

Symposium on Systematics and Diversity of Fishes

Program

6 July 2013

- 9:30-10:00 **Registration**
- 10:00 **Opening Remarks**
- 10:10-10:50 **Redefinition of and relationships within the Acanthuroidei based on adult and larval morphology.**
Jeffrey M. Leis¹ and Anthony C. Gill²
(¹Australian Museum and University of Tasmania, AUSTRALIA; ²The University of Sydney, AUSTRALIA)
- 10:50-11:30 **A ‘living fossil’ eel (Anguilliformes: Protanguillidae, fam. nov.) from an undersea cave in Palau.**
G. David Johnson¹, Hitoshi Ida², Jiro Sakaue³, Tetsuya Sado⁴, Takashi Asahida² and Masaki Miya⁴
(¹National Museum of Natural History, Smithsonian Institution, USA; ²Kitasato University, JAPAN; ³Southern Marine Laboratory, PALAU; ⁴Natural History Museum and Institute, Chiba, JAPAN)
- 11:30-13:00 **Lunch**
- 13:00-13:50 **Poster Session**
- 13:50-14:30 **Connection of fish diversity to biomimetics: a challenge for the National Museum of Nature and Science.**
Gento Shinohara
(National Museum of Nature and Science, JAPAN)
- 14:30-15:10 **Flatfishes (Teleostei: Pleuronectiformes): A contemporary view of species diversity.**
Thomas A. Munroe

(National Museum of Natural History, Smithsonian Institute, USA)

15:10-15:40 **Coffee Break**

15:40-16:20 **The biodiversity of coral reef fishes: from patterns to processes.**

David R. Bellwood

(James Cook University, AUSTRALIA)

16:20-17:00 **Speciation in Coral reef fishes.**

Luiz A. Rocha

(California Academy of Sciences, USA)

17:00-17:40 **Climate change, ocean acidification and reef fish diversity.**

Philip L. Munday

(James Cook University, AUSTRALIA)

18:00-20:00 **Mixer** (buffet style dinner with drinks)

Abstracts of Oral Presentations

Redefinition of and relationships within the Acanthuroidei based on adult and larval morphology

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We redefine the Acanthuroidei to include the traditional acanthuroid families (Acanthuridae, Ephippidae, Luvaridae, Scatophagidae, Siganidae, Zanclidae) and several families usually placed within the Percoidei (Chaetodontidae, Drepaneidae, Leiognathidae, Lobotidae, Pomacanthidae). The included families share a specialised mode of tooth replacement. Based on larval morphology (particularly head spination, sculpting on the skull, early development of posteriorly-placed pelvic fins, pigmentation, and body shape) and adult morphology (dorsal gill-arches) the Lobotidae is newly diagnosed to include the genera *Lobotes*, *Datnioides* and *Hapalogenys*. These three genera have traditionally been placed in the families Lobotidae, Datnioididae and Haemulidae, respectively, although *Hapalogenys* was sometimes placed in a separate Hapalogenyidae. The Lobotidae forms the sister group of the remaining acanthuroids. The Leiognathidae is nested within a clade consisting of the traditional acanthuroids on the basis of a number of synapomorphies, including a single postcleithrum, five or fewer branchiostegals and absence of the interarcual cartilage. The sister group of the Acanthuroidei remains unclear.

A ‘living fossil’ eel (Anguilliformes: Protanguillidae, fam. nov.) from an undersea cave in Palau

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In February of 2009, research diver Jiro Sakaue descended into a fringing reef cave in the western Pacific Ocean Republic of Palau and probably became the first human being to lay eyes on an unusual eel-like fish, with a shorter body and relatively larger head than is typical of true eels (Anguilliformes) and unique fringed, collar-like elevations of the gill openings. The fish seemed oblivious to Sakaue's presence and he was able to easily capture it, and on subsequent dives collected nine additional specimens and shot a video of one of them. Further study showed this fish to be a new genus and species of anguilliform that exhibits an unusual suite of morphological characters. Many of these uniquely characterize the Recent members of the 19 families and the Cretaceous fossils comprising the elopomorph order Anguilliformes, the true eels. Others are found among anguilliforms only in the Cretaceous fossils, and still others are primitive with respect to both Recent and fossil eels. Thus, morphological evidence explicitly places it as the most basal lineage (i.e. the sister group of extant anguilliforms). Phylogenetic analysis and divergence time estimation based on whole mitogenome sequences from various actinopterygians, including representatives of all eel families, demonstrate that this fish represents one of the most basal, independent lineages of the true eels, with a long evolutionary history comparable to that of the entire Anguilliformes (approx. 200Myr). Such a long, independent evolutionary history dating back to the early Mesozoic and a retention of primitive morphological features (e.g. the presence of a premaxilla, metapterygoid, free symplectic, gill rakers, pseudobranch and distinct caudal fin rays) warrant recognition of this species as a 'living fossil' of the true eels, which we described as *Protanguilla palau* genus et species nov. in the new family Protanguillidae. To date *Protanguilla* is known only from the single cave off the coast of Palau. However, historically it must have been much more widely distributed, because the Palau-Kyushu Ridge formed only around 60–70 Ma. Furthermore, as an elopomorph, it almost certainly has a leptocephalus larva with a long planktonic duration. Accordingly, we believe that *Protanguilla* probably has a considerably broader distribution than currently known.

**Connection of fish diversity to biomimetics: a challenge for
the National Museum of Nature and Science**

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The National Museum of Nature and Science holds about 3 million specimens in the fish collection. It still contains a huge number of uncatalogued specimens (e.g., fish larvae and demersal fishes donated from Japanese fishery institutes, which were collected worldwide). In order to give graduate students experience in fish identification and research, these specimens have been utilized in several workshops that have been held since 2008, to which specialists have been invited. Ichthyologists usually observe many characters on the body of fresh or preserved specimens. In addition to shapes and colors, scales and seismosensory systems are frequently examined—the detailed investigation sometimes requires costly instruments (e.g., scanning electron microscope: SEM) and/or special staining techniques (e.g., Cyanin Blue). Although the ichthyologists often examine curious morphological characters under the microscope, their functions of the characters are seldom considered. On the other hand, researchers of design and engineering of materials and/or machines pay attention to fish body shapes and surface structure. For example, skins of rapidly swimming fishes (e.g., some sharks and tunas) have been studied to develop mechanisms for reducing skin friction drag that are being applied to swimming suits and others uses. Unfortunately, such researchers usually lack not only a body of knowledge about the diversity of fishes but also a chance to examine fish specimens. Since 2012 I have been collaborating in a Biomimetics Project with Japanese physicists that is investigating body surface structures of various fishes using digital microscopy and SEM. Digital images of skins collected from fish specimens along with collection data and species information will be stored in a biomimetic database. The database will not only be a repository for resources about the morphological structures of fishes, but will also provide many opportunities for interdisciplinary studies between scientists in different fields. It is expected that new academic communities will promote the field of functional morphology of fishes by revealing the morphological diversity of the microscopic world.

Flatfishes (Teleostei: Pleuronectiformes): A contemporary view of species diversity

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Flatfishes (Teleostei: Pleuronectiformes) undergo an extreme form of ontogenetic development where one eye migrates to the opposite side of the head. Due to this morphological asymmetry, flatfishes are a distinctive group of fishes whose adults are easily recognized. Flatfishes occur in all of the world's oceans spanning a global distribution from north Polar seas to the waters off Antarctica. The majority of flatfish species occur in marine and estuarine waters, with relatively few species inhabiting freshwater ecosystems. Current estimates of the diversity of flatfishes indicate that approximately 800+ species in about 123 genera should be recognized as valid taxa. The most diverse flatfish families (with 100+ species/family) include the Soleidae, Bothidae, Cynoglossidae, and Paralichthyidae. Families representing medium levels of diversity (ca. 21-64 species/family) include the Pleuronectidae, Achiridae, Samaridae, Rhombosoleidae and Poecilopsettidae. Other families, such as the Scophthalmidae, Achiropsettidae, Citharidae, Psettodidae, Tephriectidae, and Paralichthodidae contain the lowest levels (ca. 1-10 species/family) of species diversity among pleuronectiform families. Geographically, the highest diversity of flatfish species occurs in the tropical Indo-Pacific region. Ecologically, the highest diversity of species is represented by flatfishes that inhabit the continental shelf. Relatively few flatfish species from a variety of families and genera occur in the deep sea (> 1,000 m). Current rates of species discovery indicate that ichthyologists are continuing to find new species at a pace similar to that when scientific nomenclature began in 1758 indicating that we are still not close to knowing the total diversity of flatfishes. A number of factors, including both those related to the fishes themselves and those related to activities of systematic ichthyologists, influence the probability that a flatfish species will be discovered. Several factors related to systematic activities have changed over time and the impacts of these changes will be discussed relative to species discovery rates for the Pleuronectiformes, with specific examples highlighted from recent and on-going systematic studies of Indo-West Pacific and New Zealand flatfishes. Finally, some thoughts on several topics relevant to the progress and future direction of species discovery of flatfishes will be presented.

The biodiversity of coral reef fishes: from patterns to processes

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In coral reef biogeography, there have been major advances in our understanding of the relationships among fishes as a result of a rapid expansion in the field of molecular phylogenetics. Yet our biogeographic hypotheses are frequently set in a framework originally conceived with no knowledge of phylogenetic relationships and often revolve around explaining distribution patterns. To explore the implications of this history, I will examine two central, but related, paradigms in coral reef fish biogeography: the role of coral reefs as cradles of biodiversity and the origins of the marine biodiversity hotspot. In both cases, recent molecular evidence has largely resolved earlier hypotheses. The challenge now is to identify the key questions that will help us to move forward in order to understand and cope with a rapidly changing biosphere.

Speciation in coral reef fishes

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Covering less than 0.1% of the ocean's surface, coral reefs harbor ~5,000 fish species, or about a third of all marine fishes. Interestingly, very few strong biogeographic barriers exist in the oceans, and most coral reef fishes have a widely dispersing pelagic larval stage. This observation creates a paradox of high species diversity combined with apparently few opportunities for the commonly accepted allopatric speciation model. I will present a summary of current hypotheses to explain this paradox, as well as phylogeographic and phylogenetic data for several groups reef fishes and talk about how next generation sequencing is revolutionizing studies in this field.

Climate change, ocean acidification and reef fish diversity

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Climate change and ocean acidification will affect tropical marine fishes in many ways, ranging

from indirect effects associated with habitat degradation and altered resource availability, to the direct effects of rising water temperature and ocean acidification on individual performance. In the short-term, the projected impact of climate change on reef fishes is largely tied to the fate of coral reef habitat, which is highly vulnerable to elevated temperature, ocean acidification and stronger storms. There is good evidence that climate-induced coral bleaching affects the community structure and abundance of reef-associated fishes, especially when it leads to the structural collapse of reef habitat. Coral-dependent fishes suffer the most rapid population declines as coral is lost, however, many other species will exhibit long-term declines due to loss of settlement habitat and erosion of habitat structural complexity. In the longer-term, warmer ocean temperatures will also have significant effects on reef fish diversity and community structure. Recent research indicates that some coral reef fish are sensitive to increases in average summer temperature within the range projected to occur in the ocean over the next 50-100 years. Aerobic performance, growth and reproductive output are all affected. Equatorial populations of reef fishes appear to be at greatest risk because they are living closer to their thermal optima compared with populations of the same species from higher latitudes. Finally, CO₂ levels that could be reached towards the end of the century affect the sensory abilities and behaviour of reef fishes, with consequences for critical ecological processes such as habitat selection, timing of settlement, predator-prey interactions and population replenishment. In this talk I will outline the evidence for predicted impacts of climate change and ocean acidification on reef fish diversity and discuss the prospects for adaptation to these threats.