FRONTIERS OF BIOGEOGRAPHY
The scientific journal of
The International Biogeography Society

Frontiers of Biogeography 18, 2025,
e163345 | DOI 10.21425/fob.18.163345

PERSPECTIVES

The role of "Big Science" in the discovery of new marine species: Experience from the International Indian Ocean Expedition of the 1960s

Edward R. Urban Jr.[1]

1 *Scientific Committee on Oceanic Research, University of Delaware, Newark, DE 19176, USA*

Corresponding author: Edward R. Urban Jr. (ed.urban@scor-int.org)

Editor Mark John Costello
Received 27 June 2025 ♦ **Accepted** 4 August 2025 ♦ **Published** 16 September 2025

Abstract

The first International Indian Ocean Expedition (IIOE-1), conducted between 1959 and 1965, ranks among the most extensive multinational oceanographic initiatives focused on the Indian Ocean. The expedition aimed to enhance foundational knowledge of the basin's physics, chemistry, biology, and meteorology, and to gain insights into the region's fish and shellfish resources for human consumption.

Australia, France, Germany, India, Indonesia, Japan, Pakistan, Portugal, South Africa, Thailand, the USSR, the United Kingdom, and the United States contributed ships to the IIOE-1. The United States played a significant role in the IIOE-1, primarily through its Program in Biology. This program included research cruises and two land-based camps. Various sampling devices were deployed throughout the water column down to the seafloor. Plankton samples were forwarded to the Indian Ocean Biological Centre in India, while larger specimens were dispatched to the Smithsonian Oceanographic Sorting Center. This article provides a comprehensive overview of the 399 species identified from specimens collected by the U.S. Program in Biology during the IIOE-1; the associated metadatabase of the species named is available for additional analysis by others.

Highlights

- Three hundred and ninety-nine species were described based on specimens collected by the U.S. Program in Biology of the first International Indian Ocean Expedition.
- Half of the species described (for which a collection year could be determined) were described within 10 years of collection of the holotypes.
- Ten authors described about 55% of the 399 species.
- About three-quarters of the described species were collected by research cruises and one-quarter from land-based camps.
- Cruises that did benthic sampling were more productive, in terms of holotypes per cruise day, than cruises focused on sampling the water column.

Keywords

Expeditionary science, holotypes, Indian Ocean biodiversity, International Indian Ocean Expedition, species discovery, specimen archiving and taxonomy

Introduction

The first International Indian Ocean Expedition (IIOE-1) was developed by the Special Committee on Oceanic Research (SCOR, later renamed the Scientific Committee on Oceanic Research) in 1959 as one of the first activities of SCOR. The Intergovernmental Oceanographic Commission (IOC) later became a co-sponsor of the project. The IIOE-1 officially ran from 1 September 1959 to 31 December 1965, and was one of the largest multi-national and multidisciplinary oceanographic research and discovery efforts focused on the Indian Ocean. This area was selected because the oceanography of this basin was less known than other areas of the global ocean, the system is influenced by monsoon winds and physical circulation that reverse annually, and the Indian Ocean was thought to have the potential to provide living resources to feed increasing human populations in developing countries surrounding the basin.

Australia, France, Germany, India, Indonesia, Japan, Pakistan, Portugal, South Africa, Thailand, the USSR, the United Kingdom, and the United States contributed ships to the

IIOE-1. U.S. scientists and national funding agencies, particularly the National Science Foundation, played a major role in conducting and financing the IIOE-1. The United States developed a U.S. IIOE-1 Program in Biology, which included sampling from several ships and from two land-based camps, in India and Madagascar. Although many other countries participated in biological aspects of the IIOE-1, it was more difficult to document species described in non-English publications and whose holotypes are held in museums outside the United States. However, increased understanding of the biology and biodiversity of the Indian Ocean was achieved by the group of participating nations and extended beyond the description of new species, as documented by Zeitzschel (1973) and summarized by Urban (2020). Other biological results of the IIOE-1 include the following:

- Development of standardized plankton sampling gear (the Indian Ocean Standard Net; Currie 1963) to be used by all nations in the same way, to create maps of zooplankton distribution across this ocean basin. This work was facilitated by the Indian Ocean Biological Centre (IOBC) in Ernakulam, India (near the port of Cochin), which received and identified the samples (Hansen 1966), promoting standardization of analysis of collected samples. Highley (1968) reported that 2,068 samples were sent to the IOBC.
- Creation of atlases of the distribution of phytoplankton and zooplankton in the Indian Ocean (IOBC 1968a, 1968b; Krey and Bebenerd 1976).
- Agreement by other participating nations on other biological methods, such as primary production estimates (Doty et al. 1965).
- Founding of the National Institute of Oceanography in Goa, India, which has become the premier oceanographic institution in India in the intervening years.
- Data from the 1960s collected as part of the IIOE-1 have been important to compare with later observations and observations taken in other parts of the global ocean (see Urban 2020 for examples).
- Collections of the IIOE-1 documented the ranges and range extensions for several species, important for understanding changes in these species' biogeography (Urban 2020).
- Documentation of potential food resources of the Indian Ocean. Trawl surveys were particularly conducted during cruises 1 and 4B of the R/V "Anton Bruun" in the Bay of Bengal and Arabian Sea (Pruter 1964). Long-line surveys were conducted on cruise 2. Cruise 3 sampled deep-sea fishes in the western Indian Ocean. Few new commercially important fish species were identified, and it was concluded that "it is impossible to assess the commercial potential of fish and shrimp inhabiting the various areas." (Pruter 1964).

Urban (2020) presents a full description of how the Program in Biology was conducted and how it advanced biological understanding of this ocean basin. A major goal of the program was to collect and describe new species from the Indian Ocean, which had only been explored sporadically in previous decades. To this end, the Smithsonian Oceanographic Sorting Center (SOSC) was established in December 1962, before the Program in Biology began its main field activities, to sort and process specimens from the program (Wallen and Fehlmann 1974), and eventually received 3.6 million specimens from the IIOE-1, of which about 1.5 million specimens were distributed to about 140 experts in the United States and 17 other countries specializing in different taxonomic groups. The archiving and description of specimens by Smithsonian scientists played a major role in knowledge of the biodiversity of the Indian Ocean, as demonstrated by the large number of publications resulting from Smithsonian scientists. The SOSC continued to play a similar role for other ocean specimens until it was closed in 1992. In 1974, the SOSC employed 45 staff members (Wallen and Fehlmann 1974). Thirteen other museums hold holotypes of some of the 399 species included in the metadatabase, including the following: Allan Hancock Foundation, Univ. of Southern Calif.; Academy of Natural Sciences of Philadelphia, British Museum of Natural History; California Academy of Sciences; Field Museum of Natural History; Natural History Museum, Los Angeles; Museum of Comparative Zoology, Harvard University; Museum National d'Histoire Naturelle, Paris; Rijksmuseum van Natuuralijk Historie, Amsterdam; Royal Ontario Museum, Canada; South African Museum; University of Michigan, Museum of Zoology; and Zoological Museum of Amsterdam. Many of these museums provide open access to their digital records.

This article will present analysis based on a list of 399 species described from specimens collected by the U.S. Program in Biology (Urban 2025) and will explore the productivity of the program and what factors contributed to this productivity. This analysis may be helpful for future programs of discovery. The article will not discuss the increases in biological understanding of the Indian Ocean beyond species discovery, which are covered in greater detail by Urban (2020).

The U.S. Program in Biology provides a unique opportunity to look at the effects of expeditionary science on species discovery for several reasons:

- The IIOE-1 took place in a defined period and the sampling stations were well documented. A comprehensive list of stations occupied by research vessels of the U.S. Program in Biology was compiled by Urban (2019a, 2019b).
- Program scientists collected a large number of specimens.
- The Smithsonian Institution created a special unit to handle the specimens, which were described by Smithsonian scientists and others in publications from the Smithsonian (e.g., "Proceedings of the U.S. National Museum", "Smithsonian Contributions to Zoology") and other sources that are easily accessible through the Web. The online catalog of specimens held by the Smithsonian Institution was a valuable resource for this compilation.

- Publications describing the species usually noted the U.S. Program in Biology (the source of research funding) and the cruise number, ship, station number, date, and/or location where the holotypes were collected. The scientists of other nations rarely mentioned the IIOE or even their national programs related to the IIOE-1.

This paper updates the results presented in Section 4.4 of Urban (2020), with a greater number of species included than Urban (2020), which included 113 species.

Methods

The list of species that can be attributed to the U.S. Program in Biology was compiled from several sources:

- Collections of the U.S. National Museum of Natural History were searched using the keywords “Bruun”, “Te Vega”, “Nosy Be”, and “Mandapam” (see https://collections.nmnh.si.edu/search/). Searches were made in the invertebrate, vertebrate, paleontology, and botany collections.
- The collected reprints from IIOE-1 collated by the IOC were searched for papers by U.S. investigators (see https://scor-int.org/project/iioe-1/#reprints), using a list of U.S. investigators compiled by the author.
- The Ocean Biodiversity Information System (OBIS: https://obis.org/) was searched for all species reported as collected from the Indian Ocean up until 21 March 2024. Species lists downloaded from OBIS were checked against the species included in the World Register of Marine Species (WoRMS: http://marinespecies.org/). OBIS species which had no listing in WoRMS or which were extinct, were eliminated from the analysis. In many cases, the species’ name in OBIS has been updated in WoRMs because the holotype has been assigned to a new genus. Species listings downloaded from OBIS covered the period from 1753 to present; original papers for species described in 1960 and later were examined to determine whether they indicate holotypes collected during IIOE-1 cruises or land-based activities, and when and where the holotypes were collected. Species were eliminated if they had no year of collection listed and species names from OBIS were corrected if WoRMS listed them as incorrect. Species with other WoRMS flags (uncertain, nomen dubium, taxon inquirendum, nomen nudum, temporary name…) were not included in the list. A few subspecies and variants listed in OBIS and WoRMS were included in the analysis.

This process resulted in the compilation of 34,205 species and subspecies found in the Indian Ocean, listed in OBIS and verified by WoRMS. 8,963 of these species were described in 1960 or later. 7,652 of the papers were located to gather information about the holotypes. The remaining papers were not available online or in the university libraries checked. Most were in non-U.S. and/or non-English language journals, although some were in English-language journals behind paywalls.

The list of new species described from specimens collected by the U.S. Program in Biology included in Urban (2025) is presented with metadata regarding collection date and location of the holotypes, the citation for the publication, and the museum in which the holotype can be found. Where only the station number was given in the descriptive publication, Urban (2019a, b) were consulted for authoritative lists of sampling stations from cruises of the “Anton Bruun” and the “Te Vega”, compiled from cruise reports and other documents. Only extant species were considered. This especially reduced the number of foraminifera species included.

Results

The methods used resulted in the identification of 399 species whose holotypes were collected by scientists involved in the U.S. Program in Biology of the IIOE-1 (Urban 2025) (Fig. 1). Specimens collected by the U.S. Program in Biology that were not defined as the holotype for a species were generally not included in the list, although a few of the 399 species listed in Urban (2025) are syntypes and no holotype was designated. The 399 species were described in 172 different publications. Some locations shown on the map represent several holotypes. 277 holotypes are from south of the equator and 117 from north of the equator. The metadata in Urban (2025) include the location

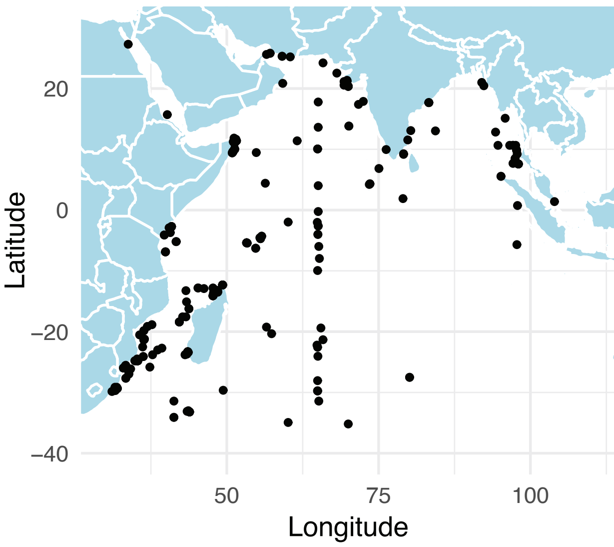

Figure 1. Locations where holotypes were collected for description of new species during the U.S. Program in Biology (n = 395). The collection location of four holotypes that could not be found in the describing publications are not included here. Note the line at approximately 65°E, which was a transect occupied by Cruise 6 of the “Anton Bruun”.

of most holotypes in museums in the United States and around the world (museums identified for 343 holotypes), in at least 19 different locations. Two-thirds of listed in the metadatabase have verified catalog numbers in the U.S. National Museum of National History at the Smithsonian Institution. The list of species is also available in an Excel file for anyone wishing to conduct further analysis of the metadata (see https://zenodo.org/records/16886784).

In the process of compiling this list, the author discovered 26 species described based on specimens collected by non-U.S. programs, but this list is not considered comprehensive.

Time between collection and description

Collections by the Program in Biology primarily took place in 1963 and 1964 and all but four of the 399 species considered here were collected within this period; two species were described based on collections made in 1962 and two in 1965. This "pulse" of collections was examined to quantify how quickly species descriptions were published. The results are shown in Fig. 2. For some species, it was not possible to find the year of collection; 23 species were not included in the analysis. The time interval was calculated as the integer result of the year of publication minus the year of collection. Half of the 376 descriptions were published within 10 years after collection and the most common period between collection and description was 5 years. However, some species were not described until 54 years after collection (Baker et al. 2018).

From the list of 399 species compiled, it was possible to analyze (1) how many species were moved to a different genus, (2) which authors were associated with the most descriptions, (3) the importance of cruises versus land-based research to discovery of new species, and (4) the distribution of discovered species by phylum.

Species moved to a different genus

Seventy species were assigned to a new genus after their original descriptions; 60% of these were copepod crustaceans. Many of these new genera resulted from a splitting of the genus *Lichomolgus* (Humes and Stock 1973).

Number of species described per paper

Most papers describe a single species (Fig. 3), but one paper (Maddocks 1969) described 19 species. This paper described ostracod crustaceans based on collections that Rosemary Maddocks made at a land-based camp supported by IIOE-1 on the island of Madagascar at Nosy Bé.

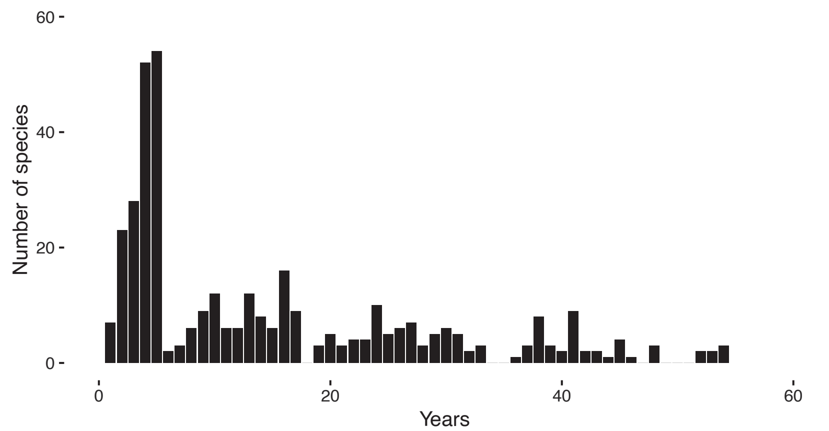

Figure 2. Time between collection of holotypes and publication of species' descriptions (n = 376).

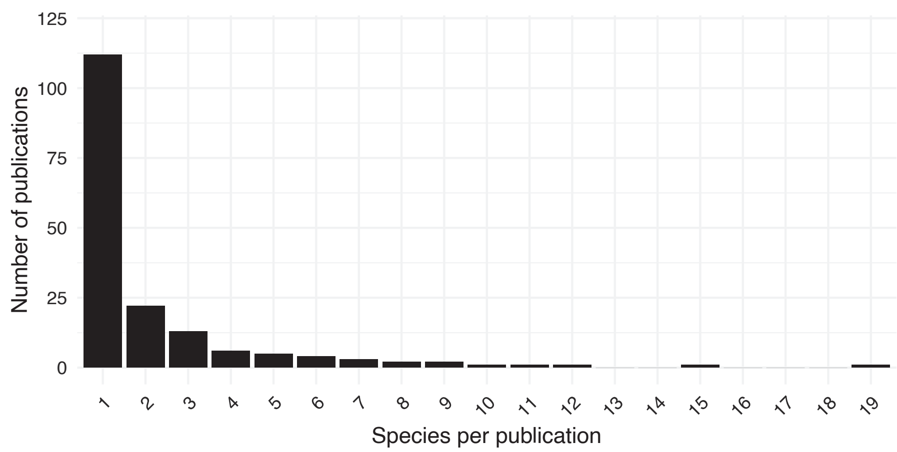

Figure 3. Number of species described per publication (n = 390).

Authors associated with the most descriptions

One hundred forty authors were involved in describing new species collected during the Program in Biology. The following authors described the greatest number of species:

1. Arthur G. Humes single-authored and co-authored publications describing 87 species from the Program in Biology, and many other Indian Ocean species before and after the IIOE-1. Humes was a professor from Boston University and was the director of the IIOE-1’s Nosy Bé laboratory in Madagascar. His taxonomic specialty was parasitic copepods.
2. Ju-Shey Ho co-authored publications with Arthur Humes describing 65 species. Ho was a Ph.D. student of Humes at Boston University and later a professor at California State University, Long Beach. His specialty was parasitic copepods.
3. Brian F. Kensley was initially a scientist at the South African Museum and worked at the Smithsonian Institution in later years. He described (in single-authored publications and with co-authors) 37 species from the IIOE-1. Kensley’s taxonomic specialty was decapod and isopod crustaceans.
4. Rosalie F. Maddocks was a Professor at the University of Houston. She was a specialist on ostracods and spent considerable time based at the Nosy Bé land-based station of IIOE-1 during 1963 and 1964 and described 35 species from Madagascar and from cruises of the “Anton Bruun”.
5. Kuni Hülsemann was a scientist at the Woods Hole Oceanographic Institution and was an expert on calanoid copepods. Hülsemann described 18 species from the IIOE-1. He worked with George Grice (see below) and others.
6. Olga Hartman was a scientist and Professor of Biology at the Allan Hancock Foundation at the University of Southern California. She described 17 polychaete annelid species from the IIOE-1.
7. George D. Grice was a scientist at the Woods Hole Oceanographic Institution and worked with Kuni Hülsemann to describe 15 calanoid copepod species.
8. Francis Dov Por described 13 species from the Program on Biology. He was a scientist at the Hebrew University of Jerusalem and a specialist in crustaceans.
9. Marilyn Schotte was a Museum Specialist at the Smithsonian Institution and worked on crustaceans with Brian Kensley. She was involved in the description of 13 species.
10. Roger Cressey described 11 species from the Program on Biology. He was a scientist at the Smithsonian Institution and specialized in crustaceans.

Importance of cruises versus land-based research to discover new species

The cruises of the “Anton Bruun”, “Te Vega”, “Argo” (Lusiad II expedition), “Pioneer”, and “Horizon” resulted in collection of 254 holotypes, 63.7% of the 399 species described from the IIOE-1. The other 36.3% of the holotypes were collected at the Nosy Bé camp (108 species), Mandapam Camp (6 species), and independent research not associated with cruises or land-based camps (31 species). Another important feature of cruise-based collections was whether the cruises focused on benthic collections or collecting species from the water column.

Cruises were focused on specific regions and purposes, with different lengths in days (Table 1). Holotypes per day was an index computed to normalize the results for cruises of different lengths, showing that cruises focused on benthic sampling produced the greatest number of new species per cruise day. Most stations produced no holotypes, but a few produced multiple holotypes: Station 444 (4), Station 447 (6), 453 (7), 456 (5), and 463 (7). These stations were occupied on 16–17 December 1964 off the northeast coast of Somalia.

Distribution of species among phyla

The species discovered included arthropods, chordates, annelids, echinoids, cnidarians, kinorhynchs, and mollusks (Fig. 4). Approximately 75% of the described species are crustaceans (most of these being copepods), about 15% chordates (mostly fish), and the remainder distributed among the other phyla.

Discussion

The IIOE-1 is one of several expeditions that resulted in discovery of new species in the Indian Ocean. Other expeditions were conducted by international projects or by national museums since the IIOE-1. The metadata presented in Urban (2025) is unusual among other expeditions in presenting detailed information about each species discovered by the U.S. Program in Biology and where most of the holotypes are located, based on the original publications and museum records. Several more recent expeditions have reported the number of species that have been collected, many of which may be new to science, but the actual number may be much smaller when the necessary taxonomic work has been done. More recent expeditions include Indian Ocean collections by the Census of Marine Life (2000–2010), a voyage to the Cocos Island in October 2022 by Museums Victoria Research Institute (MVRI), the Five Deeps Expedition – Java Trench Dive, the Maldives Deep Reef Survey in 2022–2023 conducted by the California Academy of Sciences, and the South Java Deep Sea Expedition in 2018, which was a joint effort by Singapore and Indonesia.

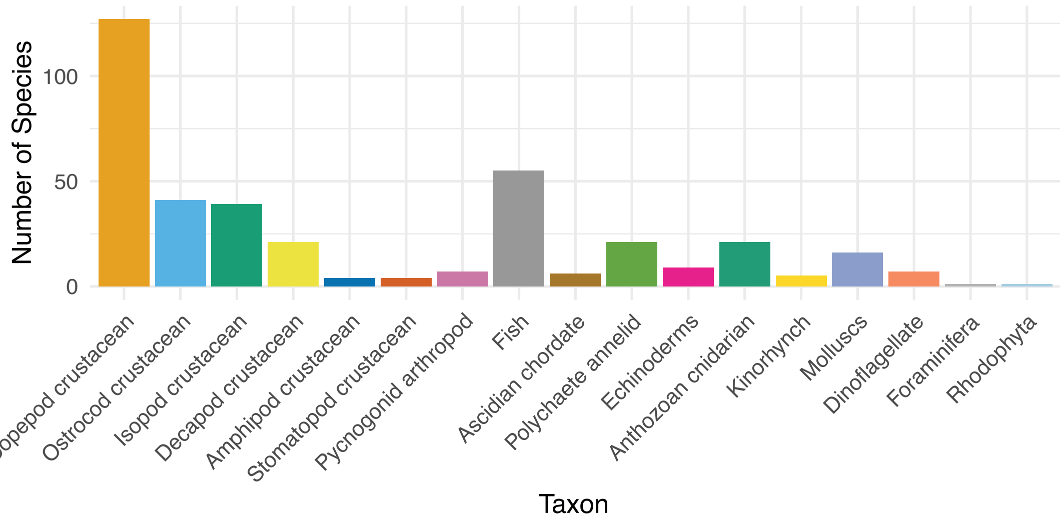

Figure 4. Distribution of U.S. Program in Biology discoveries by phyla.

Table 1. Species described based on specimens collected by each cruise of the *Anton Bruun* and *Te Vega*.

Cruise Number	Holotypes Described	Area of cruise	Focus of cruise	Length (days)	Holotypes per day
AB-1	22	Bay of Bengal		59	0.37
AB-2	6	Central Indian Ocean	Long lining for pelagic fish. All holotypes were crustaceans.	62	0.10
AB-3	2	Central Indian Ocean	Sampling of deep-sea and mid-water fish. Both holotypes were fish.	43	0.05
AB-4A	0	Arabian Sea and Western Indian Ocean	Hydrographic sampling	44	0.00
AB-4B	21	Arabian Sea coastal areas	Bottom trawling: Annelids were the most common holotype.	28	0.75
AB-5	2	Western and Central Indian Ocean	Long lining for pelagic fish. No holotypes were fish.	98	0.02
AB-6	23	Central Indian Ocean	Mid-water tows and inshore collections. Crustaceans were most common holotype.	62	0.37
AB-7	69	Southwest Indian Ocean	Sampling benthic invertebrates. Ostracod crustaceans were the most common.	43	1.60
AB-8	42	Western Indian Ocean	Sampling benthic organisms. Copepod crustaceans were the most common.	45	0.93
AB-9	54	Western Indian Ocean	Reef and shore collecting. Isopod crustaceans were the most common.	40	1.35
TV-2	4	Singapore to Sri Lanka	Graduate student training	79	0.05
TV-3	2	Sri Lanka to Madagascar	Graduate student training	125	0.02
TV-5	3	Kenya to Malaysia	Graduate student training	N/A	N/A

Based on the time required for descriptions documented for IIOE-1 (see Fig. 2), it may be premature to speculate on the productivity of an expedition until 5–10 years after the expedition is completed, although many expeditions release preliminary estimates of the number of new species discovered and highlight some of the more unusual ones in press releases rather than peer-reviewed publications.

Cruise-based collections produced about two-thirds of the holotypes, whereas land-based camps resulted in about one-third of holotypes. Land-based stations provided opportunities for specialists in specific taxa to focus their work for extended periods nearshore in limited geographic areas. Research cruises made it possible to survey broad areas, far from shore, sampling from the surface to the seafloor (including from the deep sea), using a variety of sampling equipment. Cruises were not limited to species discovery, but resulted in a large number of specimens submitted to the Smithsonian Oceanographic Sorting Center for later study by taxon specialists.

Conclusion

What lessons can be learned from the role of the IIOE-1 in the discovery of new species from the Indian Ocean?

The merits of focusing expenditures on discovering new species have been presented elsewhere. Bouchet et al. (2012) made the point that expeditions focused on discovery of biodiversity can have altruistic outcomes, in terms of documenting species while they are still extant, and providing collections that are available beyond the control of the individuals and programs that financially supported and carried out the collecting. The following recommendations assume such merits.

Focused effort on a relatively unexplored ocean basin over an extended period can yield a wide range of discoveries of new species—There has been only one other concerted effort in species discovery in the Indian Ocean to which the Program in Biology can be compared. The Census of Marine Life was a 10-year effort (2000–2010) globally, which included an Indian Ocean component. Of the 1,109 new species thought to have been described as a result of the Census collections worldwide (Ward Appeltans, OBIS, pers. comm.), 85 were from the Indian Ocean, based on analysis by the author. It is possible that more species were discovered in the Indian Ocean by the Census, but were not identified as resulting from the program because most scientists were not funded through national Census programs.

A program combining cruises and land-based collections can yield species from different taxa and marine ecosystems—Collections from land-based camps yielded the discovery of at least 114 holotypes of nearshore free-living and parasitic species. Open-ocean collections from research cruises yielded pelagic, midwater, and deep-sea species that were not available from land-based camps. The Program in Biology also demonstrated that neither land-based camps nor cruises always collect a large number of new species. The Mandapam Camp was visited by several U.S. scientists, but resulted in relatively few species being described by U.S. scientists. Two kinorhynchs (Higgins 1969), a gobiid fish (Lachner and McKinney 1978), and a stomatopod crustacean (Manning 1969) were discovered near Mandapam Camp. This small number of new species may have occurred because the shallow-water marine flora and fauna of southern India were already well described and/or because species collected there never made their way to the Smithsonian, being described by Indian scientists and archived in India. The R/V “Te Vega” collected a large number of shallow-water specimens, but its purpose was focused on graduate teaching (Pearse et al. 2016) and only a few species were named based on specimens collected from “Te Vega”’s cruises, including three isopod crustaceans (Bowman and Mariscal 1968; Kensley 1980; Schotte and Kensley 2005) and one ostracod crustacean (Kornicker 1967). Experience from the Program in Biology suggests that future marine biodiversity explorations should focus on relatively unstudied areas of the ocean, such as the deep sea, and on relatively unstudied taxa. For example, the Census of Marine Life made many of its species discoveries in the deep sea, enabled by modern collecting technologies such as remotely operated vehicles and submersibles.

Individual investigators specializing in understudied taxa can be very productive and extend understanding of those taxa—Some lessons can be drawn from the list of authors here. Arthur Humes was the resident head of the U.S. IIOE-1 at the Nosy Bé facility of the Centre d’Oceanographie et des Pêches. He had described specimens from Nosy Bé based on collections he made in 1955 and 1960 (expedition of the Academy of Natural Sciences of Philadelphia,), so he knew the possibilities for collecting parasitic copepods there. Humes also was able to collect specimens by SCUBA, extending his operating realm. Humes sometimes published his descriptions alone, but usually had a co-author working with him to describe specimens he had collected, including his students. Ho (2001) reported that Humes eventually collected and described 244 species of copepods from Nosy Bé. Based on the results of the Census of Marine Life, Costello et al. (2010) noted that the Indian Ocean—particularly deep sea, estuaries, coastal, areas, and coral reefs—had still been relatively unstudied. Costello et al. (2010) found that for all parts of the world oceans, bryozoans, cnidaria, platyhelminths, sponges, and tunicates were evaluated as having a lower than average “state of knowledge” index.

Having museums prepared to accept and preserve specimens for later examination allows study for decades—The foresight of the Smithsonian Institution in setting up the Smithsonian Oceanographic Sampling Center, the long-term employment of taxonomists, the publication of monographs describing new species, and making its collections available for study for decades after specimens were collected, demonstrates the importance of museums in description of new species. As noted earlier, many museums in the United States and elsewhere played a role in the taxonomic work required for specimens from the IIOE-1. Museums and universities should be prepared for both rapid and sustained taxonomic work. Each had a role in the taxonomy process, but museums have proven to be the best long-term archives for specimens for continued study, if they have long-term funding.

Many papers describing species sit behind “pay walls” or are otherwise unavailable online—Many of the descriptions of species from the Program in Biology and (presumably) all other taxonomic activities, are published in commercial journals that limit access to paid subscribers. This restriction makes it difficult for historical research of the type presented in this article. The number of holotypes resulting from the Program in Biology could undoubtedly be expanded if it were possible to visit museums and libraries worldwide to track down publications that are not available remotely. A welcome resource was the Biodiversity Heritage Library, which makes available many documents from journals and museums that are otherwise difficult to locate. Also, many papers were provided by scientists who link their papers to their ResearchGate accounts.

Species descriptions appear in a wide variety of journals, books, and other sources, with varying requirements for holotype descriptions—Some journals require that holotype descriptions include date of collection, place of collection, any projects related to the collection of the holotype, and where the holotype is archived. However, many publications, particularly older ones, do not include enough information to do the kind of analysis presented here. Some publications note the museum in which the holotype is stored and the accession number, but most museums do not provide online catalogs of the specimens they hold.

The number of species might be increased through additional library research. The list in Urban (2025) does not include species descriptions in publications in obscure journals, in-house museum publications, and other publications that are not available on the Web, as well as publications in non-English language journals. Since the Smithsonian Oceanographic Sorting Center sent many specimens to specialists outside the United States, descriptions are likely to have been made in non-English language journals.

Acknowledgements

The author thanks his former employer, the Scientific Committee on Oceanic Research, for providing access to historic files related to the International Indian Ocean Expedition. After exhausting open-access online resources, the author relied on the help of several librarians and others who aided in finding the papers needed: Eric Tans (Michigan State University), Charlene Stachnik (University of Michigan Research Center Library), Lori O'Hara (Bishop Museum, Hawaii), and Gretchen Rings (Field Museum, Chicago). Thanks are also owed to Ward Appeltans, who provided the lists from OBIS that were the foundation for this analysis.

Author contributions

Edward R. Urban Jr. conceptualized the topic of the article and conducted all the library research and analysis for the article.

Use of AI

I used Microsoft Copilot to improve the abstract and develop keywords, and to help write R scripts to create the figures in the article. AI was not used for other tasks related to producing the article.

Data accessibility statement

The metadata on which this article is based are available at https://zenodo.org/records/15310901.

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