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SHORT REPORT

Rediscovery of oxudercine type specimens (Teleostei: Gobiidae) assumed destroyed during World War II

Peter Konstantinidis[1] · Zeehan Jaafar[2,3] · Peter Warth[4] · Matthias Stoll[5] · Uwe Hossfeld[6,7]

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Abstract Walter Bruno Eggert described nine species and fifteen subspecies of the oxudercine genus *Periophthalmus* in 1929 and 1935. His descriptions were based primarily on specimens collected by Jürgen Wilhelm Harms during several expeditions to South-east Asia and Japan. The whereabouts of many of the type specimens were unknown, and were presumed destroyed during World War II. We recently rediscovered the type material for six species and ten subspecies in the collection of the Phyletic Museum in Jena, Germany. We provide detailed accounts of this material and the historical figures involved in safeguarding them during the tumultuous war years.

Keywords *Periophthalmus* · Oxudercinae · Mudskippers · Phyletic Museum

✉ Peter Konstantinidis
peterk@vims.edu

[1] Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062, USA

[2] Department of Biological Sciences, National University of Singapore, Singapore, Singapore

[3] Division of Fishes, Department of Vertebrate Zoology, Smithsonian Institution, National Museum of Natural History, MRC 0159, P.O. Box 37012, Washington, DC 20013-7012, USA

[4] Institute of Systematic Zoology and Evolutionary Biology with Phyletic Museum, Friedrich-Schiller-University, 07743 Jena, Germany

[5] Faculty of Science, Eberhard-Karls-University, 72076 Tübingen, Germany

[6] Biology didactics, Friedrich-Schiller-University, 07743 Jena, Germany

[7] University ITMO, 191002 St. Petersburg, Russia

Introduction

In the early 1900s, Walter Bruno Eggert described nine new species and fifteen new subspecies (including two nominal subspecies) of oxudercine gobiid fishes of the genus *Periophthalmus* (Teleostei: Gobiidae: Oxudercinae; Fig. 1a), most of which were collected in Indonesia (Eggert 1929a, 1935). These fishes, commonly known as mudskippers, are able to survive out of water for extended periods and can be observed foraging on tropical mudflats in the Indo-Pacific and western Africa (Swennen et al. 1995; Takita and Agusnimar 1999; Takeda et al. 2011; Takita et al. 2011). The publication by Eggert was, at that time, the most comprehensive treatise of the genus, as he took into account a multitude of factors—external anatomy, osteology, myology and behaviour—when considering the evolution of terrestriality in these fishes. Ichthyologists interested in oxudercine gobies assumed that the specimens Eggert used to describe the new species and subspecies were deposited in the natural history collections of the Eberhard-Karls-University in Tübingen, Germany, where Eggert was then based. In 1989, Edward O. Murdy revised the subfamily Oxudercinae, in which the genus *Periophthalmus* is classified. In preparation for this work, Murdy attempted to locate and examine all extant type material of the subfamily. He traced the location of some *Periophthalmus* specimens to Tübingen, based on the data provided in the species descriptions (Eggert 1929a, 1935). Murdy corresponded via letters with Gerhard Mickoleit, who was then in charge of the zoological collection at Eberhard-Karls-University. When a loan of *Periophthalmus* specimens used by Eggert was requested, Murdy was informed that the specimens were destroyed during World War II (Murdy 1989).

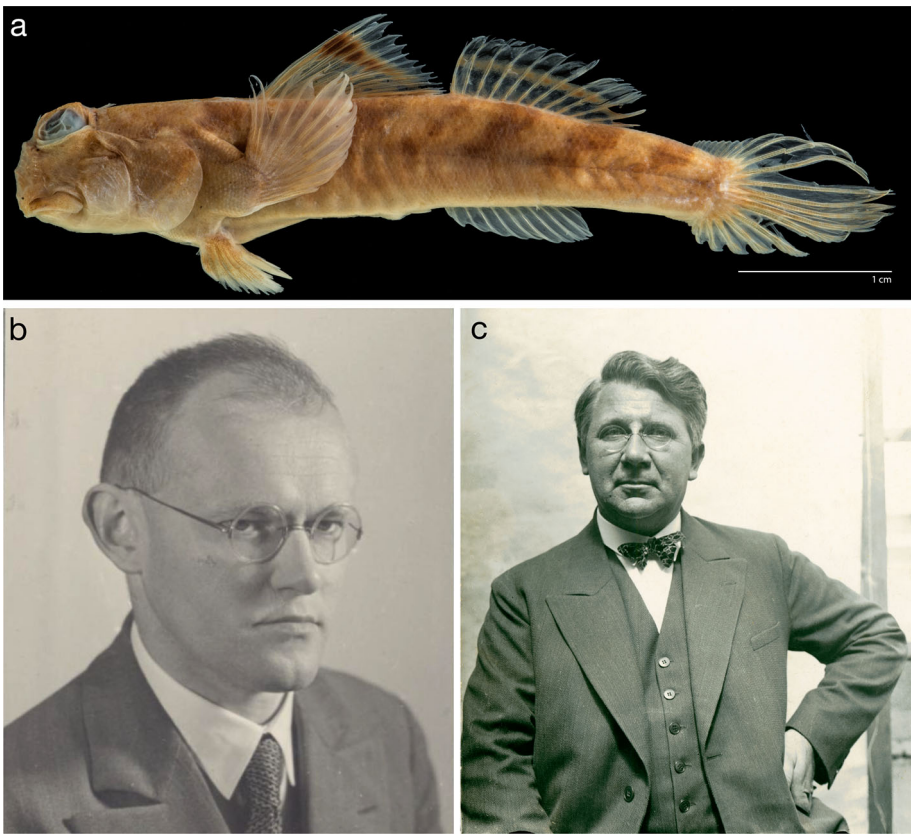

Fig. 1 **a** The type specimen of *Periophthalmus harmsi* (photographed by Sandra Raredon), **b** Dr. W. Bruno Eggert (year of photograph unknown)**, c** Prof. Jürgen Wilhelm Harms (year of photograph unknown)

While preparing a review of the genus *Periophthalmus*, the second author contacted several museums in 2013 to gain permission to examine historical collections. Upon receiving the list of extant material of specimens of *Periophthalmus* from the Phyletic Museum in Jena, Germany, she realized that these were the very specimens used by Eggert in his descriptions that were assumed destroyed. The rediscovery of some of these type specimens, after being "lost" for over five decades, will clarify nomenclatural and taxonomic problems within the genus (Jaafar et al. in prep.). Here, we provide a historical account of the procurement of these fishes and the scientists involved in ensuring the safeguarding of the type specimens during the tumultuous years of war in Europe. We also include a list of all species described by Eggert and an assessment of the condition of the extant specimens we examined.

Walter Bruno Eggert

As the author of these new taxa, Walter Bruno Eggert (19 Feb. 1902–19 May 1938; Fig. 1b) is central to this narrative. He was a broadly skilled zoologist who first began his academic career at the Albertus University in Königsberg, the capital of Eastern Prussia (now Russian territory and renamed Kaliningrad) in 1922. Before his graduation, he transferred to Eberhard-Karls-University in Tübingen, Germany. This move was precipitated by the relocation of his mentor, Professor Harms (Fig. 1c), who accepted a tenured position there (Boehm et al. 1994). Under Harms' tutelage, Eggert was awarded his Ph.D. in Tübingen on 19 November 1925; his dissertation focused on sexual changes during the life history of *Bufo vulgaris* (=*Bufo bufo*). In 1931, Eggert received the *Venia legendy* (Habilitation) at the same university based on studies of the urogenital systems of gobioid and blennioid fishes.

Eggert was a prolific scientist despite his short career. In addition to the taxonomic treatise of the goby genus *Periophthalmus* (Eggert 1929a, 1935), he studied their modified pectoral fins to understand terrestrial locomotion (Eggert 1929b) and published several papers on the morphology and histological physiology of thyroid glands in lower tetrapods (e.g. Eggert 1938). In the papers in which he described the new species, Eggert (1929a, 1935) did not state where the specimens he used were eventually deposited.

During his only expedition to Indonesia in 1926/27, Eggert became infected with tuberculosis from which he never recovered. According to the records from the archives of Tübingen University, his health fluctuated in succeeding years. In 1932, his poor health forced him to suspend his academic activities to recuperate in a hospital

in the Black Forest, Germany, close to the border of France. Eggert also faced financial difficulties; his colleagues, including Harms, sent letters to the Dean of the University urging financial support to secure his rehabilitation. On 23 April 1938, the Dean of Natural Sciences at the Eberhard-Karls-University of Tübingen appointed Eggert as a non-tenured professor. Shortly before Eggert was to begin this position, he died on 19 May 1938 at 36 years of age.

Jürgen Wilhelm Harms and the expeditions to Indonesia

Another central figure in the preservation of these type specimens is Jürgen Wilhelm Harms (2 Feb. 1885–2 Oct. 1956), who was born in Bargdorf, a small village in northern Germany (Pflugfelder 1966). Harms' interests spanned diverse fields, and he published widely in systematics, morphology, physiology, developmental biology and genetics. Harms spent time in various universities, in England and Germany, such as Plymouth, Manchester, Cambridge, Bonn, Marburg, and Münster. In 1922, Harms accepted a position at the Albertus Magnus University in Königsberg where he resided until he accepted a tenured position at the Eberhard-Karls-University in Tübingen in 1925. Some of his students from Königsberg followed Harms to Tübingen, among them was Walter Bruno Eggert (Pflugfelder 1965).

Between 1926 and 1939, Harms organized and led several expeditions. Eggert joined him for the first expedition in 1926/27 to Java and Sumatra in Indonesia. Eggert studied the mudskippers obtained from this and succeeding, expeditions (Boehm et al. 1994). Harms' second expedition (1928–30) led him to Sumatra, the Moluccas, New Guinea, northern Australia, and South China. The focal point of this expedition was the flora and fauna of mangrove forests. Harms went on several more expeditions: the Cocos and Christmas Islands between 1932 and 1933, and to Sumatra and Japan between 1939 and 40 (Boehm et al. 1994).

On 10 October 1935, Harms accepted, as the successor of Ludwig Plate (1862 – 1937), a position as the director of the Zoological Institute and the affiliated Phyletic Museum (Fig. 2) at the Friedrich-Schiller-University in Jena, Germany. During World War II, and especially at the end of the war in 1945, Jena was heavily bombed. The Zoological Institute and the Phyletic Museum were not severely affected by the extensive bombings of the allied air force, except for the broken windows of the building and the glass showcases (Fischer et al. 2008). It is not known when the type specimens of *Periophthalmus* were moved from Tübingen to Jena. Reports stated that an extensive live and

Fig. 2 The Phyletic Museum in Jena, Germany with the tree of life symbol and the terms 'Ontogeny' and 'Phylogeny' coined by Ernst Haeckel. Ernst Haeckel founded the museum in 1807

preserved collection, ranging from protozoan cultures to live apes, followed Harms when he relocated to Jena (Boehm et al. 1994). We assume the specimens of *Periophthalmus* that Eggert used were also moved during this time.

Harms left Jena on 26 November 1949 (Boehm et al. 1994), shortly after the Soviet-occupied sector of Germany became the German Democratic Republic (GDR), and at a time when Lysenkoism influenced science in Russia and the associated territories (Hossfeld and Olsson 2002). He returned to the Institute of Anatomy of the University of Marburg as a guest professor where he spent the majority of his time until his death on 2 October 1956 (Pflugfelder 1965).

Type specimens of *Periophthalmus* spp. described by Bruno Eggert

Most of the specimens that Eggert used to describe the mudskippers were collected by Harms in Indonesia, and as we now know, were eventually deposited at the Phyletic Museum in Jena (we propose the acronym PMJ for the ichthyological collection), a small town within the Thuringia state in Germany. The Phyletic Museum was founded by Ernst Haeckel and, to this day, is funded entirely through private donations. The foundation of the building was laid on 28 August 1907, coinciding with the birthday of the German philosopher and naturalist Johann Wolfgang von Goethe. On 30 July 1908, Haeckel entrusted the museum to the Friedrich-Schiller-University in Jena for its 350th anniversary (Fischer et al. 2008).

The museum houses a collection of 500,000 specimens that dates back to the 18th century when Goethe was active as a comparative anatomist. The museum was primarily built to house a teaching collection to illustrate the

Table 1 Current status and summary of all species of *Periophthalmus* described by Bruno Eggert

Genus	Species	Subspecies	Year Described	Locality	Catalogue Number	Number of Specimens Received	Current Status	Remarks
Periophthalmus	*argentilineatus*	*striopunctatus*	1935	Indonesia, Borneo, Balikpapan	PMJ 647	5	Syntype	Material appears to have been previously dried and rehydrated
	cantonensis	*novaeguineaensis*	1935	Neuguinea/ Merauke	ZMA 119466	1	Lectotype	Lectotype designated by Murdy (1989)
					ZMA 112943	1	Paralectotype	Material not examined
					ZMA 112944	2	Paralectotype	Material not examined
					ZMA 112945	21	Paralectotype	Material not examined
	dipus	*angustiformis*	1935	Flores/ Mbawa	ZMA 113218	1	Lectotype	Lectotype designated by Eschmeyer (1998)
					ZMA 113218	1	Paralectotype	
	dipus	*parvus*	1935	Indonesia, Sumatra, Belawan	PMJ 646	1	Syntype	
	gracilis		1935	Indonesia, Java, Tjilatjap	PMJ 657	8	Syntype	
					PMJ 770	4	Syntype	One specimen without head
					PMJ 790	7	Syntype	
					PMJ 791	14	Syntype	
					PMJ 1086	3	Syntype	
					PMJ 1087	2	Syntype	
				Indonesia, Sumatra, Siboga	MSNG	2	Syntype	Eggert (1935) reported 2 specimens. Material reported lost by Eschmeyer (1998)
	harmsi		1929	Indonesia, Java, Popole Island	PMJ 752	1	Syntype	
	koelreuteri	*africanus*	1935	Dar es salaam	ZMB 18365	1	Holotype	Probable holotype. Material not examined
	koelreuteri	*albostriatus*	1935	Indonesia, Java, Popole Island	PMJ 763	1	Syntype	Eggert (1935) reported 2 specimens.
	koelreuteri	*velox*	1935	Batavia/ Amsterdam Island	PMJ 650	2	Syntype	
	malaccensis		1935	Singapore	PMJ 1085	1	Type	
	minutus		1935	Indonesia, Sumatra, Deli River	PMJ 719	7	Syntype	
	pearsei		1935	India, Port Canning, Matla	Not recovered	8	Syntype	Material not recovered. Eggert (1935) reported 8 specimens.
	schlosseri	*argentiventralis*	1935	Indonesia, Edam Island	PMJ 785	3	Syntype	Eggert reported that tails of all specimens removed for histology

Table 1 continued

Genus	Species	Subspecies	Year Described	Locality	Catalogue Number	Number of Specimens Received	Current Status	Remarks
	sobrinus		1935	Red Sea	MSNG 7892, MSNG 23257	14	Syntype	Probable syntypes. Eggert (1935) reported 14 specimens.
	variabilis	*asiaticus*	1935	Thailand, Paknam	PMJ 642	2	Syntype	Material previously dried and rehydrated
	variabilis	*sumatranus*	1935	Indonesia, Sipoerah, Ment.	PMJ 722	4	Syntype	
				Indonesia, Belawan	PMJ 731	5	Syntype	
				Indonesia, Baknan, Brandan	PMJ 756	8	Syntype	
				Indonesia, Batavia	PMJ 1091	1	Syntype	
	variabilis	*tidemani*	1935	Moluccas/ Halmahera/ Baboe Island	Not recovered	3	Syntype	Material not recovered. Eggert (1935) reported 3 specimens.
	variabilis	*variabilis*	1935	Indonesia, Java, Tjilatjap	PMJ 813	2	Syntype	Jaw excised from one specimen
				Indonesia, Java, Tjilatjap	MZB 15501	1	Neotype	Neotype designated by Jaafar et al. (2009)
	vulgaris	*ceylonensis*	1935	Sri Lanka, Galle	Not recovered	2	Syntype	Material not recovered. Eggert (1935) reported 2 specimens.
	vulgaris	*notatus*	1935	Indonesia, Klappa Island	PMJ 660	4	Syntype	
	vulgaris	*vulgaris*	1935	Indonesia, Bantam Island	PMJ654	2	Syntype	
				Indonesia, Porto	PMJ 724	2	Syntype	
				Indonesia, Java, Tjilatjap	PMJ 730	1	Syntype	Two specimens accompanied label, material appears to have been dried and then rehydrated
				Indonesia, Java, Tjilatjap	PMJ 807	1	Syntype	No specimen accompanied label, specimen possibly either with PMJ 730 or PMJ 833.
				Indonesia, Batavia	PMJ 832	3	Syntype	
				Indonesia, Wijnkoopsbai	PMJ 833	1	Syntype	Two specimens accompanied label
				Indonesia, Sumatra, Siboga	MSNG	Not examined	Syntype	Eggert (1935) reported 1 juvenile specimen
				Indonesia, Salibaboe Island, Liroeng	ZMA 100077	2	Syntype	
				Indonesia, Banda	ZMA 100080	3	Syntype	

Table 1 continued

Genus	Species	Subspecies	Year Described	Locality	Catalogue Number	Number of Specimens Received	Current Status	Remarks
				Indonesia, Sulawesi, Donggala	ZMA 100101	3	Syntype	
				Indonesia, Sumbawa, Bima Bay	ZMA 109812	1	Syntype	
				Indonesia, Aru Island, Wangil	ZMA 110082	1	Syntype	
				Papua New Guinea, northern	ZMA 110088	1	Syntype	
				Papua New Guinea, Sarong	ZMA 113696	1	Syntype	
				Indonesia, Ambon	ZMA 113701	6	Syntype	
				Indonesia, Kairatoe	ZMA 113703	12	Syntype	
				Indonesia, Karakelang Island	ZMA 113719	2	Syntype	
				Indonesia, Waigeoe	ZMA 113737	5	Syntype	
				Indonesia, Banda	ZMA 114.477	1	Syntype	
	weberi		1935	New Guinea	ZMA 119465	1	Lectotype	Designated by Murdy (1989)
					ZMA 100079	3	Paralectotype	
					ZMA 100097	4	Paralectotype	
					ZMA 109805	1	Paralectotype	
					ZMA 112939	4	Paralectotype	
					ZMA 112940	2	Paralectotype	
					ZMA 112941	1	Paralectotype	
					ZMA 112941	5	Paralectotype	

MSNG Civic Museum of Natural History, Genoa, Italy; *MZB* Zoology Department Biological Research Centre, Institute of Sciences Indonesia, Cibinong, Bogor Regency of West Java, Indonesia; *PMJ* Phyletic Museum, Jena, Germany; *ZMA* Zoological Museum Amsterdam, The Netherlands

development of life, specifically in support of Darwin's evolutionary theories, of which Haeckel was a strong proponent (Uschmann 1959; Hossfeld 2010). Presumably, Harms deposited his personal collection in this museum during his tenure in Jena.

We rediscovered 29 jars of type material with assigned catalogue numbers within the ichthyological collection at PMJ that correspond to six species and ten subspecies (including two nominal subspecies) of *Periophthalmus* that Eggert (1929a, 1935) described. Within the jars are the original labels, presumably by the hand of either Eggert or Harms. These specimens were primarily collected during the expeditions led by Harms to Indonesia. We summarize these findings, together with information available for all of the species described by Eggert in Table 1. Among these is a single specimen of *Periophthalmus harmsi* (PMJ 752), a species that Eggert named in honor of Harms in 1929 (Fig. 1a). Many of the rediscovered specimens are in fair condition. *Periophthalmus variabilis asiaticus* (PMJ 642) and *Periophthalmus argentilineatus striopunctatus* (PMJ 647), however, appear to have been previously dried and subsequently rehydrated—these specimens are hard, dark black, and have lost most markings. Only the anterior halves of all three *Periophthalmus schlosseri argentiventralis* (PMJ 785) specimens were available; Eggert (1935) reported that the posterior halves were taken for histological preparations.

Specimens of two species and three subspecies used by Eggert are within the collections of other natural history museums in Europe: Zoological Museum Amsterdam, The Netherlands (ZMA; *Periophthalmus cantonensis novaeguineaensis*, *Periophthalmus dipus angustiformis*, and *Periophthalmus weberi*), Museum of Natural Science, Berlin, Germany (ZMB; *Periophthalmus koelreuteri africanus*), and Civic Museum of Natural History, Genoa, Italy (MSNG; *Periophthalmus gracilis*, *Periophthalmus sobrinus*, and *Periophthalmus vulgaris vulgaris*). As it was then widely accepted that specimens used by Eggert were destroyed, Jaafar et al. (2009) designated a neotype to clarify the identity of *Periophthalmus variabilis*. The neotype specimen was collected from the type locality in Tjilatjap, Indonesia, and deposited at the Zoology Department Biological Research Centre, Institute of Sciences Indonesia, Cibinong, Bogor Regency of West Java, Indonesia, with a catalogue number MZB 15501. Type specimens of the following species and subspecies remain unaccounted for despite efforts to locate them within the fish collections of PMJ, RMNH (Naturalis Biodiversity Centre, Leiden, the Netherlands), and ZMA: *Periophthalmus pearsei*, *Periophthalmus variabilis tidemani*, and *Periophthalmus vulgaris ceylonensis.*

Conclusion

Digitization of material from many natural history museums in recent decades has greatly advanced the study of phylogenetic systematics. Yet, some type material remains elusive, either lost or destroyed during natural and anthropogenic disasters. Our finding signifies the possibilities of further awaiting discoveries in smaller, less-known natural history collections. At present, there are 54 putative names for species of *Periophthalmus*, of which 22 can be attributed to Eggert. The rediscovery of the type material will greatly aid in clarifying the taxonomy and nomenclatural problems within this group of fishes.

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