burgeoning development seen across the region – one of many significant threats to subterranean wildlife of the area. Other major threats include overuse of groundwater for agriculture and contamination from runoff, threatening entire subterranean ecosystems. Additional threats lurk in the contemporary exploitation of cavefishes in SE Asia. For example, we surveyed a

cave and its river that we had previously visited in 2011. Back then, it was a beautiful cave with few signs of human visitation. The river boasted a healthy population of one of the cavefishes you see here, the Golden Line Barbel, *Sinocyclocheilus furcodorsalis*. During our visit this year, we found evidence of intensive harvest of this species. Locals told us why they had been harvesting the fish (for the aquarium trade) and even who they were selling them to. We saw gill nets and nets of every other variety strewn along the waterway – some in places where they could continue to trap fish. Fish captured this way would then simply die in the unattended nets. Trash now litters the cave, and there are signs of camps where fishermen burn candles and prepare food as they wait on their traps. The income from harvesting these fish is just too much of a temptation for locals and, in all truth, primary blame should not be placed on them. However, there is no excuse for unsustainable commercial collection of fish for the aquarium trade. Companies selling fish for the trade (and buying from these locals) need to avoid subterranean species – or we will lose this biodiversity in the blink of an eye. Cavefishes are particularly susceptible to overharvest. We are working on population studies but they are difficult to conduct under such circumstances. This cave was going to be one of our study sites. We encountered *no* fish on our recent visit. The locals told us that few had been seen in several years but they used to catch them “*all the time and on each visit.*” In



Top, Frogs of the genus *Odorana* are troglophiles and some species are only known from caves. Bottom, close-up of a Tile-like Horned Barbel *Sinocyclocheilus tileihornes*.

2011, we observed many dozens. Because of their unique ecology and limited population sizes, the vast majority of cavefishes worldwide cannot withstand commercial harvest (Mexican Cave Tetras are farmed in Florida, USA, for the aquarium trade). Preliminary evidence strongly suggests that most populations of cavefishes in China are highly localized, vulnerable to commercial collection, and easily removed. While it may be technically legal to capture and sell some of these species in China, it is not ethical. Too frequently, abuse of wildlife and wild places happens under the guise of “well, it’s legal,” but that does not make it ethical. Another example of contemporary threats to China’s cavefishes is the harvest of a host of “Oil Fish” (*Sinocyclocheilus* spp.) that exhibit a bat-like ecology. As mentioned above, these species live underground during the day and exit the cave to feed in productive surface waters at night. Other species migrate annually into subterranean waters to seek shelter from seasonal changes on the surface. All of these movements are very predictable in both space and time, making fish easy targets for modern fish traps and nets. Unfortunately and predictably, a commercial fishery has developed for these species, considered a delicacy in many parts of China. Overfishing is rampant and there are numerous examples of populations that have nearly vanished completely under this harvest pressure. With commercial harvest, environmental contaminants, limestone quarries, and excessive groundwater extraction, these species face a challenging future. We’d like to make an appeal to everyone: please don’t contribute to the loss of these species by purchasing

them, for any purpose. Regardless of what has happened in the past, it is our generation that needs to step up, do the right thing, and put conservation of rare and fragile species first. So who are “we.” We are the Chinese Cavefish Working Group (CCWG), a group of concerned biologists. We conduct surveys in South China to document populations of cavefishes and other subterranean fauna and to better understand the threats that they face. In addition, we are conducting studies of biomechanics, genetics, systematics, and population ecology. One of the most rewarding aspects of this work has been the opportunity for foreign cave biologists to interact with Chinese graduate students and train them in caving and cave biology. We are hopeful that the next generation of Chinese cave biologists may benefit from our efforts. A primary goal of the CCWG is to provide critically important data to wildlife authorities in hopes that some of these amazing species can be saved. Many healthy populations of cavefishes remain and much can be done to ensure their future. The San Antonio Zoo has been a key sponsor of the group and has developed labs for work with captive populations of subterranean species. Conservation breeding programs may wind up being the last stop for a few of the groundwater fishes below rugged South China and long-term plans are in place to develop an institute for the conservation of subterranean species within China. National Geographic – China, has funded field work across the past several years (grant numbers GEFC-15-13 and GEFC-15-16).