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Review Article

The odd couple of protistology: Edward Heron-Allen (1861–1943) and Arthur Earland (1866–1958)

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ABSTRACT

Edward Heron-Allen and Arthur Earland were among the last great amateur foraminifera researchers. Their partnership began in 1907 and ended in 1932. While close in age to one another, they shared little more than a fascination for forams and a lack of any university training. In most other aspects, the two men were completely different. Heron-Allen was a famous upper class polymath, expert not only on forams, but also on the Persian language, violins, palm reading, history, asparagus, and barnacles. He was also an accomplished novelist and poet, who frequented literary circles. In contrast to the flamboyant Heron-Allen, Earland was a discrete civil servant who admitted to working on forams as a relief from the monotony of his job. Hence, the two were improbable partners. However, together they produced 39 substantial works on forams. Their studies concerned assemblages from Southern Ocean to the North Sea and they are today credited with the original description of 186 species. Here the distinct lives of the two men are presented, and their contributions to protistology, as partners as well as individuals, are reviewed. The case is made for considering Earland's work as neglected relative to that of Heron-Allen, except perhaps by foram taxonomists.

1. Introduction

By the late 1800′s, in most of continental Europe, academics dominated protistology (e.g., Butschli in Germany, Jørgensen in Norway, Balbiani in France, Entz in Hungary, etc.). However, well into the early 20th century in Great Britain, protistology was largely peopled by self-taught microscopists. This was especially the case in regard to foraminifera researchers (from here on the term 'foram' is used in accordance with the opinion put forward by Lipps et al., 2011). The "English School" of notable foram researchers in the late 1800′s, described by Robison and Austin (2001), included men such as H. B. Brady (a pharmacist), H. J. Carter (a retired doctor), F.W. Millett (a civil engineer) and J. Wright (a grocer). Among the last of the English amateur foram researchers were Edward Heron-Allen (1861–1943) and Arthur Earland (1866–1958), but they are far from the least significant. Today, Heron-Allen and Earland are credited with the original valid descriptions of 186 species of forams. They began working together in 1907. It was at the instigation of Millett, who in declining to work on Heron-Allen's foram collections, suggested he contact Earland (Gregory, 1943). From 1908 to 1932, the partnership produced 39 substantial articles (works longer than 3 pages), and many notes on forams. They described new species from many geographical areas and environmental settings, from the Southern Ocean to the North Sea. Their partnership ended abruptly and mysteriously in 1932, and today it still unclear what provoked the rupture (Hodgkinson and Whittaker, 2004). However, given how different the two men were in nearly all facets, the greater mystery may be that the partnership lasted 25 years. Outside of a devotion to forams, the only apparent similarities of the two, were being of similar age and perhaps fond of pipe smoking (Fig. 1).

Heron-Allen was a wealthy upper class man of leisure and many interests and very well known in his time. He was a true polymath who produced works not only on forams, but also on palm reading (e.g., Firth and Heron-Allen, 1883; Heron-Allen, 1883a, 1885), violins (Heron-Allen, 1882, 1884, 1886; Heron-Allen, 1890–1894), Persian and Omar Khayyam (Heron-Allen, 1898), history (Heron-Allen, 1911), and barnacles (Heron-Allen, 1928), as well writing poems and short stories under his own name (e.g., Heron-Allen, 1888; 1896) and some works considered now as precursors of science fiction (Armstrong, 2018) under the name of Christopher Blayre (Heron-Allen, 1921a). He made major donations of foram material and literature to the "British Museum (Natural History)" (Hodgkinson and Whittaker, 2004), as well as donations of violin literature and artifacts to the Royal College of Music (Thompson, 2008). Today there is a society dedicated to his life and works, the "Heron-Allen Society", founded in 2000, (Hodgkinson and

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Whittaker, 2004). He was an avid diarist, and his journal recording his experiences during the First World War was published in 2002 (Harvey and Fitzgerald, 2002). In stark contrast to Heron-Allen, Earland was of a modest background and worked as a civil servant in the Post Office Savings Bank throughout most of the years of the partnership. He appears to have been relatively discrete. For example, Earland did not participate in the major controversy of Heron-Allen with regard to foram studies, his claims that some forams show intelligence in constructing their shells. As the second author, Earland's contributions to the partnership's foram work were early on neglected such as in a review of their early work in which Heron-Allen (alone) is said to have discovered hundreds of species (A.S.W., 1912). In Heron-Allen's autobiographical entry in Who's Who (reprinted in Heron-Allen, 1980), he listed many of their foram publications with no mention of his coauthor. Earland has been described as "Heron-Allen's assistant" (Kemp and Buckley, 1987) and occasionally overlooked entirely. In Vickerman's history of British protozoology (Vickerman, 2000), Heron-Allen is given 4 pages and Earland is not mentioned. Quite recently, species descriptions in their joint works have been attributed to simply 'Heron-Allen' (table 3 in Hayward et al., 2020). Here the lives and scientific works of these two very different amateur foram researchers are reviewed. First, sketches are provided of their lives and foram works. Then an assessment of their contributions to protistology, relative to one another, is attempted in support of the opinion that Earland's contributions have been, and continue to be, underestimated relative to those of Heron-Allen, except perhaps by foram taxonomists.

2. The life and multifarious activities of Edward Heron-Allen

There is a considerable amount of literature on Heron-Allen. The following account is based on his autobiographical entry in *Who's Who*, reprinted in *Who was Who*, volume IV, 1941–1950 (Heron-Allen, 1980), the obituary notices on Heron-Allen (Earland, 1943; Gregory, 1943; Thomas, 1943; 1944), as well the account by Harvey (2004), and the articles by Hodgkinson and Whittaker (2004) and Whittaker (2013), except where otherwise noted. For a complete bibliography of Heron-Allen's scientific works see Hodgkinson and Whittaker (2004).

Edward Heron-Allen was born on December 17th, 1861 into the family of George Allen, the head of London's oldest law firms, Allen and Son. Heron-Allen attended the prestigious school Harrow. It was while at Harrow that Heron-Allen was exposed to forams though a gift of a piece of chalk from the school science master. However, he did not pursue any scientific studies. In 1879, at age 18, he left Harrow to begin his law apprenticeship working at the family law firm, but he did not restrict his activities to the family firm. For several months in 1882, he worked as apprentice luthier in the workshop of the London violin maker George Chanot, and about this time began collecting literature on violins (Thompson, 2008). In 1884 Heron-Allen passed the law examinations and was admitted as a Solicitor but he did not begin practicing law until several years later. In the meantime, he devoted himself to surprisingly diverse pursuits ranging from palm reading, learning ancient Persian, the histories of the violin and magic rings, to traveling and writing fiction.

In 1883 Heron-Allen published his first two books on palm reading (Firth and Heron-Allen, 1883; Heron-Allen, 1883a) and he became a member of a most unusual and exclusive dinning and literary club, "Ye Sette of Odd Volumes". Formed in 1878, the club was dedicated to "conviviality and mutual admiration", and composed of 21 members, the same number as the number of volumes of the Variorum of Shakespeare. Heron-Allen was a member until at least 1928 (Navarre, 2010). He served as secretary in 1885 (Thomson, 1890), Vice President in the 1892–1893 season (Anderson, 2013), and as President in 1927–1928 season, according to Heron-Allen's autobiographical entry in Who was Who (Heron-Allen, 1980). Heron-Allen's first work on violins was published for the members (Heron-Allen, 1882), as well as his second book on palm reading (Heron-Allen, 1883a), followed by a short volume on 'magic finger-rings' (Heron-Allen, 1883b). His book *on Barnacles in Nature and in Myth* (Heron-Allen, 1928) was dedicated to the club. The club involved significant personalities with regard to Heron-Allen. He brought Oscar Wilde as a guest to the club in 1892 (Anderson, 2013). A fellow long-time club member, George C. Haité, would later act as one of the nominators for the election of Heron-Allen as a Fellow of the Linnean Society (Andrea Deneau, pers. comm.). The club appears to have been of considerable importance to Heron-Allen. The periodic bibliographies of privately printed works of the members, "*Opuscula*", were all proceeded by a quote attributed to Samuel Jackson, "Books that can be held in the hand, and carried to the fireside, are the best after all"; the quote which Hero-Allen used prominently in his bookplate (Fig. 2).

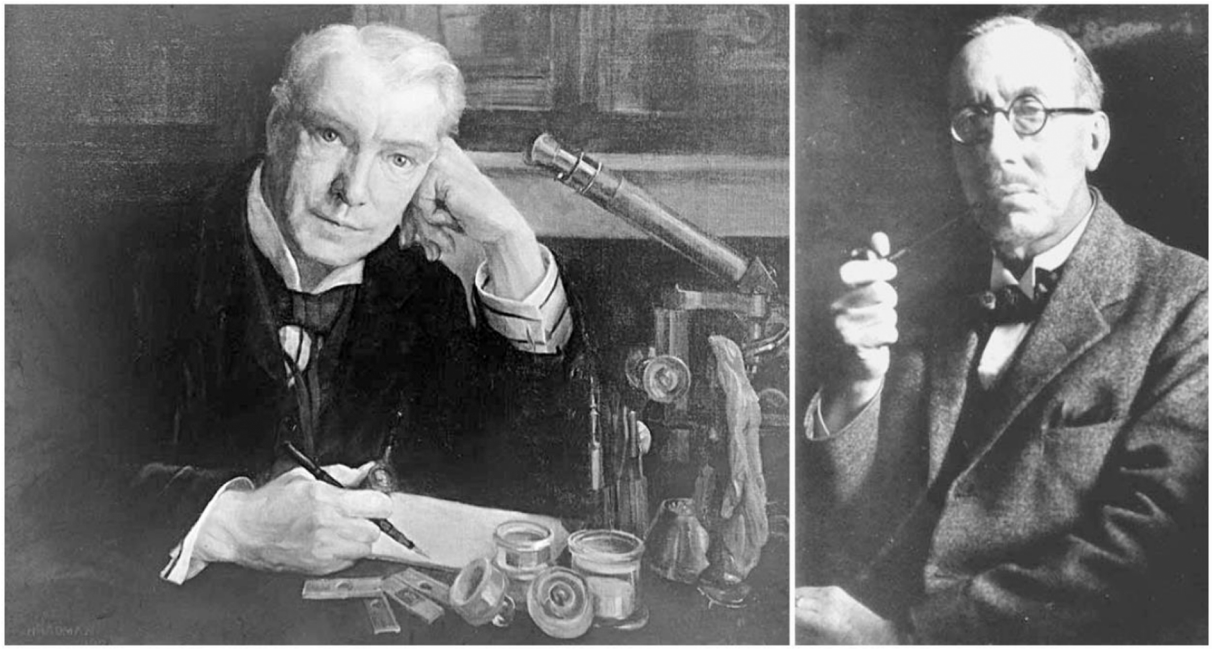


Fig. 1. The left panel shows Edward Heron-Allen, a photograph dated 1922 of a portrait (at age 61) and the right panel shows Arthur Earland in 1926 at age 60.

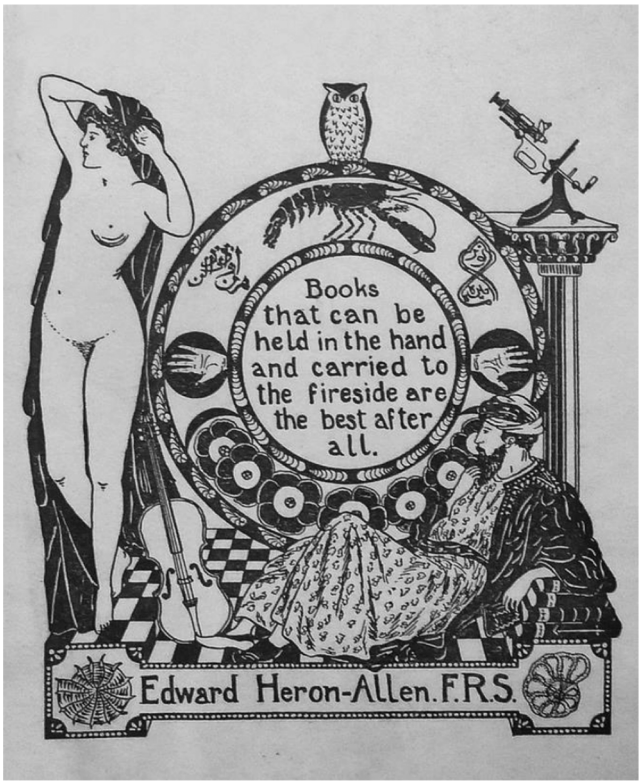


Fig. 2. The bookplate of Edward Heron-Allen showing his many interests. It dates post- 1919 when he was elected to the Royal Society becoming "F.R.S.". Forams adorn the bottom name portion, and a microscope is in the upper right corner. The text in the inner circle is associated with the club "Ye Sette Old Volumes", a quote attributed to Samuel Johnson. In the outer circle, the lobster may refer to the dinner parties of the club devoted to fine dining. Also in the inner circle are a Persian text and palms of hands, referencing his translations of Persian texts and his work on palmistry. The lounging man in mid-eastern garb in the lower right likely also refers to his interests in Persian culture, language and history. The nude woman at the left may refer to his 1923 erotic science fiction novel "The Cheetah-Girl" (Heron-Allen, 1923). The violin in the lower left refers to his interests and expertise in all matters concerning the violin. An owl, commonly associated with wisdom appears at the top in the center. Heron-Allen used different bookplates for his collection foram works now in the Natural History Museum, London (see Hodgkinson and Whittaker 2004).

His third, most popular book on palm reading, "A Manual of Cheirosophy" was first published in 1885 (Heron-Allen, 1885) and went through 11 editions (i.e., Heron-Allen, 1906). Heron-Allen also gave lectures and demonstrations, and is generally credited with instigating the "Palmistry Craze" of the late 19th century in Britain and North America (Mallory, 2014; Navarre, 2011; Small, 2015). Through his studies of violin making, both practical and academic (Heron-Allen, 1884, 1890–94), he became a recognized expert on the manufacture, history and literature of the violin. In 1886, Heron-Allen traveled to the United States for a lecture tour on palm reading. He gave popular lectures, read the palms of local notables (e.g. Anon, 1887), and even showed sketches of what he believed would resemble the palm of the infamous serial killer "Jack the Ripper" (Anon, 1888a). While in the United States, Heron-Allen published his story '*The Suicide of Sylvester Grey*' (in Heron-Allen, 1888), now known as one of the possible sources of inspiration for Oscar Wilde's '*The Picture of Dorian Grey*' (Guy and Small 2006), that was first published in 1890 (Wilde, 1890). Heron-Allen is said to have fallen on hard times at the end of his stay in the U.S.A., and been forced to take on a variety of odd jobs to make ends meet, ranging from interpreter (Anon, 1888b) to journalist, actor and circus rider (these latter jobs are mentioned in Gregory, 1943, but no source is given). At age 38, Heron-Allen finally returned to Great Britain in 1889 to work in the family law firm and shortly thereafter his scientific work began.

Heron-Allen appears to have seriously begun working on forams in 1891. His first publication was on fossil forms found in chalk deposits (Heron-Allen, 1894). The paper is largely an introduction, described as 'for the beginner', to the study of forams in chalk deposits, and reports on samples collected beginning in November 1892. It carries a postscript indicating that the manuscript was prepared between December 1891 and January 1894. In the paper, he tells of his turning to the study of fossil forams: "*After many years of more or less desultory study of the recent forms, I turned my attention to that of the Chalk in 1891 and after floundering helplessly for a year had the good fortune to make the acquaintance of Mr. Fortescue W. Millett, F.R.M.S., at Marazion (Cornwall) in August 1892.*" The 1894 paper was self-published. With his first foray into scientific publishing, the very well published Heron-Allen (e.g., his *Manual of Cheirosophy* was in its 7th edition) had met with rejection by the Royal Society of Microscopy (Hodgkinson and Whittaker, 2004). It was in these early days of his work on forams that Heron-Allen first became active in scientific societies. He asked to be, and was elected, a fellow of the Royal Microscopical Society in December 1891. It would become his main scientific society, but not his only one. In 1908, when he joined the Quekett Microscopical Club (Anon, 1907-1908), Heron-Allen listed his affiliations as F.L.S. (Fellow of the Linnean Society), F.R.M.S. (Fellow of the Royal Microscopical Society), F.R.Met.S. (Fellow of the Royal Meteorological Society), and F.Z.S. (Fellow of the Zoological Society).

By 1906, Heron-Allen had settled in Selsey Bill, in Sussex, on the Channel coast of England, and began collecting forams from the shore sands. His mentor, Millett, showed little interest in Heron-Allen's findings and suggested that if he wanted some aid he might ask Arthur Earland. It is unclear if Millett knew Earland from the Quekett Microscopical Club (as both were members) or simply knew of him and thought he could help Heron-Allen because of Earland's paper on methods of collecting forams from shore sands (Earland, 1897) or his substantial paper on forams from shore sands of Sussex (Earland, 1905). Regardless, despite some hesitation on Earland's part, the two began working together in 1907 on the forams of Selsey Bill (Earland, 1943) and produced a series of 8 papers (Heron-Allen and Earland, 1908; 1909a,b,c; 1910a,b; 1911a,b). Their next topic involving several articles was the forams of the North Sea, announced by Heron-Allen in a lecture given at the Royal Microscopical Society on the forams of Selsy Bill in February of 1911 (Anon, 1911). That same year, at age 50, he retired from his law practice and was able devote his entire attentions to forams and writing fiction.

Heron-Allen and Earland published seven articles on the forams of the North Sea (Heron-Allen and Earland, 1909d; 1912; 1913a,b,c; 1917a,b) and most of them were based on material that Earland had collected in a series of month long cruises during his summer vacations from his Post Office job from 1904 until 1913 (detailed in the section on Earland). The first article to appear (Heron-Allen and Earland, 1909d) was also the beginning of another series of papers, most by Heron-Allen alone, on a curious phenomenon, the ability of certain foram species to select and arrange particles forming their shells (e.g. Fig. 3). The phenomenon, perhaps first noted by Carpenter (1862), has been described as mysterious (Lipps, 1973; Bowser and Bernhard, 1993), and most recently attributed possibly to chemical or other interactions with particles (Cole and Valentine, 2006; Sabbatini et al., 2016; Pearson et al., 2018). Heron-Allen ascribed particle selection by certain forams to be a sign of intelligence in a series of publications (Heron-Allen and Earland, 1910c, 1912; Heron-Allen, 1915a,b,c), a view which was, understandably, controversial (e.g. Anon, 1915; Lankaster, 1916). Earland, according to Heron-Allen, did not "…entirely agree with me" (Heron-Allen, 1921b) and Heron-Allen later recognized that he "…*raised a storm…in proposing purpose and intelligence…*" (Heron-Allen, 1924). For a full discussion of Heron-Allen's 'purpose and intellegence' see Kaminski (2005). It should be pointed out that in the early 20th century, Heron-

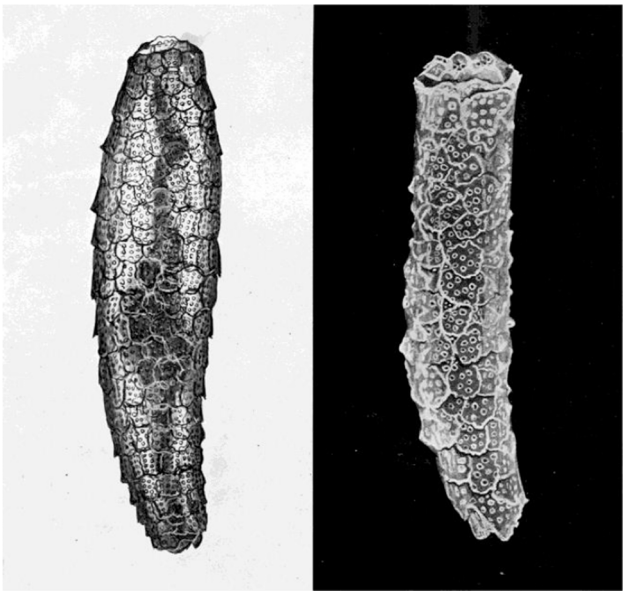


Fig. 3. The illustrations of the shell of *Technitella thompsoni*, formed of echinoderm plates, from Heron-Allen and Earland 1909, entitled "On a new species of *Technitella* from the North Sea, with some observations upon selective power as exercised by certain species of arenaceous foraminifera". The left panel show the shell in oblique illumination, the right panel show the shell using polarized illumination.

Allen was not alone in raising a storm concerning behavior in protists. In the United States, Jenning's book "*Behavior of the Lower Organisms*" (Jennings, 1905) provoked considerable controversy (e.g., Jennings, 1908). Beginning in 1915, Kofoid and his students promoted the existence of a "neuromotorium", a proto-brain, in various taxa of protists (Dolan, 2022).

During the first decade of the partnership with Earland, in addition to the Selsey Bill and North Sea studies, two major monographs were completed. The first, of 188 pages (Heron-Allen and Earland, 1913d), was on the forams of Clare Island (Ireland) based on sampling they conducted together in August of 1911 (Wyse Jackson et al., 2002) as part of the Clare Island Survey. The second, published in three parts (Heron-Allen and Earland, 1914; 1915a,b), totaling 284 pages, was on the forams of the "Kerimba Archepelago (Portuguese East Africa)", today the Quirimbas Islands of Mozambique. The Kerimba works are likely among Heron-Allen's most important foram works. The papers received compliments in the pages of Nature (Anon, 1916), and were later called the most important work of the partnership in obituary notices of Heron-Allen (Gregory, 1943; Thomas, 1944).

Heron-Allen served as President of the Royal Microscopical Society from 1916 to 1918 and was elected to Fellowship in the Royal Society in 1919. In the 1920′s the major work completed was the report on the forams of the 1910 Terra Nova Expedition to Antarctica (Hero-Allen and Earland, 1922). The 243 page report was published by the "British Museum (Natural History)", from here on BMNH. The BMNH would become an important part of Heron-Allen's life, and his remarkable donations would become important assets of the BMNH. In 1926, Heron-Allen donated his large library of works on forams. It included many rare books as he had for years been attempting to acquire all the works listed in Sherborn's classic foram bibliography (Sherborn, 1888). It now is officially "The Heron-Allen Library" in the BMNH micropaleontology Sectional Library (Whittaker, 2013). Heron-Allen also donated thousands of slides containing millions of specimens, constituting the largest single collection of forams in the BMNH (Adams et al, 1980). Although he had no official role in the BMNH, he was granted a work space and furnished it himself. Both Heron-Allen and Earland worked at the BMNH for many years, notably on material gathered during the Discovery Expedition to the Southern Ocean (1925–1927). In their publication, "Siliceous shells of protozoa" (Heron-Allen and Earland, 1930), they gave their address as "Discovery Investigations c/o British Museum (Natural History)". Sadly however, their Discovery Reports on forams marked the end the partnership between Heron-Allen and Earland. According to Hodgkinson and Whittaker (2004), in 1932, just after the publication of the first Discovery report (Heron-Allen and Earland, 1932), "…… *their long collaboration suddenly ceased. Rumours abounded as to which of the two should get the most credit.*". According to Earland's account, it was sudden, without warning or discussion. Earland received the proofs of the second Discovery Report with a letter from the Director of Discovery Research stating that following Heron-Allen's instructions, his name had been removed and Earland was left to finish the reports on his own (Earland, 1943). Several accounts (including Earland's), mention that the death of Heron-Allen's his younger daughter, in an automobile accident in 1930 had left him a diminished man (Gregory, 1943; Thomas, 1944; Harvey, 2004).

After the end of his partnership with Earland, Heron-Allen published only one research paper on forams, on finding specimens of a rare species (Heron-Allen, 1936). He did however continue to contribute letters to the journal *Nature*. For example, on nature and science in poetry (Heron-Allen, 1933). He also complained bitterly of the explosion in the number of new foram species, linked on the one hand to naming morphological variants (in his view) as new species, and the other hand to the dramatic increase in the numbers of active foram researchers with the expansion in the field of oil exploration. The first he termed "Dementia nomenclatorica americana" (Heron-Allen, 1935a, 1938), and the second "the commercialization of Protozoology" (Heron-Allen, 1935b). Afflicted with ill health during the war years; Heron-Allen died on March 28 of 1943 at age 82. His notable life is summarized in both the *Oxford Dictionary of National Biography* (Harvey, 2004) and in *Who Was Who* (Heron-Allen, 1980).

3. The life of and singular work of Arthur Earland

The accounts of Earland's life and work are fewer in number and brief compared to those on Heron-Allen. They are restricted to three concise obituary notices on Earland (Macfayden, 1959; A.M.J., 1958; Hedley, 1958) and sections in an article on the Heron-Allen and Earland slide collection in the BMNH (Hodgkinson, 1989), and an article on his slide collection and correspondence at St. Andrews University (Robinson and Austin, 2001). These accounts, and information gleaned from Earland's publications, are the basis of the sketch presented here of his life and work. For a complete bibliography of Earland's scientific publications see Macfayden (1959).

Arthur Earland was born on the third of November in 1866, the son of a schoolmaster. After attending his local school, he refused a university education fearing it would likely lead to a career as a school teacher. Instead he entered the civil service in the Post Office Bank as a 'boy clerk' in 1885, at age 19. Earland would spend his entire working life in the Post Office Bank, retiring early in 1926 at age 60, due to ill health, having reached the rank of Assistant Controller. His interest in microscopy in general, and forams in particular, is said to have begun about 1887, shortly after having started working at the Post Office Bank, when he acquired a microscope and a copy of the popular book "*One Thousand Objects for the Microscope*" (Cooke, 1869) in which forams were prominently featured (Fig. 4). The author, Mordecai Cubitt Cooke (1825–1914), listed his first affiliation as "Vice President of the Quekett Microscopical Club", perhaps providing the first impetus for Earland's lifetime involvement with the club. He would first serve on the club's election committee, then as Secretary, and finally be elected to Honorary Membership. His last publication would appear in the club's journal (Earland, 1957).

Only a few years passed before the appearance of Earland's first publication "Notes on the recent foraminifera of Malta" (Earland and Cooke, 1891). His co-author was John Henry Cooke (1862–1933), a

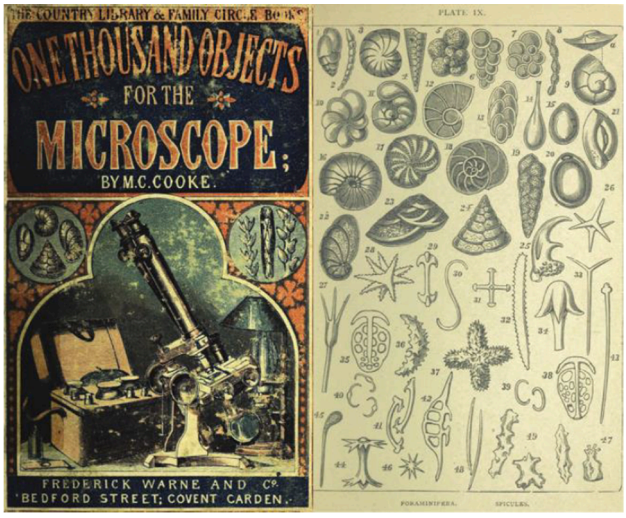


Fig. 4. The cover and a plate from Cooke's 1869 book said to have provided Earland's introduction to microscopy in general, and forams, in particular.

recent Fellow of the Geological Society, and the founder and editor of the journal in which the article appeared, "*The Mediterranean Naturalist*". He was not apparently related to M. C. Cooke of the "*One Thousand Objects for the Microscope*" book. J. H. Cooke was a school teacher in Malta who for a time published extensively on the geology and diverse fossils of Malta, often sending material to "appropriate international experts" for identification (Rose, 2021). At the time, Earland was acquainted with some notable foram workers such as Edward Halkyard, for whom Earland had collected samples (Halkyard, 1891), and Joseph Wright, with whom Earland corresponded. Wright had even named a new foram species for "*my friend Arthur Earland*" (Wright, 1891). However, Earland was not yet an "international expert". It is unclear how Earland was put in contact with Cooke. Earland had only recently become a member of the Quekett Microscopical Club.

By 1894, Earland had begun a foram commerce of sorts. He made specimen slides of forams and placed annoucement offering his slides in exchange for samples of material dredged from deep waters (Earland, 1894a), and from specific sites, such as Australia and the Cape of Good Hope (Earland, 1894b). D'Arcy Wentworth Thomson, who may have known Earland through the Quekett Club, began a long correspondence with him in 1894. Thomson was seeking to purchase prepared slides of forams for a museum of natural history he was establishing at the University of Dundee (Robinson and Austin, 2001). Thompson would later become an important friend of Earland. In 1897, Earland published the first, of what would be many papers on forams and radiolarians in the journal of the Quekett club (Earland, 1897; 1898; 1900a,b,c; 1902a,b; 1905).

Earland's paper, "The foraminifera of the shore-sand at Bangor, Sussex" (Earland, 1905) gives a good idea of his extraordinary devotion to forams. It was presented at the May 19th 1905 meeting of the Quekett Microscopical Society Journal. According to the text, it was in October of 1901 when he was at Bognor that he decided to collect material from shore sands to eventually construct a list of the local species. To this end, over the course of three tides, he collected 10–15 Kg of sand and sent it to his at home in London to be processed and studied. Earland states that he worked on the material during nearly all of his spare time through early 1905, thus devoting 4 years of his spare time to the study of the forams of Bognor. Earland shared his material with Joseph Wright to confirm species identifications and Wright pointed out some forms Earland had overlooked. The result was a substantial paper (48 pages of text and 4 plates), listing the occurrence of 140 species, including a new species of foram, *Spiroplecta fusca*, and documenting of the morphological variability of several forms (see Fig. 5).

In these early years, before Earland started working with Heron-Allen, he promoted the study of forams through articles on methods (Earland, 1899a,b,c) and published a paper on fossil forams from Pakistan (Earland, 1899d) that was noted in *Nature* (Anon, 1899a). Earland also promoted the study of forams to the members of Royal

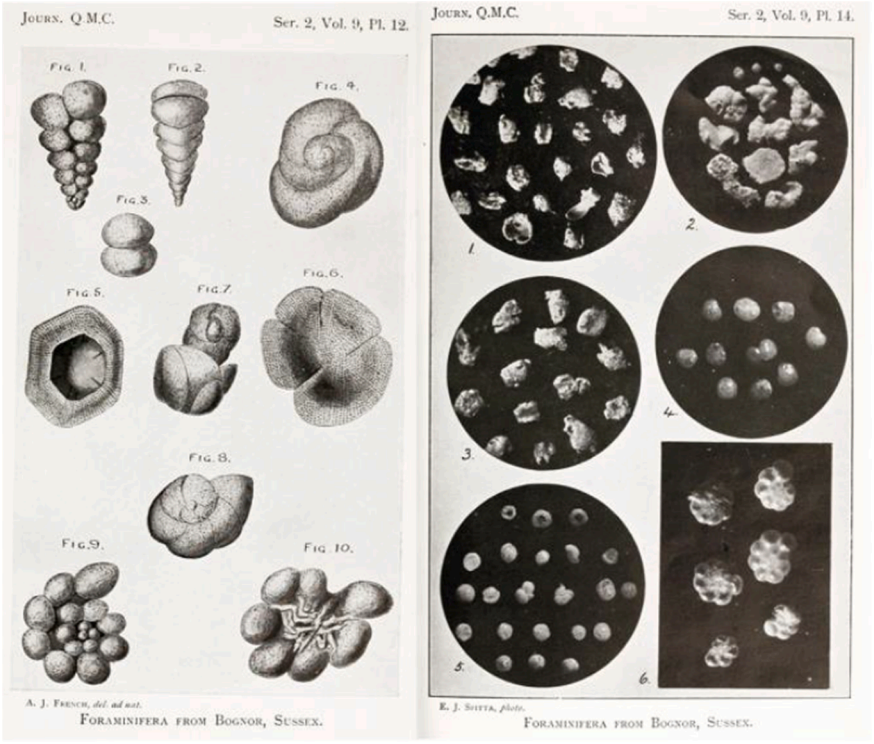


Fig. 5. Two of the four plates from Earland's 1905 paper on the forams of Bangor, Sussex. The left panel includes a new species, Spiroplecta fusca shown in the two figures at the bottom. It is currently considered 'taxon inquirendum'. The right panel shows morphological variability found by Earland of various foram species.

Microscopical Society through an elaborate hands-on demonstration using "…… *a large number of microscopes upon the table, with written descriptions in which the chief points of interest in each slide were explained. The thanks of the Society were cordially voted to Mr. Earland for arranging this very excellent exhibition*" (Anon, 1899b).

From 1904 to 1913, Earland spent a month of his annual leave from the Post Office Bank each year, to participate in the survey cruises of northern North Sea and in the Faroe–Shetland Channel as part of the British contribution to the International Council for the Exploration of the Sea, known today as ICES. It was thanks to D'Arcy Wentworth Thompson, who was deeply involved in the foundation of ICES and directed the British contribution (Rozwadowski, 2002), that Earland participated in cruises. He learned first hand how to manipulate dredge samples to extract forams using in part equipment furnished by Thompson. As mentioned above, the North Sea foram papers of Heron-Allen and Earland were largely based on samples Earland gathered during the annual cruises. He later described his time spent at sea, mostly on the Fisheries Cruiser *Goldseeker* (Fig. 6), to be among his best memories. It was perhaps the combination of his times at sea, and his time at home processing his samples, which lead to his 1910 fellowships in the both the Royal Microscropical Society and the Challenger Society, the first oceanographic society of Britain (Deacon, 1990). Earland would later serve as Vice President of the Royal Microscopical Society three times (1916–1918, 1922, 1931–1932).

Earland said that in 1907, when Heron-Allen asked for aid in working up samples from Selsey Bill, he had never heard of him (Earland, 1943). Earland's ignorance of Heron-Allen, as a famous personality, is perhaps understandable given Earland's singular devotion to forams. Earland's ignorance of Heron-Allen's foram work was likely because it consisted solely of a self-published work from 13 years before (Heron-Allen, 1894). On the other hand, it is likely the Heron-Allen knew of Earland in 1907. Heron-Allen was a collector of literature on forams and Earland had already published extensively on forams. Furthermore, Earland's demonstration of forams at the Royal Microscopical Society in 1899 was not only reported in the Journal of the Royal Microscopical Society (Anon, 1899b) of which Heron-Allen had been a Fellow since 1891, it was also reported on in *Nature* (Anon, 1899c). It is undeniable, that in 1907 at the start of their partnership, Earland was the far more experienced and active foram researcher of the two. A fair question is then is why was Heron-Allen, from the start, the first author on all of their publications until the end of their partnership?

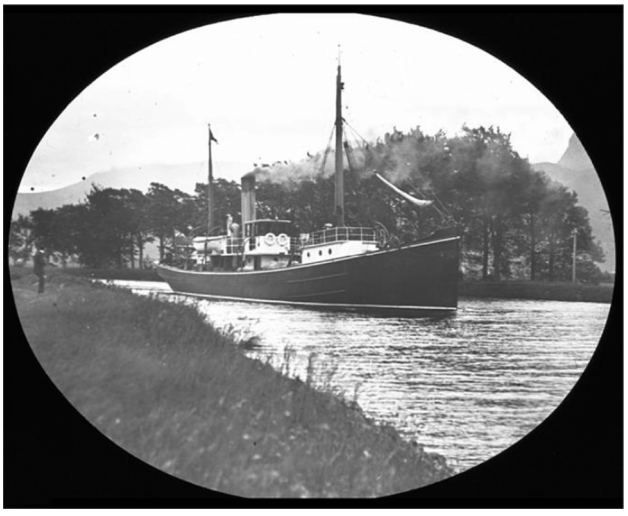


Fig. 6. The *Fisheries Cruiser Goldseeker* in 1905. From 1904 to 1913, Earland used his annual leave from his job at the Post Office Bank to participate in cruises, usually on the *Goldseeker*, to obtain foram samples. Image from the D'Arcy Wentworth Collection, courtesy of St. Andrews University, museum archives and library.

The answer may lie in the division of labor between the two described by Earland in his obituary notice on Heron-Allen.

According to Earland (1943), the partnership was profitable for both "… *for each had qualities which the other did not possess. He (Heron-Allen) was a man of unflagging industry, never happier than when picking out specimens, or engaged in the laborious spade work of indexing, proof-reading, or hunting down references, all of which jobs I detested.*" Earland, in return, alone dealt with all the new species encountered, as his part of his job, according to one of the obituary notices of Earland (Macfayden, 1959). In fairness, it must be pointed out that there is no account by Heron-Allen on the partnership. Regardless of how it was produced, the considerable body of work the partnership of Earland and Heron-Allen produced between 1907 and 1932 has been reviewed above. In the following, only Earland's work outside the partnership is reviewed.

During the partnership years Earland published little as sole author. He published only two short notes (Earland, 1916; 1922a) and a chapter on collecting and preparing forams in a manual of microscopy (Earland, 1922b). Following the dissolution of the partnership, Earland's first publications were the previously planned works on the material gathered during the Discovery Expedition: the part II (Earland, 1933), the part III (Earland, 1934), and the Part IV (Earland, 1936). These works are quite substantial with the parts II, III, and IV together representing 396 pages of text. It is possible that sections of the texts were the work of Heron-Allen. For example, the writing style of the "Introduction" of parts II and III resembles that of part I, that was likely written by Heron-Allen, and it is quite distinct from the writing style of the "Introduction" of part IV. However, the descriptions of new species in all of the four parts (pooled, 140 descriptions are considered as valid first descriptions) were likely the work of Earland.

After the last of the Discovery reports, Earland published three papers on forams in the *Transactions of the Hertfordshire Natural History Society* (Earland, 1939a,b; 1940) and served as President of the society for 1938–1399. He was named a Fellow of the Royal Society of Edinburgh in 1942, at age 76, nominated by his old friend D'Arcy Wentworth Thompson. Despite advancing age, he continued to publish on forams periodically. Earland contributed to the *Journal of the Royal Microscopical Society* in 1943 (Earland and Jepps, 1943) and in 1946 (Earland 1946). He was named an Honorary Member of the Royal Microscopical Society in 1952 (an honor not bestowed on Heron-Allen). Some of Earland's older work on fossil forams from sites in Ireland was finally published (Earland and McMillan, 1953). Earland's last two papers were fittingly published in the journals of the societies in which he had been most active. His paper on apparent abnormalities in foram shells as evidence of damage from the predators of forams appeared in the *Journal of the Royal Microscopical Society* in 1956 (Earland, 1956) and his last paper, "Mounting foraminifera as opaque objects" was published in the *Journal of the Quekettt Microscopical Club* (Earland, 1957). Arthur Earland passed away on March 27 of 1958 at the age of 92.

4. The contributions of Edward Heron-Allen and Arthur Earland to protistology as partners and as individuals

The odd couple Edward Heron-Allen and Arthur Earland can be counted among the most productive partnerships in foram studies. Together they signed 47 publications and are today credited with the first description of 186 species of forams. Admittedly, their output, pales in comparison to the much more recent partnership of Helen Tappan and Alfred Loeblich who produced hundreds of publications and are credited with 338 valid species descriptions (see Wicander, 1997). However, Heron-Allen and Earland were amateurs, not professionals. Although Earland is sometimes listed among the "gentleman British microscopists" (i.e., Murray, 2012) recall that he worked in the Post Office Bank during most of the years of the partnership until his retirement in 1926. Also, it is actually difficult to assess the magnitude of their joint contributions, especially with regard to Discovery Report papers. As alluded to above, it appears possible that the parts II to IV of the Discovery

articles, published as authored by Earland alone following the rupture of the partnership, may contain texts written by Heron-Allen. If one accords joint credit, (i.e., both Earland and Heron-Allen), to all the articles and the species descriptions of the Discovery Reports, then the partnership produced 50 publications and 273 original valid species descriptions, well within the top ranks of foram taxonomists (Hayward et al., 2020). Based on this metric (valid first descriptions), 'Heron-Allen and Earland' rank below 'Loeblich and Tappan', and above 'Wilde and Skinner'. With regard to their contributions to protistology, other than in terms of scientific publications and species descriptions, likely their most important joint contribution was to the preservation and eventual deposition of Brady's foram materials from the Challenger Expedition in the BMBH, recognized as a priceless resource (Jones, 1990).

In terms of individual contributions to protistology, Heron-Allen made major donations to the BMNH as mentioned above, all of his foram study materials; including his own slide collection and those of others he had acquired such as Sherborn's collection (Hodgkinson, 1989; Miller, 2016), as well as his foram literature collection with many rare works (Hodgkinson and Whittaker, 2004). Heron-Allen though published little on forams or protistology outside the partnership, writing mainly on 'intelligence' in forams (e.g., Heron-Allen, 1915a,b) and on d'Orbigny (Heron-Allen, 1917a,b). In contrast, Earland had published several papers before working with Heron-Allen, and continued working on forams after the end of the partnership, until shortly before his death, as detailed above. One of Earland's major individual contribution to protistology may have been his ardent advocacy of protistology through his articles introducing forams and study methods over many years (e.g., Earland, 1897; 1899a,b,c; 1902c; 1957).

Heron-Allen's donations to BMNH are an important resource, as has been documented in some length (i.e., Adams et al., 1980; Hodgkinson, 1989; Hodgkinson and Whittaker, 2004). However leaving aside the donations of Heron-Allen, Earland's contributions as a whole to protistology appears to exceed those of Heron-Allen, especially if one accepts Earland's assertion that Heron-Allen as a first author, was not responsible for the descriptions of new species in their joint publications. Regardless of the value placed on Heron-Allen's donations to the BMNH, or whether or not Heron-Allen did any of the descriptions of new foram species, it is a curious fact that Earland's contributions to protistology have been over-looked or ignored.

As alluded to in the Introduction, the first slight of Earland was in a review of the Selsey Bill foram papers that appeared in Nature (ASW, 1912) stating "*Mr. Heron-Allen has also worked industriously at the collection and identification of the Foraminifera which occur in patches on the beach* (Selsey Bill). *Altogether he has discovered about four hundred species, of which a large proportion agree closely with forms now common in Torres Straits and on the Great Barrier Reef of Australia.*" Heron-Allen was prominently featured in Vickerman's history of protozoology in Britain (Vickerman, 2000) while Earland is simply not mentioned.

Another way to assess the reputation or fame of an individual in a given field may be to consider the number of taxa named for the person. The number can be considered as a gauge of the honor accorded a person by the taxonomists of the field. Interestingly, there is a sharp contrast in the number of taxa named for Heron-Allen compared to Earland. Named for Heron-Allen, there is one foram genus (*Heronallanina*) and 12 species. Named for Earland there are four genera of forams (*Earlandia*, *Earlandinita*, *Earlandammina*, and *Earlandinella*) and 35 species. For both Earland and Heron-Allen, being honored by having species named for them has stretched across several decades (Fig. 7) suggesting that for both, generations of foram taxonomists recognized their contributions. However, the disparity in favor Earland by foram taxonomists suggests perhaps that despite being the second author of the partnership, Earland's contributions have been accorded greater weight than those of Heron-Allen?

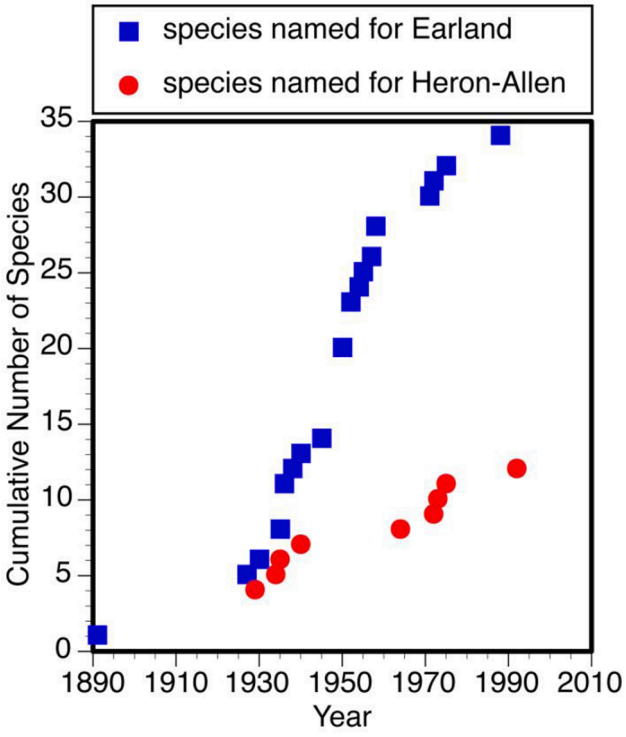


Fig. 7. The cumulative number of foram species named for Earland, and named for Heron-Allen, with time. Note that for both men the record stretches across decades. Earland has been honored may more times than Heron-Allen by having a species named for him. The numbers include all species descriptions, including those not currently recognized as a valid first description.

5. Conclusion

The flamboyant polymath, Edward Heron-Allen, and the single minded civil servant of the Post Office Bank, Arthur Earland, formed a very odd couple indeed. According to Earland's own words, they complemented one another with their distinct talents and distinct tastes for various tasks. It is certain that together they produced a prodigious number of publications on forams. However, they left behind some considerable mysteries. How did they get along? Who exactly did what in their work together? Why was Heron-Allen always the first author on their common papers? Why did the partnership end?

Earland's contributions to the work produced through the partnership have often been overlooked. The larger than life character of Heron-Allen may have relegated Earland to an apparent background role such that Earland could be thought by some to have been Heron-Allen's assistant (Kemp and Buckley, 1987). Perhaps the posthumous revenge of the neglected second author is the fact that Earland has been long been held in higher regard than Heron-Allen by foram taxonomists if species named for one is any indication.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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character to portray, leading to this work. Andrea Deneau of the Linnean Society of London kindly provided the names of the Linnean members who sponsored Heron-Allen's membership. The efforts and suggestions of the reviewers led to significant improvements in the manuscript. However, I retain full responsibility for all errors of fact, interpretation and omission.

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