



NEW SPECIES

2022

THE FRESHWATER FISH SPECIES
DESCRIBED IN 2022



SSC
SPECIALIST GROUP



CALIFORNIA
ACADEMY OF
SCIENCES





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Cover image: Juan Deriba killifish © Heinz Arno Drawert



Shoal is the global initiative to halt extinctions and recover populations of the most threatened freshwater species around the world. It is hosted by Synchronicity Earth and Re:wild. Learn more about their work at shoalconservation.org.



The IUCN SSC FFSG has a mission of achieving conservation and sustainable use of freshwater fishes and their habitats through generating and disseminating sound scientific knowledge, creating widespread awareness of their values and influencing decision making processes at all levels.



Eschmeyer's Catalog of Fishes database was begun in the 1980s at the California Academy of Sciences by Bill Eschmeyer. It is the primary resource for current knowledge on the kinds of fishes, and is updated continuously as new species are described¹.

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FOREWORD: Kathy Hughes and Brian Zimmerman



It may come as a surprise to some to learn that hundreds of freshwater fish species are described every year. But it shows just how much there is for us to learn about what lies beneath the surface of the planet's freshwaters. More than half of all fish species live in freshwater, which is remarkable considering less than 1% of Earth's water is liquid freshwater. Yet humans have historically neglected and mistreated freshwater habitats, meaning that many of these incredible species are at risk of being lost. SHOAL's annual New Species reports, in collaboration with the IUCN Freshwater Fish Specialist Group and the California Academy of Sciences, puts a much-needed spotlight on these species, which will ultimately give them a greater chance of being saved.

Over the following pages, you can read about some fascinating species with some incredible adaptations: turn to p.9 to read about a fish that can leap out of water to escape predators, discover an extremely rare 'pelvic-brooder' on p.11, and scare yourself silly on p.16 with some devilishly creepy catfishes that seem to like nothing more than drinking blood.

Only if people know about the incredible diversity found in the world's wetlands will they be catalysed into action to help ensure it survives for future generations. With one in three freshwater fishes facing extinction, it is imperative that funds are raised, and action is urgently taken to ensure these incredible species are not lost forever.

We hope you enjoy the read.

Kathy and Brian,
Co-chairs, IUCN Freshwater Fish Specialist Group

Kathy Hughes

Brian Zimmerman

SUMMARY

201 FRESHWATER FISH SPECIES DESCRIBED IN 2022

COMPARED WITH 212 DESCRIBED IN 2021

This is the second edition of SHOAL's annual New Species reports, in partnership with the Freshwater Fish Specialist Group of IUCN's Species Survival Commission and the California Academy of Sciences, which draw attention to the freshwater fish species described throughout the previous year.

Each of these newly described species helps deepen our understanding of the richness of the freshwater biodiversity on Earth, and hence its evolution, and about how these freshwater species interact with their environment and other organisms.

Knowledge of biodiversity 'hotspots' – areas of species richness, endemism, and threat - helps inform conservationists on where to prioritise their work to ensure they are being as effective as possible in preventing extinctions and recovering populations of highly threatened species. Of course, we should also focus on conserving areas of pristine wilderness and their species, which may be currently unthreatened, to ensure they do not become the 'hotspots' of the future.

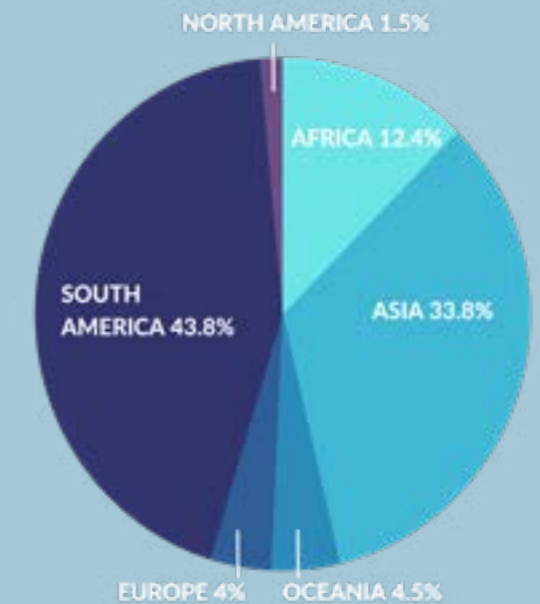
Furthermore, understanding taxonomic relationships of species allows us to identify those that are particularly genetically unique, helping ensure they can be prioritised for conservation and thus helping safeguard them and their genetic uniqueness.

During 2022, 201 new species of freshwater fish were recorded by taxonomists as being new to science, with many of the descriptions being the result of many years of hard work by researchers.

Most of the species can be found in South America (43.8%) and Asia (33.8%), an unsurprising figure considering the incredible fish diversity in those regions, and the amount of research being done there. This stacks up closely with last year, when 44.3% of the freshwater fishes described were from South America, and 38.7% were from Asia.

Over the following pages, you can read about a selection of these freshwater fish species described in 2022. We chose these as they display some interesting behaviours or have particularly noteworthy stories. Many, due to anthropogenic pressures, are already facing the threat of extinction.

Alongside highlighting a selection of species, New Species 2022 also profiles some of the taxonomists and researchers who work so hard to describe new species. Take a look at the 'Spotlight on researchers' pages to learn about what drives a selection of four scientists, and what memorable species discoveries and descriptions they have been part of.



HIGHLIGHTS

The Pathala eel loach, p.26, was discovered by a local in Chenagannur, India, while he was taking his morning shower. Thanks to a programme from the Kerala University of Fisheries and Ocean Studies (KUFOS) to engage locals in citizen science, the person knew to call the KUFOS researchers, who assessed the fish and discovered it was a newly identified species.

The Juan Deriba killifish, p.9, has the ability to leap out of water up to 50cm - more than ten times its body length - and stay attached to terrestrial foliage for hours at a time in a bid to escape being eaten. They can even move tens of meters across land in search of another suitable pool to call home.

The first species of South American darter to be discovered in 57 years, p.14, are already facing extinction due to encroaching human activities. The researchers were in a rush to describe them before they disappear forever.



The KUFOS research team searching for the Pathala eel loach. See p.26. © KUFOS

BLACK TIGER DARIO

Latin name: *Dario tigris*

Researchers: Britz, Kullander & Rüber 2022

Location: Kachin State, Myanmar

Highlight: Sports bright red and black stripes



The black tiger dario is a miniature chameleon fish that can be found in the mountain streams of the Ayeyarwaddy River basin, northern Myanmar. They are tiny, barely exceeding 22mm, but what the black tiger lacks in size, they make up for with colour. Bright red vertical pyjama stripes line a light body and black scales dot the head and back. The dorsal, tail and anal fins match the same vibrant red, making this a really attractive fish!

So attractive, in fact, that it has been a mainstay in the aquarium trade for at least 15 years, where it was thought to be a colour variant of the similar-looking red melon dario *Dario hyssinon*. It was only last year that, through the work of Britz, Kullander and Rüber, it was described as a separate species.



© Frank Schäfer

Britz, one of the researchers on the paper describing the black tiger dario, told SHOAL that, “We were pretty confident that *D. tigris* is a separate species as soon as we had more material [i.e. specimens of the fish] to study. Our initial hypothesis that these are a new species was based on morphological characteristics, which then was confirmed by molecular analyses”.

Last year, Britz, Kullander & Rüber 2022 also described *Dario melanogrammus*, another miniature chameleon fish species from northern Myanmar.

Regarding the conservation status of these two species, Britz is positive: “I have not been to the type locality of *Dario tigris* myself, but the area is still well forested and I would think not much influenced by anthropogenic activities. *Dario melanogrammus* occurs in a number of rivers and streams around Homalin, an important town on the Chindwin River. The streams had clear water and there was no significant human impact when we collected this fish back in 2013. I would think that this is still the situation today. I think these two species are not threatened by human activities at the moment”.

JUAN DERIBA KILLIFISH

Latin name: *Moema juanderibaensis*

Researcher: Drawert 2022

Location: Santa Rosa del Sara, Bolivia

Highlight: Can leap out of water and stay there for many hours to escape predators



The Juan Deriba killifish has a remarkable adaptation: when stressed, it can leap out of the water, attach itself to some foliage, and bide its time until a perceived threat has past. It may even move to an entirely different body of water.

Heinz Arno Drawert, Associate Researcher at the Museum of Natural History Noel Kempff Mercado, and representative for the Bolivia of the Killifish Foundation, discovered this small killifish. He said, “they can jump about 30 to 50 cm, which does not seem much, but considering that they can be several hours out of the water it is possible that they can move several tens of meters without problems”.

The Juan Deriba killifish is part of the Rivulid family of fish, which can live in bodies of water which are often dry. Their survival strategy is to bury their eggs, which hatch once the rains come – sometimes many months after spawning. They cope so well with drought, that some Rivulids been known to stay out of water for up to three weeks, so long as the environment is humid enough.



© Heinz Arno Drawert

In the early 90s, Drawert’s parents bought the 700-hectare Juan Deriba ranch, north of Santa Cruz in the Bolivian rainforest. A passionate aquarist from a young age, Drawert knew on first seeing the Juan Deriba killifish in a puddle on a road after heavy rain in 1996 that he had stumbled across something not known to science. “I immediately knew it was something special because it was unlike other killifish I knew”.

But it wasn’t until 2021, as part of a research project called the Rivulids of Bolivia, that he was able to collect the specimens needed to make the species’ description. Drawert explained that, once he set about searching for the species, “it was not difficult at all to collect the specimens needed to make the description”. He said, “On the one hand, I knew with certainty where to find them and on the other hand, if the habitat conditions are suitable (i.e., very well-preserved forest) the species becomes abundant at the beginning of the dry season when the pools dry up and reduce their size”.

Although the species currently appears relatively plentiful on the ranch, Drawert is cautious on its future: “This species has only been found in temporary pools within forests in good conservation status and in the vicinity of the type locality. This allows us to assume that the species has a small population size, with a small area of occupancy (less than 500 km²) that’s possibly highly fragmented due to the loss of habitat caused by the advance of the agricultural frontier in recent decades and the associated ecological degradation that still persists. “I personally think the species is endangered”.

The good news is that, as the species can survive in small puddles, it wouldn’t require a large conservation area to safeguard its future. An area of healthy forest in the species’ range that harbours puddles after rains would be enough.

TIGER SAND PLECO

Latin name: *Pseudohemiodon almendarizae*
Researchers: Provenzano-Rizzi, Argüello, Barriga-Salazar 2022
Location: Only confirmed records in Ecuador, though range likely extends to Peru.
Highlight: Only two confirmed records identified of this species in 25 years.

The type specimens of the tiger sand pleco were collected from the Ecuadorian Amazon during a study of migratory fish in 1998 by Ramiro Barriga and Donald Stewart, funded by the National Science Foundation and National Geographic. In the identification process, Barriga observed striking characteristics that did not coincide with the species reported for the area. In 2019, these specimens were shown to Francisco Provenzano, who, after carrying out a comparative analysis with the described *Pseudohemiodon* species, confirmed that it was a new species for science, thus leading the process of its description.

Pablo Argüello joined the research team, working with the other authors on the collection and analysis of data from the type specimens and other specimens of *Pseudohemiodon* that are deposited in the Ichthyology collection of the “Escuela Politécnica Nacional”.

The description process was paused due to the COVID-19 pandemic. At the end of 2020, the description was resumed, and in 2021 the description of *P. almendarizae* was submitted to the journal *Zootaxa*.

At the end of 2020, Pablo Argüello visited the Drexel University Academy of Natural Sciences (ANSP), where more specimens of the genus *Pseudohemiodon* were analysed. The data obtained were included in the article, generating greater support for its results.

Finally, in April 2022 the description of this species was published, whose etymology “*almendarizae*” honours Ana de Lourdes Almendáriz, in recognition of her significant contributions to the Ecuador herpetofauna knowledge, and her enthusiasm and friendship for many years.

To date, the only confirmed records of the tiger sand pleco are from Ecuador, however it is very likely that its distribution range extends to Peru, since the type locality of its description is located on the border between Ecuador and Peru.

Because the only information on the population of this species comes from the two specimens from which the description was carried out, its conservation status cannot be determined. They are the only records of this species in 25 years, so it is likely it will be rare in its ecosystem.

Currently, the main threat that the tiger sand pleco faces is oil exploitation which, through activities that generate contamination, such as spills, puts the habitat of the species at risk. There is also an increase in sedimentation in the rivers of the type locality and the deforestation of the riverside vegetation.



© Pablo Argüello

KALIMPA'A RICEFISH

Latin name: *Oryzias kalimpaaensis*
Researchers: Gani, Suhendra, Herder, Schwarzer, Möhring, Montenegro, Herjayanto, Mokodongan 2022
Location: Lake Kalimpa'a, Sulawesi
Highlight: Pelvic brooder

One of only five known pelvic-brooding ricefish, the Kalimpa'a ricefish is endemic to Sulawesi's Lake Kalimpa'a in Lore Lindu National Park.

Pelvic-brooding, only known from a handful of freshwater fish, is an adaptation where females carry fertilised eggs under their bellies, well protected by their elongated pelvic fins, until the larvae hatch. This is a very different strategy from most freshwater fish species, which deposit the fertilised eggs on substrate.

The evolutionary reasons for this behaviour are still being researched. Researchers from the Leibniz Institute for the Analysis of Biodiversity Change, Museum Koenig Bonn, the Museum Zoologicum Bogoriense, Indonesia, the Department of Fisheries and Marine Science at Sam Ratulangi University of Manado, Indonesia, and the University of Oldenburg have studied the genetic basis for the development of the reproductive strategy of pelvic-brooding, and were able to show that the traits adapted to it are determined by only a few gene loci, essentially meaning only a relatively small amount of the genes are responsible for the behaviour. Jana Flury, PhD student at LIB, Museum Koenig and lead author of the study, said, “The small number of responsible loci as well as the modular body structure might have enabled the rapid evolution of the particular way of brood care”.

Dr. Julia Schwarzer, Head of Evolutionary Genomics at the LIB, Museum Koenig Bonn, added, “The Sulawesi pelvic-brooding ricefishes are a promising model system to study different aspects of the evolution of complex reproductive strategies in the future”.

The most substantial threats to Sulawesi's endemic freshwater fishes are exotic fish introduction, eutrophication, overfishing, and pollution (Parenti & Soeroto 2004, Herder et al. 2022). Lake Kalimpa'a already contains non-native fishes such as African tilapia (*Oreochromis sp.*) and snakeskin gourami (*Trichopodus pectoralis*) (A. Gani & N. Suhendra, pers. obs.), which might affect together with direct anthropogenic impact (Lake Kalimpa'a is a popular destination for nature tourism) the lake flora and fauna.

At approximately 1,660 m above sea level, Lake Kalimpa'a is at the highest altitude at which ricefishes have so far been recorded in Sulawesi.

This discovery brings the number of recognised ricefish species on Sulawesi to 23, which also includes the duck-billed buntingi, one of SHOAL's Top 10 Most Wanted Lost Fishes.

Turn to p.12 to read an interview with lead researcher on the Kalimpa'a ricefish, Abdul Gani.



© Abdul Gani

SPOTLIGHT ON RESEARCHERS: ABDUL GANI

Abdul Gani is a Lecturer at the Faculty of Fisheries, University of Muhammadiyah Luwuk, Banggai District, Central Sulawesi, Indonesia, and an advocate for Sulawesi's diverse and abundant endemic freshwater species. He is discovered and described the Kalimpa'a ricefish highlighted in this report (p.11).



What do you enjoy about discovering and describing species?

One of my passions is exploring the world around me, especially because I know that the island of Sulawesi is included in the Wallacea designation, and is a biodiversity hotspot, especially freshwater ichthyofauna. There are many places on the island with incredible diversity of ichthyofauna, and I love to explore the island and learn about the creatures there. Describing species is a good challenge that adds to the exploration.

In 2020, my team and I discovered a new endemic species from the Adrianichthyidae family in Lake Kalimpa'a, Lore Lindu National Park, which we described in 2022 and named *Oryzias kalimpaaensis*.

In my opinion, there are still many freshwater fish species that can be obtained and described as new species because Indonesia has a high level of diversity and the exploration of freshwater fish in Indonesia is still low. This can be an opportunity to find new freshwater fish species.

What has been a particularly memorable species discovery for you?

The most memorable species discovery for me was when I discovered the new species *Oryzias kalimpaaensis* in Lake Kalimpa'a, Lore Lindu National Park in 2020 and published in 2022³.

Also, in 2017 my team ERA Indonesia and I found a species that had not been seen for a long time: *Oryzias bonneorum* in Lake Lindu. This species was described by Parenti in 2008, based on specimens preserved since 1939. But we have not published the paper about that yet.

My plan is for *Oryzias bonneorum* and *Oryzias kalimpaaensis* to become my next research project for the dissertation material in my Doctoral program.

ERA Indonesia is a community of young people who focus on preserving biodiversity, especially endemic flora and fauna.

Could you describe the process of discovering *Oryzias kalimpaaensis*?

It started through my hobby of adventuring in the wild. When I was in high school, I joined a community of nature lovers, which led me onto discovering and describing new species.

From 2020 until now, my team ERA Indonesia and I have been exploring the river and lake in the Lore Lindu National Park along with Fish Quarantine Station Quality Control and Safety of Fishery Products (SKIPM) Palu, Indonesia, with the purpose of collecting data about invasive species and finding new species.

During one of these explorations, we found this new fish from the *Oryzias* genus that had not been identified before.

In the next exploration, we took measurements of the water quality and prepared several specimens for morphological and molecular identification. Based on the results of morphological and molecular identification, we found this was a new species from the Adrianichthyidae family and *Oryzias* genus. We named it *Oryzias kalimpaaensis*. Kalimpa'a is the name of the place where the fish was found, Lake Kalimpa'a.

Why do you think *Oryzias kalimpaaensis* was not discovered before?

Freshwater fish exploration hadn't then been carried out there, so the existence of the species wasn't known. Sulawesi has remarkable endemism and almost all lakes have unique species that live in them. Nobody had looked in this lake before and there are many other places still left to be surveyed on this amazing island.

What notable things can you tell us about the species?

The discovery of *Oryzias kalimpaaensis* is a remarkable achievement for me personally and also for my friends who are involved in the exploration and writing up of the publication. The discovery gives new information about the diversity of Sulawesi's endemic species, especially in Central Sulawesi. Central Sulawesi's freshwater endemics are now 16, whereas in 2019 it was 15.

We know that Sulawesi is hotspot the freshwater biodiversity, and I think we have to explore it more. With that in mind, I think the discovery of *Oryzias kalimpaaensis* could be the start of other endemic species being discovered in the area.

I hope that the diversity and populations of freshwater endemics in Sulawesi sustains and thrives: let's protect and preserve Sulawesi's endemic freshwater!



Oryzias kalimpaaensis type locality © Abdul Gani

BEAUTIFUL FIN DARTER and APUÍ ROOT DARTER

Latin names: *Poecilocharax callipterus* and *Poecilocharax rhizophilus*

Researcher: Ohara, Pastana & Camelier 2022

Location: Apuí municipality, Amazonas, Brazil

Highlight: The first South American darters to be discovered in 57 years: deforestation places them in imminent danger of extinction.

Back in 2015 and 2016, researchers Willian O'hara and Murilo Pastana undertook expeditions to the Brazilian Amazon to search for undocumented fish species in the waterways of the Madeira River Basin which is, according to a 2019 estimate, the richest river basin in the world for fish biodiversity⁴. On one of these expeditions, they caught a small fish that excited them immediately.



Beautiful fin darter locality © Murilo Pastana



Beautiful fin darter male (top) and female © Murilo Pastana

In the net was a distinctive fish with bright orange fins and a dark spot in front of its tail. Pastana, a researcher with the Division of Fishes in the Department of Vertebrate Zoology at Smithsonian's National Museum of Natural History, said: "We knew right away that this fish was different. We were so excited, like little kids".

The species, later named *Poecilocharax callipterus* (meaning beautiful fins), could only be found in one single black water stream.

On a separate expedition to the same area, the team found a second species they didn't recognise in a tangle of tree roots next to the river bank. This would later be named *Poecilocharax rhizophilus*, for its love (phil) of roots (rhiz).

A thorough search confirmed that the beautiful fin darter was limited to a single stream with roughly four square kilometres of habitat. The Apuí root darter's range was larger, at around 50 square kilometres.

The team analysed the small fish species in the lab, and concluded that each of them were from the Crenuchinae subfamily, colloquially known as South American darters – the first in the this group to be discovered in 57 years.

"The last species of *Poecilocharax* was described in 1965, more than half a century ago," Pastana said. "So seeing these fishes in our net was one big 'wow' moment".

But both species live in an area that is at the very edge of human encroachment into the Amazon rainforest, approximately 25 miles north of the city of Apuí. Ongoing deforestation in the region places these fishes in imminent danger of extinction. In the six years since that expedition, the forest home of the species has been razed to make space for livestock, crops and gold mining – all of which decimate native flora and fauna.

Pastana thinks the Apuí root darter, with the more extensive range, is probably still holding on, but he fears that even a small amount of human development could have destroyed the limited habitat of the beautiful fin darter⁵. He said: "It was exciting to find new species. But in the field, we saw the forest on fire, logging trucks carrying out huge trees, and cleared patches turned into cattle pasture".

As a Brazilian-born scientist, Pastana is passionate about preserving the country's biological heritage, and his hope is that naming and describing these species might motivate the Brazilian government to protect and conserve these newly discovered, endangered fishes⁶.

These fishes, Pastana said, are like works of art and "losing either of these species would be like losing priceless masterpieces." Like masterworks from Monet or Picasso, each species is full of irreplaceable details that might bear some resemblance to other creatures on Earth but in concert are utterly unique. Extinction would cause all those details, wrought over millions of years of evolution, to blink out. "You'd lose everything about these species," he said.

He added, "This made us feel a lot of urgency to document these species and publish this paper as quickly as possible."



Apuí root darter male (top) and female © Murilo Pastana



Apuí root darter locality © Murilo Pastana

VAMPIRE CATFISHES

Latin names: *Paracanthopoma ahriman*, *Paracanthopoma capeta*, *Paracanthopoma carrapata*, *Paracanthopoma daemon*, *Paracanthopoma irritans*, *Paracanthopoma malevora*, *Paracanthopoma satanica*, *Paracanthopoma truculenta*, *Paracanthopoma vampyra*

Researchers: de Pinna & Dagosta 2022

Location: Various rivers in Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru and Venezuela

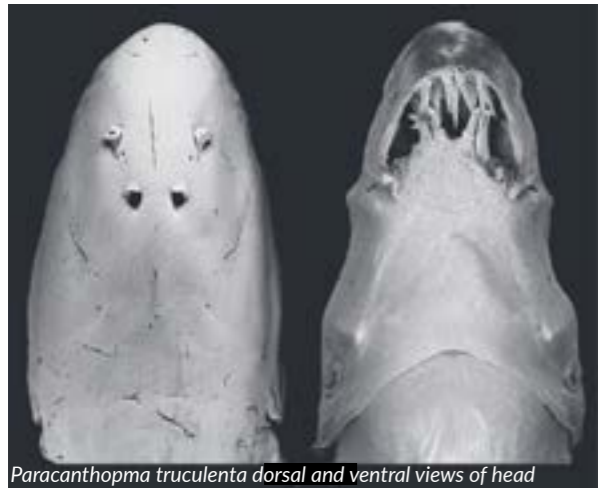
Highlight: Along with vampire bats, the only jawed vertebrates that feed exclusively on blood as adults. Have a horrific reputation for swimming up urethras of mammals, including humans.



There are certain creatures with such a grasp on our imaginations that they have worked their way into folklore as being intrinsically disturbing - evil, even. Serpents, to some, black widow spiders, to many, represent beasts from the underworld that do the bidding of shadowy, creepy forces beyond the ken of mortal humans. With names like 'Daemon', 'Satanica', and 'Vampyra', the vampire catfish species certainly sit firmly in the 'Halloween ideas' category.

Vampire catfish, from the subfamily Vandelliinae, are a subfamily of catfish that feed on the blood of larger fish. Vandelliinae species are often known as candiru in the Amazon basin, and have the disturbing reputation of swimming up human urethras to feast on human blood.

While there is at least one confirmed case, medically recorded in 1997, it is an accidental, extremely rare event, and even more calamitous for the fish than it would be for the unlucky person - the vampire catfishes are micro-parasitic bloodsuckers. Their feeding habits are attested mostly by the presence of blood, and nothing else, in the guts of preserved museum specimens.



According to de Pinna and Dagosta, the researchers who revised the species outlined here, the vampire catfishes are, "one of the emblematic subjects of natural history. Along with vampire bats, they are the only jawed vertebrates that feed exclusively on blood as adults," going on to say that, "They have been the subject of two popular books (Gudger, 1930; Spotte, 2002), tens of articles in newspapers and magazines and have also been featured in a number of television documentaries, to varying degrees of sensationalism".

The researchers present a revision of the *Paracanthopoma* genus, which they claim is, "probably the least-known vandelliine genus at present"⁷. Very little is known of their biology, with some species having been found only once so far. Still, the diversity of morphology suggests that major differences must exist in their feeding strategies and ecology.

Paracanthopoma ahriman - The name is from Zoroastrian religion and refers to Angra Mainyu (Ahriman in Persian), creator of the universe. Ahriman is the maker of snakes, demons and all things evil from a human standpoint and is approximately equivalent to, and probably historical ancestor of, the devil in Abrahamic mythology. Known from the upper río Orinoco in Venezuela.

Paracanthopoma capeta - From the Portuguese vernacular term capeta (probably from a combination of capa, meaning cape, and -eta, diminutive suffix), meaning the devil. Recorded from a single locality in the middle rio Negro, Northern Brazil.

Paracanthopoma carrapata - The specific epithet comes from carrapato, which in Portuguese is a collective name for blood sucking ticks in general. Known from a single locality in the middle rio Madeira in the Brazilian Amazon.

Paracanthopoma daemon - Daemon is a latinized form of the Greek daimon, referring to the supernatural entities hierarchically between gods and mortals, including inferior divinities and ghosts of some dead men. The word was incorporated into the Judean-Christian tradition by its usage in Greek translations of sacred texts. Known to occur in a single locality in the rio Coronel Vanick, tributary to the upper rio Xingu in central Brazil.

Paracanthopoma irritans - From the Latin irritans, irritating, taken from the name of the human flea, *Pulex irritans*. *Paracanthopoma irritans* has a widespread but patchy distribution in the tributaries of the Amazon basin in Brazil and Peru, and río Orinoco in Venezuela. Except for a record in the río Nanay (rio Amazonas drainage in Peru), all other lots are from Amazonian tributaries east of the mouth of the rio Negro. It has not yet been recorded in the southwestern Amazon. This is the only species of *Paracanthopoma* that occurs in any of the isolated drainages north of the mouth of the Amazon (rio Amapá Grande). The smallest vandelliine specimen found to date with evidence of ingested blood belongs to this species.

Paracanthopoma malevora - From the Latin malevolus, meaning ill-disposed, inimical. *Paracanthopoma malevola* has been recorded from tributaries of the rio Madeira basin draining the Brazilian shield such as the rio Aripuanã, Machado, and Sucunduri. It is also found in the upper rio Madeira, in a tributary of the rio Mamoré, and in the upper rio Juruena (rio Tapajós basin).

Paracanthopoma satanica - Satanicus is an adjective (treated as Latin) derived from the Hebrew verb satan, meaning literally "to oppose", but commonly used to refer to an enemy or the devil. Known from a single locality in a tributary to the upper Amazon drainage in Peru.

Paracanthopoma truculenta - From the Latin truculentus, meaning harsh, cruel, brutish; an allusion to the size of this species, the largest of all *Paracanthopoma*. *Paracanthopoma truculenta* occurs primarily in the rio Madeira, along nearly its entire course, through upland and lowland sectors in Bolivia, Brazil and Peru. A single record exists in the rio Solimões, this being the only record of any *Paracanthopoma* species in the main channel of the Amazon.

Most individuals (including those distended with blood) have remains of flesh tightly held in their jaws.

It seems possible that they attach to the surface of the body of their hosts by a tight bite, so firm that the removal by collectors result in tearing and removal of part of the bitten tissue.

It may even be possible that they attach semi-permanently to the body of a host, occasionally leaving their anchoring spot and entering the gill chamber only to feed subsequently reattaching to the body surface. But also possible is that they feed on juices directly from the bitten tissues on the surface of the body, therefore never letting go of their bite on the body of the host, and not entering the branchial cavity.

Paracanthopoma vampyra - From the Slavic (treated as Latin) wampir, a blood-sucking ghost or demon. *Paracanthopoma vampyra* is an eastern Amazon form from Brazil.



Paracanthopoma vampyra

SPOTLIGHT ON RESEARCHERS: DR. ROBERTO E. REIS

Dr. Roberto Esser dos Reis, is a Brazilian ichthyologist, professor and Curator of Fishes at the Pontifical Catholic University of Rio Grande do Sul. With his students and collaborators, he has described 151 new taxa (including 139 new species), 17 new genera, and one new subfamily of fish.

In 2022 alone, he described eight species and one genus of freshwater fish, and discovered a further six freshwater fish species that will likely be described over the coming year.



© Roberto E. Reis

What is it about discovering and describing new species that appeals to you?

What moves me is revealing undetected biodiversity and studying their phylogenetic relationships. Discovering and describing new species completes our knowledge about the diversity of life on Earth and allows for adequate conservation planning. Revealing their phylogenetic relationships – the part I like the most – uncovers the diversification of the group and brings to light explanations on evolution, biogeography and phylogeography of organisms.

Can you talk about the process of describing a species?

This is not a simple process. It usually takes many years of detailed study of a museum or other biodiversity collection, careful fieldwork, and lots of reading of specialised literature.

Once you have the expertise, you must compare newly collected specimens (or those residing in a collection) with type-specimens (those previously used to describe species) and published descriptions. Then you will be able to find the subtle differences that can tell independent evolutionary lineages (i.e. species) apart.

In the last 20 or so years, the possibility of using DNA segments to help this process has improved our ability to detect such lineages and demonstrate they are evolving independently. This is the process of discovering undescribed diversity. Describing and publishing is a much simpler processes, that also requires some expertise and training. I am proud of having trained many grad students in both parts of the process.

Can you talk through a particularly memorable species discovery?

Back in 2003 I was conducting fieldwork in the Ucayali River in Peru, and I knew from European aquarium magazines of a new species of *Otocinclus* (a small suckermouth catfish) from that region. I spent around two weeks looking for this and other fishes and could not find it. At the end of the expedition, I was with my team at the harbour in Jenaro Herrera to take the boat back to Iquitos, and suddenly a local fish collector for the aquarium trade arrived at the harbour with dozens of flat, wooden trays coated with plastic, obviously carrying ornamental fishes to sell to the aquarium fish exporters in Iquitos. I asked permission and started peeking at each tray and eventually found one full of the new *Otocinclus* I was looking for! They were collected in a nearby creek and lake which I was not aware of! I then purchased some 30 specimens from

the fisher, preserved them during the boat trip, and used those specimens to describe *Otocinclus cocama* – a very beautiful fish!

Are there any characteristics of a place that make it more likely to have undescribed or undiscovered species living there?

Well, this is a tricky question. Obviously, I would expect unexplored areas (like the eastern Amazon, or the southern Orinoco basin) to have more unknown species. This is generally true. However, I can show you several papers, some by myself, describing new species from areas heavily sampled during the last 200 years!

At this very moment I am conducting a study describing five new species of another group of suckermouth catfish from the upper Uruguay River in south Brazil, an area that my team have collected heavily for about 30 years. Most of the fishes were already pickled and sitting on a shelf in our own museum, but were so far undetected as undescribed. It's a matter of being able to detect them.

Can you estimate how many species may yet be discovered and described in South America, and the world?

Fish is a big group with about 36,400 species today. Approximately half are freshwater and half are marine. In the last 20 years or so, an average of 104 new species are described every year for the Neotropical region alone. In 2016 I published with colleagues an article showing that we had in South America some 5,160 freshwater fish species, and we estimated a final diversity between 8,000 and 9,000 species.

***Sturisoma reisi*, one of the notable species in this report, was named after you. Are there other species named after you?**

Yes! A former PhD student described *Sturisoma reisi* in my honor. As well as that, there is *Ancistrus reisi*, *Phalloceros reisi*, *Rineloricaria reisi*, *Scleromystax reisi*, and *Brachychalcinus reisi*. *Sturisoma reisi* is a very beautiful fish, from the Guaporé River, Madeira River basin, and collected near Costa Marques in the state of Rondônia, Brazil. It's a really cool fish that lives, as most other suckermouth catfishes, in the bottom of swift creeks and rivers. This particular species can be found more commonly on logs and tree branches fallen into the water.



Rhinotocinclus isabelae Discovered by Roberto E. Reis © Daniel Konn-Vetterlein

MONSEMBULA CATFISH

Latin name: *Clarias monsembulai*

Researchers: Bernt & Stiassny 2022

Location: Tributaries of the Congo River in the Salonga National Park, Democratic Republic of Congo

Highlight: Named after a Congolese researcher and Greenpeace campaigner

In 2006 and 2010, Raoul Monsembula collected various species from rivers in the Salonga National Park in the Democratic Republic of Congo (DRC), and flew them to New York, where he had ties with the American Museum of Natural History. Fast-forward to 2022, and Max Bernt, an evolutionary biologist who studies the diversity of fishes, came across some of the samples Raoul had collected, and was quick to recognise that one fish in particular was something different. Bernt analysed the fish with ichthyologist Melanie Stiassny, who together named the new species after Monsembula, a biology professor at the University of Kinshasa and the Greenpeace regional coordinator in Central Africa, for his substantial contributions to central African ichthyology.

Stiassny, Axelrod Research Curator of Ichthyology at the American Museum of Natural History, told SHOAL, “It is really honouring Raoul. It is because of his efforts that this came to be”. She added, “He is really terrific”.

This fish is the first new species of catfish in the *Clarias* genus to be described in 42 years.

Clarias species are known as ‘air-breathing catfishes’, for the uncanny ability of some in the genus to be able to spend long periods of time out of water. The walking catfish (*Clarias batrachus*) even has the slightly disturbing knack of walking and wiggling across dry land in search for suitable aquatic habitats. But Stiassny believes it’s not likely the Monsembula catfish can survive long out of water – it lives in the tributaries of the Congo River, where humidity is high, and there is no need for fish to go looking for water.

It is likely, however, to have the ability to take occasional gulps of air, thanks to a highly vascularised appendage in its gills, known as the ‘arborescent organ’.



Raoul Monsembula © Greenpeace



© Raoul Monsembula

Monsembula told Mongabay that having the species named after him was, “just a good moment. Any biologist would love to have his name dedicated to the species on which he is working. So, it was a good surprise of my life”.

But he added that, “[We need to] keep Congo Basin forest intact to make sure that we are not disturbing its endemism. There [could] be many things we can discover in the near future if our forest stands in a good state. If we are destroying it, we are surely helping new species to disappear even before describing them”⁸.

According to Greenpeace, ‘The *Clarias monsembulai* is also an addition to over 128 fish species that have already been identified in the Salonga National Park, a UNESCO World Heritage Site and Africa’s largest tropical rainforest reserve. Plans for oil blocks in Salonga National Park have recently been scrapped, but a recent auction of 30 oil and gas blocks in DRC threatens at least 13 protected areas, including the Virunga National Park, another UNESCO World Heritage Site.’

“The biological richness of the Congo Basin rainforest stretches beyond our imagination, so it is hard to imagine how fast we are destroying it. To be an African scientist today, one has to be an African activist as well – in order to prevent all these known and yet unknown species from going extinct,” Monsembula said. “Wherever nature in the DRC is threatened by pollution and extractivism, human communities there are being displaced, impoverished and robbed of their local traditions. We, *Homo Sapiens*, will never thrive while exterminating all other species. Researching nature for me is an integral part of the campaign for improving the lives of Indigenous People, local communities and all of us who depend on nature”⁹.



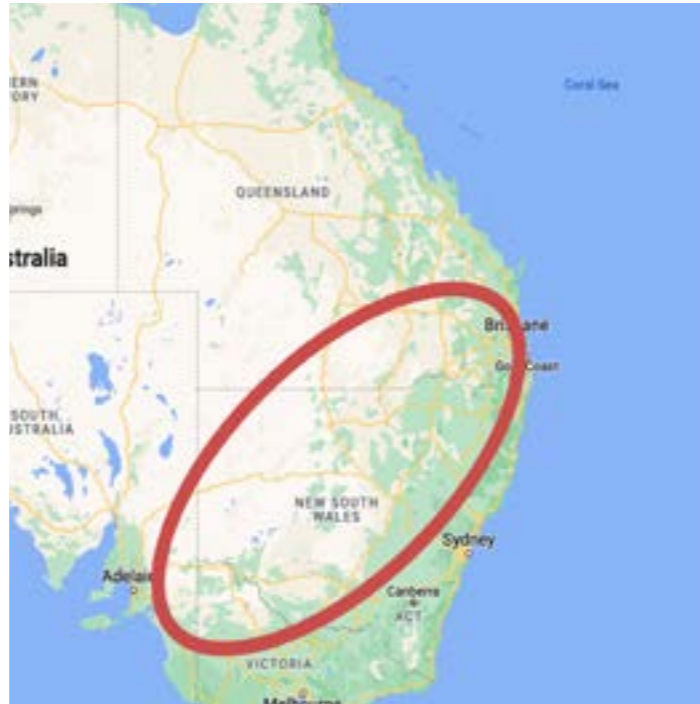
Clarias monsembulai habitat © Raoul Monsembula

AUSTRALIAN CARP GUDGEONS

Latin names: *Hypseleotris acropinna*, *Hypseleotris bucephala*, *Hypseleotris gymnocephala*, *Hypseleotris moolooloolaensis*
Researchers: Thacker, Geiger & Unmack 2022

Location: Queensland, New South Wales, Victoria, and South Australia, Australia

Highlight: A hybrid complex of Australian freshwater fishes is unravelled and given new names



Fishes in the family Eleotridae, according to Christine Thacker, Curator Emeritus of Ichthyology, Natural History Museum of Los Angeles County, and Research Associate, Santa Barbara Museum of Natural History, “normally have small populations and there are just a few species thinly spread around the world. But in Australia,” she said, “they have really exploded. They invaded the rivers from the oceans and they have formed big species radiations in the north in the Kimberley region, and also in the southeast in the coastal rivers and interior drainages”.

Each of the four *Hypseleotris* species that Thacker and colleagues described in 2022 are members of this family. They occur in southeastern Australia, where rivers drain inland low elevation plains as well as coastal mountains. In these drainages, *Hypseleotris* species occur together and often interbreed, forming distinct hybrid lineages that coexist with their parents. Many of the parents and hybrids have wide ranges, “But”, Thacker said, “we identified one parent taxon of one of the hybrids that has a very restricted range. The hybrids are found very widely – they are very common – but one of the parents is very restricted and potentially very threatened”.

As with other species that are endemic to small ranges, this gives them cause for conservation concern.

Differentiating between individual species and their hybrids can be challenging, especially when they look incredibly similar to the naked eye. Thacker and her research team used a process called single nucleotide polymorphism (SNP) genotyping, which measures genetic variations between individuals of a species, which enabled them to quantify variation among evolutionary lineages, and allowed them to assign names to each of the species.

Cryptic carp gudgeon (*Hypseleotris acropinna*) – Queensland, New South Wales, Victoria, and South Australia: The common name ‘cryptic’ refers to the extreme difficulty in distinguishing this species from its hemiclone, or hybrid offspring, with *Hypseleotris bucephala* and from the related species *Hypseleotris galii*. *Hypseleotris acropinna* was not recognised as a distinct species until identified with DNA data, despite being common and widespread.

Boofhead carp gudgeon (*Hypseleotris bucephala*) – Queensland, New South Wales, Victoria, and South Australia: Distinguished among southeastern *Hypseleotris* in possessing a blunt head with a rounded snout. The species name is formed from the Greek roots ‘bu’ meaning large, and ‘kephale’, Latinised to ‘cephalus’ meaning head, describing the blunt profile and enlarged forehead seen particularly in the males.



Hypseleotris gymnocephala male (top) and female © Daniel Geiger

Bald carp gudgeon (*Hypseleotris gymnocephala*) – New South Wales: Currently only known from two small creeks in the upper Lachlan

River in the Murray Darling Basin. The species name is formed from the Greek roots ‘gymnos’ meaning naked, and ‘kephale’, Latinised to ‘cephalus’ meaning head, describing the scaleless skin of the forehead, nape and dorsal midline anterior to the first dorsal fin characteristic of this species. The bald carp gudgeon, at the time of writing, is being proposed for listing in the threatened species list of Australia’s Environment Protection and Biodiversity Conservation Act 1999 as Critically Endangered.



Hypseleotris gymnocephala habitat © Mark Lintermans

SPOTLIGHT ON RESEARCHERS: DR. CHRISTINE THACKER

Dr. Christine Thacker is the Curator Emeritus of Ichthyology, Natural History Museum of Los Angeles County, and Research Associate, Santa Barbara Museum of Natural History.

Her research concerns the evolution, systematics, and biogeography of gobies and cardinalfishes. She established the evolutionary relationships of this diverse radiation, yielding new family and lineage level classifications for the group¹⁰.

In 2022, she described six species of sleeper goby, including two from New Zealand and four from Australia, which are highlighted in this report.



© Christine Thacker

What do you love so much about gobies?

Gobies are so wonderful! They are so important in ecosystems and are found around the world in all kinds of different habitats and it's just fascinating because they exhibit such a wide range of evolutionary strategies. The new genomics tools that are coming out are opening up a whole new frontier.

What kind of new frontier are genomics tools opening up?

The thing about gobies is that they are in many cases morphologically sort of uniform – not entirely, obviously, but there's not the range of variation that's seen in the tunas or the flatfishes or things that are larger and much easier to work with in terms of their morphological data, meaning their appearance. Gobies are small and yet they have so many important differences in terms of how they adapt to their environments and how they evolve, the way they speciate, that it's been incredibly useful to use molecular tools to get at what's going on. A lot of the time these patterns can't be seen just from the external appearance.

Taxonomy and describing species is very technical. What exactly is the process?

The first thing is that something is found, captured, and examined and people think it is unusual and wonder, 'Is this a new species?' From that initial curiosity, you look at it very carefully, the morphology, the external appearance, the scales, the fin rays, the colour, the way the tail is shaped, the mouth, the teeth maybe and any ecological information you may have – where does it live, what does it eat, how does it reproduce – and then compare it to other species that are related to it to try and determine if this is really new.

And if it's different, either in appearance or behaviour or genetics, then the next step is to determine if the differences are really consistent. So, for instance you could look at some fish and say, 'These red ones are different from these green ones,' but if you find out that the red ones are sometimes half green or the green ones are sometimes a bit reddish, maybe that's an indication that the red population is not actually a distinct species.

Once you think it's new, the next step is to determine if there's a name already assigned. And this is the paperwork part, the library research. You reach out to your colleagues, you look at field guides, at whether this has been treated by somebody else, as it's entirely possible that somebody else knows this species and

named it years ago or in some other context. You then write a paper that includes what it looks like, how it can be distinguished from its relatives, what the name is going to be, where the name comes from, what it means, and then crucially you want to provide as much information about this species as you can so that others can identify it.

It's customary in a description to include photographs, drawings, tables, and any other information that will aid others in identifying it.

Crucially, you have to deposit a type specimen: choose an individual that is representative of a species, that is preserved well, and then deposit it in a museum so that it is publicly available. There are rules about making type specimens available to others and making the paper published in an accessible form – other people need to be able to access it and use it.

What do you most enjoy about discovering and describing new species?

I think what I most enjoy about it is getting a deeper appreciation for how evolution has proceeded. In order to really understand how things are evolving, what they are doing, you need to know who's there, how many there are, you need to know what they're doing. That's sort of the foundation for any further ecological, evolutionary, or behavioural studies.

From the species that you described last year, is there one that is a standout to you?

I would say the bald carp gudgeon (*Hypseleotris gymnocephala*) is the most interesting (see p.22). It has a very restricted parental distribution, and we didn't think that we were going to find it. Chris Hardy found it in a little stream in New South Wales, Australia¹¹, and Peter Unmack and I confirmed it as a new species with our genetic work and broader sampling. It is a beautiful little fish! They don't have any scales on their heads, have tiny little faces and they have established a hybrid lineage that is incredibly widespread. The hybrids outcompete their parents. The question is, what is it about those hybrids that allow them to do better than their parents? They must have some incredible hybrid vigour. '*Gymnocephala*' means 'naked head', as it doesn't have scales on its head like most of the other taxa.

Is there anything else you'd like to add?

Freshwater ecosystems are so crucial for humans and for conservation concerns, but they also contain these unique delightful faunas that are great for all of us to appreciate.



© Christine Thacker

PATHALA EEL LOACH

Latin name: *Pangio pathala*

Researchers: Sundar, Arjun, Sidharthan, Dahanukar & Raghavan 2022

Location: Chengannur, Kerala

Highlight: Discovered by a local resident after a campaign to engage community members in citizen science

The pathala eel loach was discovered by sheer accident. Mr Abraham, a stage decorator who lives in the small town of Chengannur, in Kerala State, India, was taking a shower when a small, wriggling creature fell from the showerhead and landed on the bathroom tiles. Having been briefed on what to do if this happened, he placed the organism in a glass bottle and called a team of researchers from the Kerala University of Fisheries and Ocean Studies (KUFOS).

Mr Abraham, like other residents in certain towns and villages of Kerala State in southern India, knew to save the species and call the specialists, as the researchers had made a concerted effort to engage communities about the magnificent groundwater and subterranean biodiversity found in that part of the world. Close to 200 freshwater fish species are known from the state of Kerala of which 11 comprise evolutionarily unique and bizarre groundwater and subterranean fishes. The 11 species also encompass two endemic families and three endemic genera, highlighting that it is a hugely important region for subterranean fish species conservation. Through a series of workshops and door-to-door awareness raising from the researchers, Mr Abraham knew the small wriggling thing on his shower floor may have been more interesting than at first glance.

In fact, according to Abraham's wife Suja, these fish may have passed through their taps before, but they didn't acknowledge them because they had not been alerted to the potential for new species discoveries. "Now we're always on the lookout for these creatures in our wells, tanks and tap water, after the researchers told us about them," she said¹².

Rajeev Raghavan, one of the KUFOS researchers, and SHOAL Advisor, told SHOAL that the team discovered that the water feeding Mr Abraham's shower is connected to an overhead storage tank, which pumps water from a 17ft deep, homestead, dugout-well. He said, "The first thing our team did was to comb through Mr Abraham's overhead water storage tank. Shining a torch into the tank, our team could see three more tiny fish in there. These fish formed the basis of the scientific description that was eventually published in *Zootaxa*".



The homestead well © Rajeev Raghavan



© Rajeev Raghavan

How did the fish end up in a well? According to Raghavan, they "live in narrow lateritic aquifers from where water is drawn to the homestead dug-out wells". He added that, "The subterranean fish diversity in the lateritic landscape in the state of Kerala is exceptional, presently numbering 11 endemic species in five genera. Though the exact reasons for this high levels of micro-endemism is not fully understood, it is highly likely that they are an artefact of the complex geological and biogeographic history of the Indian subcontinent including ancient links with the Gondwanan supercontinent".

Pâtâla in Sanskrit means 'below the feet' - a nod to the subterranean realm that this species inhabits.

The discovery of the Pathala eel loach is an excellent example of the benefits of engaging local communities with science, as they can provide data that may be very difficult to find elsewhere. As a result of the work from the KUFOS team, residents in this region know what to look out for and what to do if they find something unusual, and scientists working here have in turn reported more frequent subterranean fish sightings.



Abraham and Suja © Rajeev Raghavan

RIFFLE SCULPINS

Latin names: *Cottus ohlone ohlone*, *Cottus ohlone pomo*, *Cottus gulosus wintu*
Researchers: Moyle & Campbell 2022
Location: California, USA
Highlight: Two of only three freshwater fish species described from North America in 2022



The Ohlone riffle sculpin (*Cottus ohlone ohlone*), Pomo riffle sculpin (*Cottus ohlone pomo*), and Sacramento riffle sculpin (*Cottus gulosus wintu*) are the only freshwater fish species to be discovered from North America in 2022. Using population genomics – the application of genomic technologies to study populations of individuals - researchers Moyle and Campbell demonstrated that the Ohlone riffle sculpin has two subspecies and is a separate species from the inland riffle sculpin (*Cottus gulosus*). Within the inland riffle sculpin, they also found evidence that the Sacramento riffle sculpin has a distinctive genetic background and should be recognised as a subspecies.

All are endemic to California’s watersheds and confined to cool headwater streams or rivers with cold water releases below dams.



Coastal Riffle Sculpin (*Cottus ohlone*)



Coastal Riffle Sculpin (*Cottus ohlone*) © prickly_sculpin

‘Ohlone’ honours the Ohlone people, a Native American group which lived around southern San Francisco Bay and the Santa Clara Valley. ‘Pomo’ honours the diverse native peoples who were once the principal human inhabitants of the Russian River region, which contains streams that are important habitat for Pomo riffle sculpin.

According to Moyle and Campbell, “[Each of] their populations are increasingly isolated from one another because of anthropogenic changes to California’s river systems”¹³.

Peter Moyle, Distinguished Professor Emeritus, Centre for Watershed Sciences, University of California Davis, and one of the researchers on the paper describing these species, outlined the process for concluding which of the fish were new species, and which were subspecies. He said, “We looked carefully at the studies of Jason Baumsteiger who used standard morphometrics and meristics and mitochondrial DNA to conclude the inland and coastal populations of riffle sculpin were probably different enough to be designated as species. The results showed that the two major lineages were sufficiently divergent genetically to qualify as species, indicating long isolation.



Penitencia Creed *Cottus ohlone* habitat © Jennifer Watson, ValleyWater

“The subspecies designations were a bit of a surprise, even though each subspecies occupied a separate geographic area which was reflected in the genomics. For subspecies, we figured geographic isolation was not complete or fairly recent. Thus the two subspecies of *Cottus ohlone* are found on opposite sides of San Francisco Bay, which is about 10,000 years old. The two species (*C. ohlone* and *C. gulosus*) have been separated for much longer than that”.

While *Cottus gulosus* is listed as Least Concern on the IUCN Red List, with the species having now been divided into separate species and subspecies, the conservation threat is necessarily higher. Moyle said, “The causes of decline are multiple and interacting; each population has its own problems. But most pervasive are the effects of dams that are present in virtually every permanent stream in California.

“The isolation of most populations makes extirpation more likely, one population at a time. Their small habitats are also subject to degradation, especially from urbanisation, agriculture, grazing, logging and mining. Added to all this is climate change. All species and subspecies require cool water habitats that will become increasingly restricted to higher elevations and northern latitudes as stream temperatures increase and summer base flows decrease. During periods of extended severe drought, cold water releases below most dams may disappear, with severe consequences to sculpin populations.

It may be surprising for some to read that there are still species being discovered and described in North America. Based on genomics, Moyle suggests there are still, “likely to be dozens”.

SPOTLIGHT ON RESEARCHERS: DR. MAURICE KOTTELAT

Dr. Maurice Kottelat has discovered and described hundreds of freshwater species: 472* species descriptions, to be precise, and an unknown number of discoveries, and has published 401* papers and books in a remarkable career that spans five decades.

Although he has spent the majority of his career focusing on species in Southeast Asia, he literally wrote the handbook, alongside Dr. Jörg Freyhof, on European freshwater fishes¹⁴. He also discovered the world's smallest fish, *Paedocypris progenetica*¹⁵.

*At time of writing - the number continues to rise.



What is it about discovering and describing species that appeals to you?

Discovering new species is not my primary aim; it is a nice by-product of surveying or other work for clients, and somehow demonstrates that the work was done critically, or that the money was well spent. But it is fair to say that the output is often calculated as number of species, especially new species. When it comes to non-commercial activities, I am interested in places I have not been and where I expect there will be novelties.

To be frank, describing is boring and repetitive. It was interesting at the beginning, to show what was being discovered. But now it is linked with administrative burden. Now I prefer writing books or large papers or describing species in bulk. Obviously, there is a fair amount of ego!

Also, I write because I sort of feel an obligation to make information public, for others to use for conservation, to leave a record of what existed before the construction of dams and highways, before an influx of tourists etc. I think this is a kind of moral duty. It makes me angry to read colleagues writing about a 'pristine' lake when their pictures show something totally different from what I saw when I visited the same lake years ago.

Can you talk through the process of going out into the field to search for fish?

It's all about the instinct to select places and habitats that haven't been sampled before - rapids, waterfalls, deep swamps, anything weird that people would usually avoid - and look for any fish. In fact, you can look just about anywhere there is water, including puddles and saturated soils.

What sorts of places are likely to have undiscovered species living in them?

Habitats: headwaters, rapids, wet soil, caves, swamp forests, deep water, in fact everywhere where there is water.

Areas: in Asia: Myanmar, northeast India, central Borneo, southwest Asia. New species are still being discovered in southern Europe!

What was a particularly memorable species discovery?

A trip to Laos in 1999 yielded about two new species per day for a month and a paper describing 64 new species in one shot.

At that time, the published information on the fishes of Laos was more or less restricted to the main Mekong River. Somehow reports of my surveys for hydropower clients in 1996-1997 had quickly become 'the' identification manuals. In 1999, an environment department at the World Bank (through Tony Whitten) had a programme to translate field guides from English, French, German etc into the local languages. I was asked if I could compile these reports into a single volume to be translated into Lao. I objected because there were too many areas where I had not yet sampled and where few or no ichthyologist had ever been. I negotiated to write the book only if there was funding to fill the main gaps.

I spent one month fishing in selected river basins and 'creamed' the easily accessed areas. Because of the publication deadline and the need to have valid names for the species, I had to rush a paper diagnosing as many of them as possible, which ended in a paper describing 64 new species and one new genus¹⁶.

The book came out in 2001 and the Lao version was distributed for free to fisheries and conservation agencies, NGOs, high schools and other places.

Before I started work on the fishes of Laos in 1996, about 210 species had been recorded in the country, all in the Mekong. The 2001 book includes 480¹⁷. The next edition, to be published this or next year, includes 570 named species, with about another 50 unnamed species I'll try to add.

You're potentially the only person in the world who has built a career flying round the world getting paid to discover and describe freshwater fish species. What was your route into that?

Not around the world, Asia and southern Europe are enough.

I worked in a research institution and became unhappy with several conditions and resigned. I was quickly asked to do surveys, for conservation agencies and NGOs, then for EIAs of hydropower, mining, forestry projects. I was not paid to discover new fish species, but I took time to do real surveys and brought proof of what I reported, which leads to discoveries.

When I was much younger, it was not my ambition to describe fish but to travel and see fish in their habitats.

What sorts of changes have you seen to freshwater habitats and species throughout your career?

Many areas that could only be reached after days in a boat or in a helicopter 20 years ago are now crossed by highways. Some habitats have been greatly reduced, e.g. peat swamps, or have disappeared.



Some species have become very rare and fish densities have become very low because of overfishing. Introduced species are more and more present. Even in protected areas, aquatic habitats are not given attention, and fish are seen as a resource or as food for waterbirds, not as species in themselves. It is a tragedy that a kilogram of introduced tilapia has more value than a kilogram of 20 small endemic species.

NOBLE TETRA

Latin name: *Astyanax nobre*

Researchers: Dagosta & Marinho 2022

Location: Paraguay River basin, Brazil

Highlight: Discovered in a tourist hotspot near an urban centre

The discovery of the noble tetra highlights there is still much that remains unknown about what lies beneath the surface of the planet's freshwaters, even in areas where humans gather to enjoy the water for recreation.

Described from the Salobra River, a tributary of the Cuiabá River in the Paraguay River basin, Brazil, this small tetra was discovered in a tourist hotspot, close to the large urban centre of Cuiabá in Mato Grosso State.

According to the researchers Dagosta and Marinho, “*Astyanax nobre* was collected in clear water river. [It] is one of the most abundant fish species in the locality. Individuals are very used to the human presence; frequently approaching the swimmers to nibble skin from the legs and arms.

“The discovery of a new species in an underwater tourist point relatively near a large urban centre underscores that even fish species daily observed by hundreds of people in limpid waters may lack a formal taxonomic identity. Such finding also highlights how the megadiverse Brazilian freshwater ichthyofauna still needs efforts and investments to identify and describe new taxa”.

The noble tetra is endemic to Brazil, and only known from its type locality. Only snorkelling is allowed at the tourist site, so it is thought there is likely low environmental impact. The headwaters of the Cuiabá River are relatively well protected and, given that no significant environmental threats were identified for the species, it has been assessed as Least Concern according to the International Union for Conservation of Nature categories and criteria.

Dagosta and Marinho said that, “*Astyanax nobre* was discovered at an underwater tourist point, which means that even species daily observed by hundreds of people in limpid waters can lack a formal taxonomic identity. Interestingly, the case of *A. nobre* is not exclusive. Several freshwater fish species from popular underwater tourist points in Brazil were described in the last decades. If fish diversity that is daily observed is barely known, what can be predicted for the ichthyofauna that inhabits turbid water rivers, or even deep channel of rivers? Definitely, there are many more species waiting to be described¹⁸.



Noble tetra type locality © M. A. Junghans



© W. Ohara

NOTABLE MENTIONS

Tembeassu titanicus, Peixoto, Campos-da-Paz, Menezes, de Santana, Triques & Datovo (2022). Systematics of Neotropical electric knifefish *Tembeassu* (Gymnotiformes, Apterontidae).

Weakly electric. South American ghost knifefishes are the fastest discharger of electricity in animal kingdom.

Sturisoma reisi, Londoño-Burbano & Britto (2022). A new species of *Sturisoma* Swainson, 1838 (Loricariidae: Loricariinae), from the Madeira River basin, with a discussion of historical biogeography of western Amazonas and Paraguay River basins.

Sturisoma means ‘sturgeon bodied’ - it is a very elegant fish. Named after Roberto E. Reis (see p. 18).

Synbranchus royal, Sabaj Pérez, Arce H. & de Sousa (2022). *Synbranchus* of the Middle to Lower Xingu Basin, Brazil, with the description of a new rheophilic species, *S. royal* (Synbranchiformes: Synbranchidae). A species of swamp eel. Several species in the Synbranchidae are well known for their amphibious habits and the presence of accessory air breathing organs (see e.g., Rosen & Greenwood, 1976; Liem, 1987; Munshi et al., 1989a, b) that enable them to undertake overland excursions.

Coelonotus kaupuae, Haÿ, Mennesson, Keith & Lord (2022). A new species of freshwater pipefish (Teleostei: Syngnathidae: Coelonotus) from Papua New Guinea.

Males in the Syngnathidae family carry fertilised eggs in a ventral pouch, taking care of them until they hatch.

Oryzias landangiensis, Utama et al. (2022). Deeply divergent freshwater fish species within a single river system in central Sulawesi.

A Sulawesi ricefish in an area of deeply divergent fish species, even in the same river system.

Astronotus mikoljii, Lozano, Lasso-Alcalá, Bittencourt, Taphorn, Perez & Farias (2022). A new species of *Astronotus* (Teleostei, Cichlidae) from the Orinoco River and Gulf of Paria basins, northern South America. An Oscar cichlid named after Venezuelan explorer Ivan Mikolji.

Pethia dikhuensis, Praveenraj, Limaakum, Knight, Moulitharan & Imchen (2022). *Pethia dikhuensis* (Teleostei: Cyprinidae), a new species from Nagaland, Northeast, India.

Unique among all species of barbs because the male fish of this species have reddish-orange fins and bodies. An attractive fish.

Pseudohemiodon almandarizi, Provenzano, Argüello & Barriga Salazar (2022). *Pseudohemiodon almandarizi* Provenzano-Rizzi & Argüello & Barriga-Salazar 2022, new species.

This species has more of a slender body than any other member of this genera and the ventral fins are very large. A very elegant fish.

FULL LIST

Aborichthys bajpali
Akysis patrator
Amblyceps hmolaii
Ammoglanis nheengatu
Ancistrus luzia
Aphyosemion mitemelense
Aspidoras aldebaran
Astronotus mikoljii
Astyanax nobre
Australoheros mboapari
Australoheros ricani
Cambeva alphabelardense
Cambeva betabelardense
Cambeva gamabelardense
Cambeva melanoptera
Capoeta svanetica
Chaetostoma orientale
Characidium krenak
Clarias monsembulai
Clarias rennyae
Cobitis indus
Coelonotus kaipuae
Congochromis rotundiceps
Corydoras hypnos
Corydoras psamathos
Corydoras thanatos
Cottus cyclophthalmus
Cottus gulosus wintu
Cottus ohlone ohlone
Cottus ohlone pomo
Ctenochromis scatebra
Cyphocharax caboclo
Cyphocharax tamuya
Dario melanogrammus
Dario tigris
Devario ahlanderi
Diapoma pampeana
Diapoma potamohadros
Eigenmannia bumba
Eigenmannia cacuria
Eigenmannia robsoni
Enteromius radari
Exostoma dhritiae
Fundulus herminiamatildae
Garra deccanensis
Garra rezai
Geophagus pyrineusi
Geophagus pyrocephalus
Glaridoglanis ramosa

Glyptothorax yuensis
Gobiobotia lii
Gobiomorphus dinae
Gobiomorphus mataeraerore
Guigarra cailaoensis
Haplochromis aquila
Haplochromis curvidens
Haplochromis falcatus
Haplochromis glaucus
Haplochromis kimondo
Haplochromis latifrons
Haplochromis pardus
Haplochromis quasimodo
Haplochromis rex
Haplochromis simba
Harttia canastra
Hemiculter nikolskyi
Hemiculter yungaoi
Hemimyzon yushanensis
Heptapterus carmelitanorum
Homatula geminusclathratus
Homatula longibarbus
Homatula microcephala
Homatula robusta
Hongshuia brevibarba
Hyphessobrycon atencioi
Hyphessobrycon barranquilla
Hyphessobrycon bayleyi
Hyphessobrycon comodoro
Hyphessobrycon corozalensis
Hyphessobrycon olayai
Hyphessobrycon quibdoensis
Hyphessobrycon reya
Hypostomus fuscomaculatus
Hypostomus krikati
Hypostomus velhomonge
Hypseleotris acropinna
Hypseleotris bucephala
Hypseleotris gymnocephala
Hypseleotris moolooboolaensis
Hypselobarbus nitidus
Hypselobarbus procerus
Knodus guajajara
Lacustricola margaritatus
Lentipes niasensis
Lethrinops atrilabris
Liobagrus brevispina
Liobagrus chengduensis
Listrura menezesi

Marcusenius elegans
Mesoaphyosemion losantosi
Mesoaphyosemion montealenense
Microlepidogaster roseae
Microphysogobio oujiangensis
Mikrogeophagus maculicauda
Misgurnus amamianus
Misgurnus chipisaniensis
Moema juanderibaensis
Mustura daral
Mustura yangi
Mystus cyrusi
Mystus irulu
Nemacheilus cacao
Nemacheilus pezidion
Neodontobutis lani
Nothobranchius balamaensis
Odontesthes crossognathos
Oryzias kalimpaaensis
Oryzias landangiensis
Osteochilichthys elegans
Osteochilichthys formosus
Oxynoemacheilus axylos
Oxynoemacheilus eliasi
Pangasius icaria
Pangio pathala
Paracanthocobitis epimekes
Paracanthocobitis hijumensis
Paracanthopoma ahriman
Paracanthopoma capeta
Paracanthopoma carrapata
Paracanthopoma daemon
Paracanthopoma irritans
Paracanthopoma malevola
Paracanthopoma satanica
Paracanthopoma truculenta
Paracanthopoma vampyra
Parakneria alytogrammus
Parananochromis moutingae
Pareiorhaphis pumila
Parotocinclus hardmani
Parotocinclus pukuixe
Pethia dikhuensis
Phenacorhamdia sua
Plataplochilus eliasi
Poecilocharax callipterus
Poecilocharax rhizophilus
Ponticola hircaniaensis
Pseudohemiodon almendarizi
Pseudohomaloptera tecta
Pseudolaguvia meghalayaensis
Rhinogobius aonumai
Rhinogobius ishigakiensis

Rhinogobius lianchengensis
Rhinogobius lingtongyanensis
Rhinogobius yangminshanensis
Rhinotocinclus discolor
Rhinotocinclus isabelae
Rhinotocinclus loxochelis
Rhinotocinclus marginalis
Rhinotocinclus pilosus
Rineloricaria quilombola
Rineloricaria zawadzki
Rivulus adrianae
Salminus santosi
Salmo araxensis
Salmo ardahanensis
Salmo murathani
Satanoperca setepele
Schizothorax gulinensis
Scleronema (Plesioscleronema) auromaculatum
Silurichthys exortivus
Silurichthys insulanus
Squalius verepi
Steatocranus masalamasoso
Sternopygus sabaji
Sturisoma reisi
Synbranchus royal
Tachysurus latifrontalis
Tanichthys albiventris
Tanichthys dongxingensis
Tanichthys flavianalis
Tanichthys guipingensis
Tanichthys hainanensis
Tanichthys huidongensis
Tanichthys luheensis
Tanichthys shenzhenensis
Tatia luisae
Tembeassu titanicus
Trichomycterus altipombensis
Trichomycterus araxa
Trichomycterus barrocos
Trichomycterus brucutu
Trichomycterus illuvies
Trichomycterus ipatinga
Trichomycterus largoperculatus
Trichomycterus mutabilicolor
Trichomycterus saquarema
Trichomycterus tantalus
Trichomycterus vinnulus
Triplophysa daryoae
Triplophysa qini
Triplophysa xuanweiensis

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