Forest and Society
Vol. 7(2): 435-449, November 2023
doi: 10.24259/fs.v7i2.18877

REVIEW PAPERS

Fish, Freshwater, and the Promise of Biodiversity History for Indonesian Studies

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RECEIVED 2021-11-24
ACCEPTED 2023-06-17

ABSTRACT

Freshwater fishes abound in Indonesia. They are everywhere in the archipelago—from rice fields and irrigation canals to brackish lagoons and highland rivers. They even populate the most unassuming bodies of water. Some species are found in the remotest of volcanic lakes while others call the blackest and most acidic peat swamps their home. Every island has its habitats and every habitat has its fishes, making Indonesia one of the world's richest centers of ichthyofauna diversity. And yet, thinking with freshwater fishes—and their biodiversity history—has been largely absent from the field of Indonesian studies. A telling example of this biological blindspot can be found in the ways in which the Cornell Modern Indonesia Project (CMIP) has produced—and continues to constitute—Indonesia as an area of study and attachment. In CMIP's Producing Indonesia: The State of the Field of Indonesian Studies, a landmark volume published in 2014, there were twenty-seven contributions that spanned the humanities and social sciences but none that looked at the role local scientists played in knowing the archipelago's freshwater fauna or even broader the interplay between environment and society in shaping the study of modern Indonesia. In response, this essay centers the interplay between environment and society to show how it can open up new directions for future research and interdisciplinary collaboration. In doing so, and in particular, the paper argues that the story of fish and freshwater illustrates the promise of biodiversity history for the field of Indonesian studies in the age of environmental humanities and beyond.

KEYWORDS

Freshwater fishes; Biological blindspot; Biodiversity history; Indonesian history; Environment and society.

1. INTRODUCTION

Freshwater fishes abound in Indonesia. They are everywhere in the archipelago—from urban drains, rice fields, and irrigation canals to park ponds, brackish lagoons, and highland rivers. They even populate the most unassuming bodies of water. Some species are found in the remotest of volcanic lakes while others call the blackest and most acidic peat swamps their home. Every island has its habitats and every habitat has its fishes, making Indonesia one of the world's richest centers of ichthyofauna diversity (see Sukmono & Margaretha, 2017; Sah et al., 2015; Sukmono et al., 2013; Miesen et al., 2016; Dahruddin et al., 2017; Parenti et al., 2014).

It is this unrivalled scale of biodiversity that offers something new for the field of Indonesian Studies. For scholars within and beyond the archipelago, biodiversity can be seen as a source, method, and archive all at once. As a source, biodiversity checklists communicate histories of species data and taxonomic knowledge. But they also convey information about cultural and economic life, local nomenclature, seasonal flux, and geographical range. As method, fishes can open up new routes for knowing old waters. Following fishes, as opposed to thinking with political events, urban elites, or social changes, can reveal worlds—whether in nature or science—that might be harder to see but are no less relevant to the field of Indonesian studies. As archive, the archipelago's

biodiversity is layered with cultural, scientific, and environmental history.

The story of Pieter Bleeker (1819-1878), one of the most prolific ichthyologists of the nineteenth century, reveals the productive ways in which biodiversity can serve as source, method, and archive for knowing Indonesia in the age of environmental humanities.[1] During his 18-years in Batavia (1842-1860), Bleeker left the city just once in 1855 for a two-month expedition to Sulawesi and Maluku (for more on Bleeker's travels beyond Batavia, see Bleeker, 1856). And yet, despite the lack of travel, he managed to "collect" more than 18,000 fishes from across Indonesia for his ichthyological library.[2] Drawing on his library, Bleeker published hundreds of fish articles, described numerous new species, and produced the nine-volume *Atlas ichthyologique des Indes Orientales Neerlandaises* (1862-1878). What is crucial to this story is that Bleeker collected fish not from fieldwork but from people. In large part, he collected fish from young Indonesians and, in particular, the midwife and medical students who attended *School voor Inlandsche Vroedvrouwen* and *School voor Inlandsche Geneeskundigen*. As director of these "Inlandsche" schools from 1851 to 1860, Bleeker turned his community of students into a network of collectors, having them bring from their home areas (such as Padang or Makassar) specimens for his fish library. Many of these contributions were freshwater types, reflecting not only the scientific and baseline significance of Bleeker's *Atlas ichthyologique des Indes Orientales Neerlandaises* but also, and equally important, the cultural, social, and decolonial stories embedded within its epistemological production and biodiversity history.

But thinking with biodiversity—or accounting for its history—has been largely absent from the circles of scholarship that have cultivated, cared for, and shaped the field of Indonesian studies since the 1950s.[3] A telling example of this biodiversity blindspot can be found in the ways in which the Cornell Modern Indonesia Project (CMIP) (1956-present) has produced—and continues to constitute—Indonesia as an area of study and attachment. "In late April 2011," for instance, "an extraordinary gathering was convened at Cornell University in Ithaca, New York. The meeting focused around the 'State of Indonesian Studies'" (Tagliacozzo, 2014: 1). What resulted from this landmark, two-day conference was *Producing Indonesia: The State of the Field of Indonesian Studies*, an edited volume of twenty-seven contributions that spanned the humanities and social sciences. Published under the auspices of CMIP in 2014, *Producing Indonesia* was an unprecedented "exercise in 'taking stock'…of the focus and direction of Indonesian Studies writ large, as well as from the perspectives of individual disciplines—anthropology, art, history, linguistics, government, and music" (Tagliacozzo, 2014: 2). However, neither fish, water, nor biodiversity figured in CMIP's contributions about the state of the field of Indonesian studies. Missing from this historic and well-intentioned "exercise in 'taking stock'" was a sense that the interplay between environment and society matters to the field of Indonesian studies.

In response, this essay centers the interplay between environment and society to show how it can open up new directions for future research and interdisciplinary collaboration. In doing so, the paper argues that the story of fish and freshwater

[1] For more from Bleeker, see Carpenter, (2007). On thinking with Indonesian natures in the age of environmental humanities, see the important works by Sophie Chao, including Chao (2022; 2019; 2018)

[2] For more on the scale of Bleeker's ichthyological library, see Peristiwady (2012).

[3] The 1950s is used as a starting point for the field, but this starting point is very much based on an American genealogy of knowledge production. In large part, it is associated with the establishment of the Cornell Modern Indonesia Project in 1956 and the subsequent founding of the academic journal *Indonesia* in 1966 (which Cornell University continues to publish) (Tagliacozzo, 2014).

illustrates the promise of biodiversity history for the field of Indonesian studies in the age of environmental humanities and beyond.

2. WHAT DO WE KNOW ABOUT INDONESIA'S FRESHWATER BIODIVERSITY?

Our knowledge of Indonesia's freshwater biodiversity is extensive and well-documente.[4] From the nineteenth-century work of Bleeker and his Indonesian students, for example, we know that the archipelago is a wonderous biological archive, incomparably diverse in terms of habitats and species. Ecologically, the country is home to all kinds of wet natures: from mountainous lakes, limestone caves, muddy rivers, and salty swamps to artificial reservoirs, urban canals, and rural drainages. Ichthyologically, Indonesia is second in the world, after Brazil, with regards to freshwater fish diversity (Kottelat & Whitten, 1996).

Figure 1. *Een gevangen zaagvis [sawfish] wordt op de kade gehesen*, 1930. [Source: Leiden University Libraries, Digital Collections, Southeast Asian and Caribbean (KITLV) Images, KITLV 32841].

As for species density (the number of freshwater fish species per 1000 km^2), Indonesia tops the global list (Hubert et al., 2015). And while Asia is the site of some 3,500 recorded freshwater fish species, nearly a third of these fishes are found among the islands of the archipelago like in Sumatra, Java, and Borneo, and more than half of them are endemic to the country's freshwaters (Kottelat & Whitten, 1996). One of these endemic species looms larger than others. It is *Paedocypris progenetica* (Kottelat et al. 2006). Restricted to the peat swamps and blackish streams of Jambi and Bintan, this freshwater fish is the world's smallest known vertebrate (Kottelat et al. 2006). Dynamic, unique, exceptional, and rare, Indonesia's freshwater biodiversity is rich with ecological importance as well as cultural-historical value.

[4] For Bleeker's works about the ichthyofauna of Batavia, central and east Java, Borneo, Biliton, and Ceram, see Bleeker (1846; 1850; 1851; 1852a; 1852b) and Schuster (1852).

But Indonesia's freshwater biodiversity is under threat from a variety of anthropogenic forces. Development and infrastructure are reshaping the archipelago in far-reaching ways. Dams, highways, mines, logging, industrial agriculture (palm oil expansion), urban sprawl, and other land-use changes have impacted the country's habitats: from fragmentation and degradation to outright loss (Hubert et al., 2015; Aryani et al., 2020; Clements et al., 2006; Sunardi et al., 2016). In fact, a recent comprehensive analysis of dams and their impacts on freshwater fishes determined that hydropower schemes were the greatest threat to global ichthyofauna diversity because they fragmented habitats and thus disrupted river connectivities and critical life-cycles (Barbarossa et al., 2020; Dudgeon et al., 2006; Reid et al., 2019; Albert et al., 2021).

Figure 2. *Bouw van een dam bij Bodjonegoro [Jawa Timur],* 1930.
[Source: Leiden University Libraries, Digital Collections, Southeast Asian and Caribbean (KITLV) Images, KITLV 91030].

Indonesia's freshwaters are also growing more eutrophic as a result of pollution. The endless flow of effluents, whether discharge, sewage, or fertilizer, has impacted the biodiversity of aquatic habitats, causing excessive nutrient (plant) growth and, consequently, massive oxygen depletion in lakes such as Toba and Rawa Pening.[5] Increased oxygen loss (a marker of eutrophication) has led to mass fish die-offs, further threatening the ichthyofauna of Indonesia's lakes, rivers, streams, and estuaries (Bakkara, 2016).

The spread of aquaculture has similarly impacted—and continues to threaten—the biodiversity of the archipelago's freshwater systems. Aquaculture, or fish farming, has reshaped the nature of wet habitats in two direct ways. Related to the problem of eutrophication, lakes such as Toba have become sites of widespread cage sprawl, where each cage holds—and farms—a single species in exceptional number. Because these cages keep high concentrations of fish, extraordinary amounts of excrement and feed

[5] For more on eutrophic levels in Lakes Toba and Rawa Pening, see Lukman et al. (2019), Rahman et al. (2016), Soeprobowati & Suedy, (2010), Soeprobowati & Suedy, (2014), and Sulastri et al. (2016).

accumulate in the water, producing noxious levels of nutrient growth and oxygen decline that choke the life out of places like Toba and result in tons of fish die-off (Damanik, 2017; Leandha, 2020).

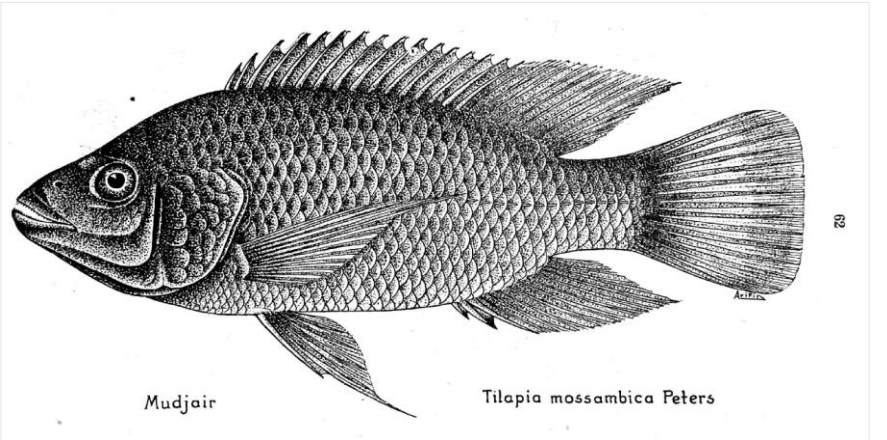

Figure 3. *Mudjair*.
[Source: Schuster & Rustami (1952)].

But the practice of aquaculture, and fish farming in lakes in particular, has also involved the introduction of alien species. Once introduced for economic purposes, non-indigenous fishes such as ikan Mudjair (*Tilapia mossambicus*) and ikan Mas (*Cyprinus carpio*) quickly establish themselves in local waterways and native ecosystems. Indonesia's lakes are especially vulnerable to these kinds of biological introductions. Recent research suggests that alien fish species account for a 30% decline in the diversity of the archipelago's freshwater ichthyofauna (Johnson et al. 2019).

3. HOW DO WE KNOW WHAT WE KNOW ABOUT INDONESIA'S FRESHWATER BIODIVERSITY?

While our knowledge of Indonesia's freshwater biodiversity is attentive to all kinds of matters that animate the present, from faunal richness and species loss to habitat changes and eutrophic lakes, it is also grounded in the past. A history of biodiversity research has shaped our understanding of Indonesia's freshwaters and the wonders and worries that lurk within them. That said, it is without question that the culinary worlds of the archipelago have profoundly contributed to what we know about Indonesia's freshwater biodiversity. Fish and water have been, and remain, at the heart of everyday life for most people. But the story of Indonesian scientists—and a forgotten story at that—plays an integral part in the formation of our knowledge as well.[6]

One Indonesian scientist who stands out among the many who researched and popularized freshwater fishes is Raden Odjoh Ardiwinata (1896-1967). Born in Ciamis, West Java, Ardiwinata studied at the Middlebare Landbouwschool in Buitenzorg before joining the Department of Economic Affairs in 1916 as an "Aspirant Inlandsche Landbouwleraar" (Rosidi, 2000; Dutch East Indies, 1917; Dutch East Indies, 1918).

[6] Of course, a history of non-local scientists and foreign-led expeditions have played a role in the knowledge production of Indonesia's freshwater biodiversity too. See Göltenboth (1996) for more.

Figure 4. Raden Odjoh Ardiwinata.
Soewito et al., *Sejarah Perikanan Indonesia* (Jakarta: Penerbit Yasamina, 2000).

Figure 5. Students and teachers in the drawing room of the Agricultural School in Buitenzorg, 1920.
[Source: Leiden University Libraries, Digital Collections, Southeast Asian and Caribbean (KITLV) Images, KITLV A173].

Over the course of more than a decade, Ardiwinata progressed within the Department's division for agriculture. His first post was to Soekaboemi, where he worked as an "Aspirant Inlandsche Landbouwleraar" and later as an "Adjunct Landbouwconsulent (second class)" (Dutch East Indies, 1928). In 1929, Ardiwinata was promoted to a new post and position, serving as the only "Inlandsche Landbouwleeraar" at the Normaalschool voor Inlandsche Hulponderwijzers in Garoet (Dutch East Indies, 1929). He was again promoted in 1933, this time to the position of Adjunct Landbouwconsulent (first class) (Dutch East Indies, 1933). Just two years before, in 1931, Ardiwinata was appointed to the Regentschaparaad van Buitenzorg (Dutch East Indies, 1931).

Figure 6. Installation of the Regency Council in Buitenzorg, 1926-1929.
[Source: Leiden University Libraries, Digital Collections, Southeast Asian and Caribbean (KITLV) Images, KITLV A17].

And yet, from Ardiwinata's agricultural work in Soekaboemi and Garoet to his time on the regency council in Buitenzorg, there was one thing missing: fish. That changed in 1935, when Ardiwinata moved to Bandoeng to commence a new line of service as an Adjunct Visscherijconsulent (Dutch East Indies, 1936). Joining the Department's division for inland fisheries was a decision, perhaps even a minor decision at the time, that would come to reshape the study and culture of freshwater biodiversity in Indonesia. In particular, Ardiwinata's move to the division for inland fisheries transformed not only the arc and nature of his career but also, and more broadly, the life and legacy of fish research in the archipelago.

From the 1930s to the 1960s, fish became the center of Ardiwinata's world. He worked from serving as an Adjunct Visscherijconsulent in Bandoeng in 1935 to becoming the first Indonesian appointed to head the Department's division for inland

fisheries in 1949.[7] In collaboration with his Dutch colleagues who directed the division for sea fisheries, the laboratory for the investigation of the sea, and the laboratory for inland fisheries, Ardiwinata launched and edited the monthly magazine *Berita Perikanan* (de Groot, 1973; Visscherijnieuws, 1973; 1949a; 1949b).

Figure 7. *Berita Perikanan* 1, 7 (September 1949).
[Source: Majalah Koleksi, Perpustakaan Nasional, Indonesia].

Published out of Jakarta by the division of agriculture from 1949 to 1962, *Berita Perikanan* was a popular platform that shared details about edible species, fishing methods, and robust areas of decolonial research such as documenting the vernacular taxonomies of Indonesia's ichthyofauna. Ardiwinata was at the forefront of creating national space for local scientific knowledge production. In the magazine's September 1949 issue, for example, he provided a checklist of Sundanese names for some of the different kinds of freshwater fry found in West Java's Priangan district (Visscherijnieuws, 1949c). *Berita Perikanan* also captured news and developments that extended beyond the work of the Department. In 1953, the editorial committee reported the founding of *Masyarakat Perikanan Indonesia* and how this national organization of fishers, scientists, and technologists elected Ardiwinata as its first "ketua" and Anna Vaas van Oyen and Hasannuddin Saanin as its two "penulis" (Visscherijnieuws, 1953). Copies of *Berita Perikanan* are available at Perpustakaan Nasional in Jakarta and remain a rich source of data for scholars looking to bring the wealth of biodiversity history to the field of Indonesian studies.

But Ardiwinata's growing career also shaped the expanding study of Indonesia's ichthyofauna. In particular, his popular writings about food fishes—and the threats to them—fostered widespread public interest in the ecology and economy of the country's

[7] On Ardiwinata's appointment as head of the division for inland fisheries, see Departement van Landbouw en Visserij (1949).

freshwater systems. In 1950, for instance, he authored a little pamphlet about the "dangers" of *elong-elong* (*Eichnornia cressipes*, water hyacinths) and how the invasiveness and abundance of this alien plant (native to the Amazon basin), this "musuh dalam selimut," posed a risk to the ichthyofauna of Rawa Pening (Visscherijnieuws, 1950). Ardiwinata's research in effect documented the slow violence of eutrophication and how this process was not only contributing to the "overgrowth" of *elong-elong*, but also, and as a consequence, choking the fish life out of one of central Java's most important freshwater lakes (Visscherijnieuws, 1950).

The study of Indonesia's freshwater biodiversity—and in particular its fishes, lakes, and rivers—gained new urgency in the 1950s, with matters of population and provisionment figuring at the heart of national development. Ardiwinata was crucial to this period of local scientific knowledge production. By 1952, for example, he was no longer administering the division for inland fisheries but rather directing the newly-established Balai Penjelidikan Perikanan Darat from its headquarters in Bogor (Buitenzorg) (Kementerian Pertanian, 1956). As head of the institute, Ardiwinata was in charge of overseeing research that was borne out of a need for popular knowledge about Indonesia's freshwater fishes and habitats and the ways in which this knowledge could be extended to the public during "masa pembangunan besar-besaran ini" (Ardiwinata, 1955 [1952]: 4).

Yet while guiding the development and direction of the country's new research focus on freshwater fishes in the 1950s, Ardiwinata was also authoring a series of species biographies, or what he called "buku-buku ketjil," about Indonesia's important ichthyofauna (Ardiwinata, 1955 [1952]: 5).

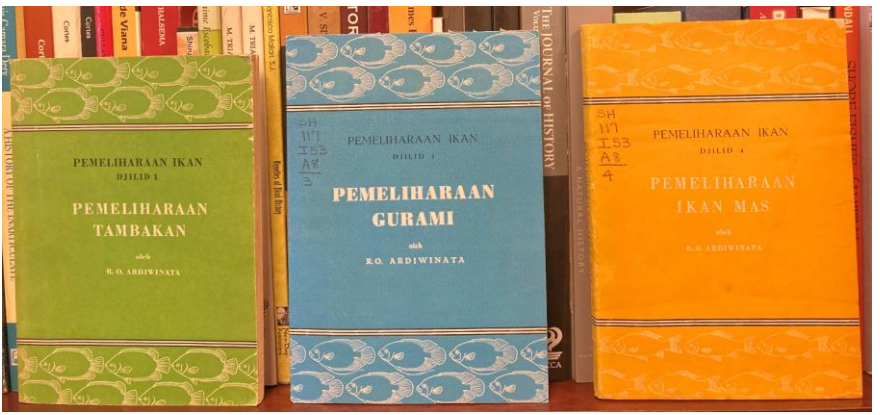

Figure 8. A few of Ardiwinata's "*buku-buku ketjil*."

His first two species biographies were published in 1952 and centered on tambakan (Kissing gourami, *Helostoma temmincki* Cuvier, 1829) and tawes (Java barb, *Puntius javanicus* Bleeker, 1855), respectively (Ardiwinata, 1955 [1952]; 1952).[8] Ardiwinata followed with two more species biographies in 1953: one on gurami (Giant gourami, *Osphronemus gouramy* Lacepede, 1801) and the other about ikan mas (Common carp, *Cyprinus carpio* Linaeus, 1758) (Ardiwinata, 1957; Kementerian Pertanian, 1956). Collectively, Ardiwinata's species biographies, his "buku-buku ketjil," provided useful information about the ecological, scientific, and economic life of some of Indonesia's key food fishes. On tambakan, for example, we learn that this fish was first sourced from the *rawa-rawa* (swamps) around Palembang in the late nineteenth century and

[8] Today, *Puntius javanicus* is classified as a synonym of *Barbonymus gonionotus* (Bleeker, 1850).

introduced to other regions in the archipelago such Java and Kalimantan (Ardiwinata, 1955 [1952]). And based on the research of scientists at Balai Penjelidikan Perikanan Darat, we also learn about the different kinds of plankton that tambakan consumed—from the names and colors of these plankton to what they looked like under a microscope (Ardiwinata, 1955 [1952]; Sachlan, 1954).

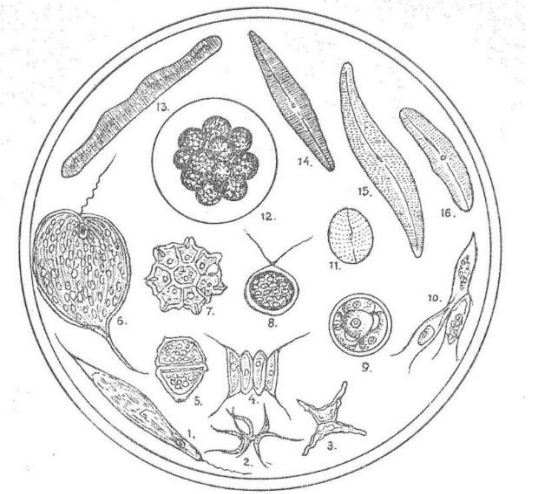

Figure 9. Makanan ikan tambakan, berasal dari sekitar Garut dan Tasikmalaja (Priangan-Timur).
[Source: Ardiwinata (1955 [1952])]

Ardiwinata and the other scientists who worked at Balai Penjelidikan Perikanan Darat in the mid-twentieth century are but some of the storied lives that help explain how we know what we know about Indonesia's freshwater biodiversity. And while Ardiwinata's expertise and career reflect a body of local environmental scholarship, they also constitute an archive replete with data about the country's ichthyofauna. From fry names and fish biographies to alien hyacinths and plankton types, histories of local scientific knowledge production run through the archipelago in ways that offer new directions for scholars as well as new opportunities for collaboration. Surfacing these pasts, making them known, and incorporating their details into narratives about the story of modern Indonesia is just one example of how the work and legacy of Ardiwinata and other local scientists can serve to seed new grounds for the field of Indonesian studies.

4. CONCLUSION

Despite the many threats to Indonesia's aquatic species and wet habitats, freshwater fishes still abound in globally significant ways. Their resilience and diversity, and our understandings of both, speak to the labors of today's fishers, scientists, institutes, and universities and the interactions between these expert groups. But the story of Indonesia's enduring ichthyofauna also speaks to a history of biodiversity research and how this history has sought to know, document, and value the islands' freshwater systems. Fish and water have been central to the rhythms and radials of Indonesia, and a history of biodiversity research brings this centrality to the surface.

From Bleeker and his network of student-collectors in the 1850s to Ardiwinata and his community of local researchers in the 1950s, it is clear that Indonesia's freshwater fishes have long shaped the interplay between environment and society as well as

inspired genealogies of scientific knowledge production. Thinking with biodiversity—and accounting for its history as source, method, and archive—opens up new possibilities for scholars to work together, cross disciplines, and refashion the study of Indonesian natures, cultures, and languages through a kind of decolonial lens. To this end, our knowledge of Indonesia's freshwater fishes and the ichthyological work of Ardiwinata are two sides of the same promise: the promise of biodiversity history for expanding and enriching the field of Indonesian studies.

But it is worth pointing out, if even briefly and by way of conclusion, that freshwater fishes are not the only thread running through the story of modern Indonesia. Other histories of biodiversity research are equally productive for reimagining the future of Indonesian studies. Insects, plants, and birds, for example, offer fresh horizons for communicating histories of species data and taxonomic knowledge as well as stories about scientific practice, cultural and economic life, and environmental change. For the field of entomology, we might think of Tjoa Tjien Mo (b. 1905 in Bukittinggi – d. 1978 in Amsterdam) and his contributions to our knowledge of Indonesia's evolving insect diversity and how injurious—and often alien—insects, in particular, threatened food crops and native flora.[9] In 1955, the same year as the Asia-Africa Conference in Bandung, Tjoa Tjien Mo published *Awas! Hama-hama asing mengantjam pertanian kita!* as a call to mobilize and protect Indonesia's plant systems from "foreign pests" (Mo, 1955b). From fishes to insects, the lives and careers of Ardiwinata, Tjoa Tjien Mo, and other local scientists suggest how the promise of biodiversity history can yield not only new directions and archives for Indonesian studies but also, and more broadly, a new kind of relevance for the archipelago in the age of environmental humanities.

Competing Interests: No competing interests.

Acknowledgments: A Social Science Research Thematic Grant (MOE2020-SSRTG-027) made this article possible and for that, I would like to thank the Singapore Ministry of Education. I would also like to thank the invaluable assistance provided by my research assistant Anastasia Kurniadi, a fourth-year student in the Environmental Studies program at Yale-NUS College. Finally, I would like to thank Rebekah Daro-Minarchek, Robert Cribb, Micah Fisher, and Luthfi Adam for their comments on an earlier version of this paper, which was presented via Zoom at the 1st AIFIS-MSU conference on Indonesian Studies in 2021.

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[9] Like Ardiwinata, Tjoa Tjien Mo joined the Department of Economic Affairs shortly after graduating from the Middelbare Landbouwschool in Buitenzorg in 1926. By 1937, he was working as an "adjunct-dierkundige" at the Institute for Plant Diseases. That same year, Tjoa Tjien Mo published a research note titled "Aanteekeninge over eenige schadelijke insecten op hibiscus sabdariffa (Roselle)" in *Bergcultures* 11 (1937): 1850-1852 with illustrations. Much of Tjoa Tjien Mo's postcolonial career was spent in Bogor at the Balai Besar Penyelidikan Pertanian. Some of his entomological publications include Mo (1952; 1953a; 1953b; 1955a; 1957a; 1957b; 1958) and Mo et al. (1974).

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