

Peter Artedi, founder of modern ichthyology

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*Wheeler, A. 1987. Peter Artedi, founder of modern ichthyology. Proc. V Congr. europ. Ichthyol., Stockholm 1985, pp. 3–10. A brief biography of Peter Artedi (1705–1735) is given with some emphasis on his activities in the last year of his life in England and Holland. His posthumously published *Ichthyologia* is discussed with reference to its influence on the development of ichthyology. Artedi's work was fundamental in establishing modern ichthyological methods as well as in his analysis of earlier literature. His influence on Linnaeus's development as a naturalist is suggested to have been profound. Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD, UK.*

Peter Artedi was born in 1705 and died in 1735.

In spite of the brief span of his life he made a fundamental contribution to the study of fishes from which much of the modern discipline of ichthyology has developed. His achievements were striking in that in his one major publication, the posthumously published *Ichthyologia* (1738) he capably reviewed the earlier literature on fishes, clarified the synonymy of known species, provided a synoptic treatment of the genera, accurately described more than seventy species of European fish, but above all established the fundamental principles which he employed himself and on which systematic ichthyology would depend for the next two centuries. His wider contribution to the development of systematic disciplines in natural history is unacknowledged, and may be impossible to establish clearly, but merits examination and was probably profound because of his influence on Linnaeus at the beginning of his career.

Artedi's contribution to ichthyology has to be assessed in the intellectual context of the discipline at his time and this is briefly discussed. In the first decades of the eighteenth century knowledge of fish stemmed largely from the works of the sixteenth century encyclopaedists of natural history such as Guillaume Rondelet (1554–1555), Conrad Gessner (1558) and Ulisse Aldrovandi (1613). Each was strongly influenced by earlier interpretations of the writings of Aristotle, whose original and often accurate observations were sometimes obscured by the glosses of later editors. Although each of these works contained original observations (for example, William Turner's notes written in 1557 in a letter to Gessner (1558) were the first contribution to British ichthyology to appear in print (Wheeler *et al.* in press), much of the information was derived from earlier published sources. Natural classifications were not seriously attempted in these works which, being compendia

of derived knowledge, were more conveniently organized on pragmatic lines. Rondelet's (1554–5) often ridiculed division into sea-fishes, river-fishes, lake-fishes, and marsh-fishes was merely one example of a solution to the need to organize information in a comprehensible manner and in these terms is not less apt than those depending on single morphological features in artificial classifications.

The work of the brilliant French diplomat, secret agent, and traveller, Pierre Belon, best known from his *De aquatilibus libri duo* (1553), was based largely on his own observations on fishes and other aquatic animals in France, the Mediterranean and the Levant (where he also searched for the remains of Homer's Troy). The later publication by John Ray of Francis Willughby's *Historia Piscium* (1686) was strongly derived from the sixteenth century encyclopaedists, and Belon, with the addition of original information that the authors had obtained during their travels in the British Isles, and in Europe. It also contained accounts of a number of species of fish from South America which were derived from the observations of Georg Marcgrave in the *Historia naturalis Brasiliae* (Piso & Marcgrave 1648).

With the exception of those species described by Marcgrave, and a few others, virtually all the fishes described in the literature were European. Most of the freshwater species were those found in the Rhine system and the upper Danube, with the addition of several boreal salmoniform species. Marine fishes were mostly Mediterranean species with an element of the Atlantic fauna, many from North Sea examples. In total there were probably about 150 of the species recognized today by the beginning of the 18th century, but the number was obscured by the complexity of nomenclature employed by the authors of the various works and the repeated description of the same species under different names.

By a combination of patient literary search and the adoption of strictly defined criteria Artedi reduced this confusion to an orderly system of ichthyological knowledge. He clarified the literature of ichthyology in a unique fashion which had no contemporary zoological equal although it was paralleled by Linnaeus's *Bibliotheca Botanica* (1763) and paid the compliment of being revised by J.J. Walbaum. As a work in its own right it was a monument to a mastery of Latin, to patient bibliographical searching, and to a wide knowledge of fishes.

Biographical notes

Peter Artedi was born in Anundsjö, an inland town in Västernorrland (approximately 63°30'N 18°00'E) on 10 March 1705 (27 February in the Old Style calendar)*.

His parents were Olaus Arctaedius and Helena nee Sidena; his father was curate to the community at Anundsjö. In 1716 the family moved to Nordmaling on the coast of the Gulf of Bothnia, when Olaus Arctaedius succeeded to the living there which had, until then, been held by his father but who was now disabled by age in the discharge of his parochial duties. This move to the coast afforded opportunities for the young naturalist to study a richer fauna and flora than had been the case at his earlier, inland home. Linnaeus (1738) in his 'Vita Authoris' refers to the dedication showed by Artedi to the dissection of fishes and the study of plants from the time when he first went to school at Härnösand in the autumn of 1716.

By 1724 Artedi had matriculated from the upper school at Härnösand and in October of that year he enrolled in the University of Uppsala. Although parental guidance had indicated a course of theology and philosophy his interest in alchemy and the natural sciences led him to enroll in the Medical Faculty for it was only there that his interests could be channelled into an academic course.

Unfortunately at this period teaching in the Faculty of Medicine was of a low standard. Both the occupants of professorial positions were elderly, although gifted, and played only a minor role in the academic life of the faculty. Lars Roberg the senior of the two is reputed to have given no public lectures at all in the period Artedi was at Uppsala, while the junior professor Olof Rudbeck was more

active in philology and is reputed to have given only a short course of lectures on the birds of Sweden. Linnaeus, who enrolled in the University a few years later than Artedi wrote of the tuition 'no one heard or saw any Anatomy, nor anyone any Chemistry; I myself never had the opportunity of attending a single lecture on Botany, either private or public', but despite this (or perhaps because they were forced into a self-sufficient mode of learning and enquiry) both Artedi and Linnaeus were recognized as eminent in their disciplines on leaving Uppsala.

Artedi had been at Uppsala for four years before Linnaeus enrolled in the University but on the latter's arrival he was absent attending to family affairs following the death of his father. Linnaeus heard on all sides of Artedi's attainments and distinction as a botanist, zoologist, and for his chemical studies, but the two did not meet until the spring of 1729. It seems clear that when they did meet they proved to be mutually compatible in interests and personality although of totally contrasting temperaments, and they became firm friends, with Artedi, the senior in age by two years, being to some extent cast in the role of advisor and mentor at least in the early period of their relationship.

After nine years at the university Artedi decided to travel to other European centres of learning to further his medical education. In September 1734 he sailed for England. Little is recorded of Artedi's stay in England and that which has been written earlier (Wheeler 1961, Nybelin 1966) is largely pieced together from the evidence of references to specimens seen in parts of London. However, as he later recounted his impressions of London to Linnaeus (1738) he clearly had been well received. 'He expressed. . . in the warmest terms his sentiments of gratitude for, and appreciation of the many marks of consideration and goodwill that had fallen to his lot in England. . . he specially mentioned Sloane, the celebrated naturalist, and spoke with grateful recognition of the extreme kindness and consideration he had been the recipient of from him in particular' (translation from Lönnberg 1905).

From the incidence of many of the places mentioned by Artedi there seems little doubt that he made his base in London in the area of Ratcliff Highway (later known as The Highway, and now in the London borough of Tower Hamlets), which then and later was the centre of the Swedish merchant community. From there he travelled to Stratford (then a village about 3 km to the east), made repeated notes in Stepney (very close to Ratcliff Highway), and refers to a Mr Lillia, clearly

* Most of the purely biographical information is derived from the bicentenary memoir of Artedi written for the Swedish Royal Academy of Science by Einar Lönnberg (1905).



Figure 1. The monument to Peter Artedi erected in the grounds of the 'Artis' garden, Amsterdam in the two hundredth anniversary year of his birth. (Photograph: Sven Kullander.)

a fellow countryman who Nybelin (1966), with great patience, has identified as Lars Lilja, owner of the 'King of Sweden' inn at Shadwell, only 1–2 km downstream on the Thames. Moreover, Artedi describes a whale in London in November 1734, which must have been seen downstream of the London Bridge of that period.

However, the most influential person Artedi met was Sir Hans Sloane, to whom he bore a letter of introduction on leaving Sweden (Nybelin 1966). Sloane was a physician, a naturalist, a great collector of both natural productions and artefacts, and a man of great influence in medicine, contemporary science, and intellectual circles at the period. Living at Bloomsbury, where after his death in 1753, his collection would form the foundation collection of the British Museum, he made Artedi welcome to examine fishes in his collection (although the only evidence that he did so rests on his notes on four *Ostracion* specimens examined ('apud Sir Hans Sloane'). It must have been Sloane who introduced Artedi to the quasi-

museum of Don Saltero (really James Salter) at Cheyne Walk, Chelsea (close to Sloane's Chelsea property) where all kinds of curious objects were displayed including more *Ostracion* specimens.

Artedi must have brought to London (possibly he completed it in London) the manuscript ('Catalogus Piscium Maris Balthici') which he presented to Sloane, which was reproduced by Nybelin (1934) and is still in the British Library (Sloane MS 3870). He also dated the introduction to his *Ichthyologia* 'Scripsi Londini 1735' and from this it could be assumed that the work was considered to be finished then, although a few additional notes were added (see, for example, *Anableps* in the *Genera Piscium*, p. 25 and *Synonymia*, p. 43).

During the early summer of 1735 Artedi left London for Holland where he had planned to obtain his doctorate in medicine and on the 8th of July he and Linnaeus met by chance in Leiden. Artedi was penniless and Linnaeus was able to introduce him to Albertus Seba, an apothecary of Amsterdam and owner of a huge natural history

collection, who was attempting to complete the *Thesaurus* describing his collection (Seba 1734–1759). Artedi was engaged by Seba to write the descriptions of fishes for the third volume of the *Thesaurus* and made considerable progress with his work (including the detailed account of *Anableps*, with a description of its remarkable eyes, which is included in the third volume of the *Thesaurus*, p. 108, as well as his own work).

On the night of 27 September 1735 Artedi stayed late at Seba's house spending the evening with several friends. Returning to his lodgings in the early hours of the morning he fell into a canal and drowned.

His body was recovered the following day and taken to the City Hospital. Linnaeus, then at Hartekamp, was told of Artedi's death two days later by a fellow Swedish student Claudius Sohlberg, and hurried to Amsterdam. Artedi was buried on 2 October 1735 in St Athony's churchyard in an unmarked grave. He had no memorial until, 200 years after his birth, a memorial stone was erected in the 'Artis' garden in Amsterdam.

The publication of Artedi's *Ichthyologia*

After Artedi's death and burial Linnaeus attempted to obtain his effects and manuscripts. Engel (1951) has researched the official records relating to the burial as a pauper and the Public Notary's statement of the estate and there are several discrepancies between the official accounts and Linnaeus's published record of the negotiations. The details can be established from Engel (1951) and Wheeler (1961), but the outcome was that Linnaeus eventually was able to borrow sufficient money from his patron, the English-born George Clifford of Hartekamp, to pay off Artedi's debts with his landlord and to recover the manuscript.

Five of the manuscripts that were complete, or almost so, were published by Linnaeus in 1738 in Leiden as the *Ichthyologia*.

Undoubtedly Linnaeus edited them, and he compiled the dedicatory pages to Clifford, and to Liungberg and Biur (both dated March 1738). He also wrote the biography of Peter Artedi (as 'Vita Petri Artedi') which forms the major source of information for the relationship between the two Uppsala students, and the details of the recovery of Artedi's papers. However, he made no attempt to complete the unfinished passages (for example *Anableps*, above) nor apparently to integrate the later additions into the body of the text as three sections of the book end as an Appendix.

The *Descriptiones specierum piscium*

The *Descriptiones* forms the fifth and last section of the *Ichthyologia* but it is discussed first here as it illustrates the meticulous manner in which Artedi examined and described his fishes. In all it includes the descriptions of 71 species of fish (plus the whale seen in London). Most of these are Swedish fishes and Linnaeus (1738) in his introduction to the section states that these were obtained in the vicinity of Uppsala, at Lake Mälaren, on the Norrland coast of Sweden, the North Sea, some off the English coast, and others in museum collections.

The exotic species seen in museum collections are relatively few. There is little doubt that the *Exocoetus*, the *Coregonus amboinensis*, the seven *Chaetodon* species, and the *Lepturus* were all fishes seen in museums, not just because they are not members of the European fauna, but because they are described with less detail concerning internal organs, although the external morphology is carefully recounted. Clearly it was not possible to dissect such material.

The descriptions of Swedish fishes were, however, exemplary, and Günther (1880) wrote that they 'even now are models of exactitude and method'. In his prefatory note to this section, Linnaeus (1738) wrote 'you would, indeed, have been amazed, courteous reader, could you have watched with what persistency, with what never wearing toil, the author of this work proceeded about his self-imposed task of describing his fishes, spending in many cases several whole days over one single fish. . . to the wonderfully adroit way in which he would count over the fins, and the individual rays in them, not once only but many times, and to the method he had of enumerating and giving an account of all and each of the dorsal vertebrae' (Lönnerberg's (1905) translation).

To give an example of one of Artedi's descriptions that for the zander or pikeperch, *Stizostedion lucioperca*, can be cited. The morphological information is organised under numbered headings but the description begins with the short diagnostic sentence ('*Perca pallide maculosa, dentibus duobus utrinque majoribus*') that served as a species name before the introduction of binominal nomenclature, references to accounts by earlier authors (equivalent to a synonymy today), and the Swedish vernacular name. Then follows a list of measurements, which total thirty-four in number, starting with the total length of 'unc. 21. lin. 2 à 3' (21 inches and 2 to 3 twelfths of an inch), continuing with measurements along the vertical axis of various features, then across the depth of the body at set points.

The account then continues under the numbered headings describing the head, body, nostrils, eyes, jaws, opercular apparatus, pectoral girdle, lateral line, scales, dentition in detail (including the palatine and pharyngeal regions), gills, tongue, the pectoral, pelvic, both dorsal, the anal, and caudal fins. Then the internal organs are described the shape and position of the liver, heart, intestines, spleen, gonads (in the fish described ovaries), the gas bladder in detail, and the peritoneum. As a detailed account of this species it is without parallel in its time, and clearly it involved dissection of the fish to its virtual destruction.

Most of the European fishes described by Artedi were described to this standard, although the details sometimes differed. Not infrequently also they included notes on breeding seasons, and sometimes generalizations about the habitat of the species. Some (but not the species discussed in detail above) included details of the number of vertebrae and ribs.

Such detail was unequalled by earlier authors (although on rare occasions Willughby's *De Historia Piscium* (Ray 1686) approached it) and few contemporaries of Artedi's, or even nineteenth century ichthyologists attained the same standard except for single species accounts. It demonstrated both Artedi's painstaking approach to ichthyology that he so patiently measured and dissected his material, and his disciplined philosophy in the presentation of his results.

Their significance for ichthyology lay in that Linnaeus (1758) cited no fewer than 71 of these descriptions in the tenth edition of the *Systema Naturae* and this laid a firm foundation for the taxonomy of European fishes. It has, however, to be emphasized that no specimens of Swedish fishes described by Artedi exist today. Presumably they were discarded after such detailed dissection, although the account of the description of *Stizostedion lucioperca* ends '*Caro candida & sapida*' which suggests that it might have eventually been eaten!

The literature of ichthyology

As suggested earlier the literature of ichthyology at the beginning of the eighteenth century was heavily dependant on the writings of the sixteenth and early seventeenth century encyclopaedists and their interpretation of classical authorities. In his *Bibliotheca Ichthyologica* or *Historia Litteraria Ichthyologiae*, which forms the first section of the *Ichthyologia*, Artedi reviewed the earlier literature on fishes. It represents a formidable project, both in its interpretation of ancient languages both

Latin and Greek, and in the way so many early, scarce books are carefully reviewed. As a bibliographic exercise it is outstanding for it is quite clear that Artedi had seen and analysed most of the books himself.

The literature is arranged chronologically beginning with the ancient Greek poets and philosophers, giving brief biographical notes and for published works mostly from the sixteenth century a synopsis of the contents of the work including comments on the sources used by the author. With later works such as Willughby's *De Historia Piscium* (Ray 1686) the analysis of the contents is detailed listing by title the major 'books' within the whole then giving a detailed list of the sections within the 'books'. In some cases, such as in Ray's (1713) *Synopsis Methodica Piscium*, he lists the genera of fishes recognized.

This is not merely a listing of the literature, for the works cited are later classed by author's name and short title chronologically, then under various headings such as 'Ichthyologi Systematici', geographically, those whose books are arranged without method, or are arranged alphabetically. The *Bibliotheca* ends with an index to the major entries for each author. In summary Artedi's work provided everything that one could wish from a bibliography, from the clear statement of author, title, and date of publication to the analytical indexes of the contents. It was a major production of language, patience, and bibliographical expertise, but more importantly it provided the basic information required for the clarification of the names of fishes.

The fourth part of the *Ichthyologia* is the *Synonymia nominum Piscium* in which, following the systematic order adopted throughout his work, Artedi gave a list of the names applicable to each of the species he recognized. Organized within his Orders and Genera each species was introduced by the descriptive polynomial sentence that served as a name for the species, and was then followed by a synonymy with references to the author of the work in abbreviated form and pagination. In addition, the entry ended with a list of vernacular names in European languages (sometimes Swedish, Danish, German, Belgian, and English, at others only some of these).

As a contribution to clarifying the nomenclature of fishes it was a major step forward and taken together with the analysis of the literature in the *Bibliotheca Ichthyologica* it summarized existing knowledge unambiguously. To appreciate it as such is to understand what an immensely painstaking feat of indexing and cross-referencing it must represent.

The *Genera Piscium*

The third section of the *Ichthyologia* is titled *Genera Piscium*, but to a considerable extent this is a misnomer for the work is a classification of the fishes recognized by Artedi, and containing, according to the title-page synopses 52 genera and 242 species. Earlier (Wheeler 1961) I suggested that this section was identifiable as the manuscript titled 'Historia piscium universalis' in the inventory of the possessions of Artedi made after his death (see Engel 1951) and this suggestion still seems tenable. It is more truly descriptive of the section than the title given it for publication by Linnaeus.

The *Genera Piscium* opens with a key to the orders of fishes ('Clavis ordinum') in which each of the five recognized orders is simply characterized by the vertical or horizontal (in cetaceans) position of the tail fin, the alternatives of bony or cartilaginous skeletons, the presence or absence of gill covers, and presence or absence of spines in the fins. Then each of the two major orders Malacopterygii (soft-rayed fishes) and Acanthopterygii (spiny-rayed fishes) are divided into subsets by listed characters.

Thereafter each genus is listed with a short but trenchant set of distinguishing features, and the recognized species within the genus are listed by number each being characterized with a short diagnosis. Other information is given, frequently vernacular names, sometimes meristic data, notes on coloration, and general notes on notable features. In all there are 48 genera of fishes included here (plus seven mammals, mostly cetaceans) all of which were later adopted by Linnaeus (1758) and thus validated, and all of which are in current use today. Many of the species Artedi included in this section are those which he had described from his own observations, but others were taken up from the literature, for example *Echeneis* and *Coryphaena*. In the Appendix to the *Genera Piscium* there are six species added which clearly were later additions. Most are species which Artedi must have encountered after he had left Sweden, although one, *Silurus glanis*, is a Swedish fish which he had described in detail. These late additions are not included in the list of the contents and comprise two genera which were never recognized by Linnaeus, e.g. *Taenia* (possibly *Cepola*, in part), *Mustela* (possibly *Zoarces*), two which later became established *Sphyræna* and *Phycis*, and also the first use of the name *Clarias*, as 'Clarias Nilotica Bellony' (*sic*).

The *Genera Piscium* was thus a fundamental part of Artedi's organization of ichthyology. It

depended for its simplicity on the clarification of the literature and the synonymy of fishes in other parts of the *Ichthyologia* and was compiled using the rigorous criteria he laid down in his *Philosophia Ichthyologica*. In the short space of 84 pages it encapsulated all the fishes he recognized in 1735 and it was not substantially added to or altered for twenty years when L.T. Gronovius revised the section on fishes for the ninth edition of the *Systema Naturae* (1756) which J.F. Gronovius edited (Wheeler 1979).

The *Philosophia Ichthyologica*

The second section of the *Ichthyologia* contained the essence of Artedi's experience with fishes and his philosophy for the establishment of ichthyology as a science. However, as he clearly recognized, many of the rules that he laid down were applicable to other branches of zoology as well as botany, and there is great similarity between his precepts and those established by Linnaeus (1736a) in his *Fundamenta botanica*. Both works had the same objects, to lay down the precepts for the study of the discipline by the introduction of rules for the definition of all levels of classification, the establishment of valid characters for these definitions, and the clarification of names at all levels so that the same term was not employed for more than one taxon.

The first part of the *Philosophia Ichthyologica* starts with the basic definition of a fish. Then under the heading 'Partes Piscium' proceeds to discuss the fins and their variation in number. The shape of the head, snout, the placement of teeth in the buccal region, their shape and number, the position of the nares and eyes. The lateral line is described. In each case examples of species are cited to demonstrate the variation known to exist. Internal organs, such as the heart, blood vessels, intestine, liver, spleen, gonads, and brain are also described but in the knowledge that external features are of greater practical use in classification.

In a latter part where the classification of fishes is discussed Artedi shows that fishes (and other animals) can be arranged in divisions or groups, pointing out that the arrangement can be either hypothetical (and thus artificial) or based on natural divisions.

He pointed out that an arrangement of fishes based, for example, on the number of fins was artificial and grouped together species which were clearly unrelated on other grounds, and then advocated the grouping of fishes on the basis of common features. Thus, many of Artedi's genera—where he was basing his arrangements on fishes

which he had himself dissected – still stand today as systematic units, examples being *Cobitis*, *Cyprinus*, *Gadus*, although his genera have been elevated to family rank. This emphasis on the importance of natural characters was far in advance of the thinking of his contemporaries, for the controversy surrounding Linnaeus's sexual system of botanical classification continued to the end of the eighteenth century before the system was abandoned in favour of a natural classification.

The levels of classification adopted by Artedi include the Class for all fishes (equivalent to mammals and birds), with a subdivision of Maniples (equal to families, a term he uses in discussion but does not formally apply) thence Genera and Species. In the light of the present complexity of classification this appears simplistic, but viewed with the knowledge that in the eighteenth century at the most 250 species of fish were recognized and Artedi had critically examined fewer than 100 species, it was a pragmatic level of division. His major groupings of fishes into Malacopterygii, Acanthopterygii, Branchiostegi and Chondropterygii (and Plagiuri) continued in use by Linnaeus in the *Sytema Naturae* through to 1756, and Branchiostegi continued into the tenth edition (Linnaeus 1758).

Later sections of the *Philosophia Ichthyologia* are devoted to discussion of the characters to be used in establishing genera. He advocated the use of characters associated with the skeleton of the fish, especially the number of branchiostegal rays, the shape, placement and composition of bony elements in the fins, and the number of vertebrae. Presence, size and number of scales, teeth, and the form of the jaws, as well as general body form also had to be considered. In advancing the use of such fundamental characters he made a major step forward in the clarification of groupings of fishes.

Moreover, he also advanced rules for the formation of generic names, insisting that each should consist of the single word common to all members of the genus. He also ruled out the use of the same genus name in more than one animal group, thereby saving ichthyology from many of the problems caused by homonymy which would have ensued had he not ruled out the use of such names as *Turdus*, *Passer*, *Merula*, *Asellus*, *Rana* and *Serpens*, which had been used by earlier authors for fishes and for other animals. In the choice of suitable words to use as genus names he advanced strict rules, approving only of those of Latin or Greek origin, rejecting vernacular names, or those based on patronyms or place names, and relative terms such as those ending in *-oides*. Many

of these rules were identical to those advanced by Linnaeus in his *Fundamenta Botanica*, and it is clear that the two authors had mutually agreed objectives.

The *Philosophia Ichthyologica* was a major advance in ichthyology. It established a clear order of logic, which as it was applied throughout the other sections of the *Ichthyologia*, laid the foundation of a disciplined approach to the subject. It was also applicable to other disciplines in zoology, although little of the philosophical approach was carried through to them. The only valid comparison was in the science of botany where Linnaeus in a series of publications established comparable rules and put them into practice (Linnaeus 1736a, 1737). Much of the wider impact of Artedi's work was lost due to his early death and the fact that his *Ichthyologia* was posthumously published, but at least it provided a firm base for the development of ichthyology.

The influence of Artedi's work

Artedi's work was fundamental to the development of ichthyology. In his philosophical approach to the criteria to be adopted in the recognition of different taxonomic levels he established the hierarchy which was used for a further century, when the work of Georges Cuvier (1769–1832), with his background of comparative anatomy, supplanted it. Artedi's analysis of the literature of fishes, and his erudite synopsis of the synonymy from this literature, laid the foundation for later authors, but not least it was a remarkable achievement for a man in his twenties who had been educated in the not then well-endowed atmosphere of the University of Uppsala. However, it was in the detail with which he examined and described the fishes that he studied that he was unsurpassed. In these descriptions all the features, both morphometric and meristic (including for the first time the number of vertebrae in his specimens), which were to be used for two centuries in taxonomic ichthyology were given. Indeed there was much more, for his descriptions of internal anatomy were unique, and are rarely equalled today except in special circumstances.

Artedi's work with fishes established ichthyology as a scientific discipline and his methods were valid until the mid-twentieth century when studies of chromosomes and biochemical techniques have provided fresh insights into the distinctions between species.

Artedi's wider influence was probably much greater than has been appreciated, but it is impossible to assess from direct evidence. After his

death his manuscripts were rescued by Linnaeus who edited them, wrote a short life of the author, but otherwise appeared to do little to revise them. It was not until mid-1738 that the work was published.

Virtually all that we know of the relationship that existed between Linnaeus and Artedi stemmed from the former's biography and while it is obvious that the *Vita Auctoris* was written in a mood of sorrow for the loss of his friend, it was not compiled on the spur of the moment for Linnaeus had had two and a half years to reconcile himself to Artedi's death. Whatever gloss Linnaeus put on Artedi's work there is no doubt, as Stearn (1959) aptly remarked, that their work 'reflects their temperaments, Artedi's is remarkable for monographic depth and thoroughness, Linnaeus's for encyclopaedic breadth and variety', although this was true of Linnaeus at the height of his career not necessarily as a young man. Linnaeus was two years younger than Artedi, and four years his junior, when he commenced his studies at Uppsala, where – as we have seen – academic standards in the Faculty of Medicine were temporarily low. Artedi already well established as a student, deeply committed to natural history studies, medicine, and 'alchemy' must have been instrumental in guiding and stimulating the younger man's interests and learning.

Whether their studies were intentionally paralleled, Artedi in ichthyology and Linnaeus in botany, is impossible to say, but there are striking points of coincidence at this time in their publications. Artedi's *Ichthyologia* was virtually finished before he left Sweden in the autumn of 1734, and Linnaeus's *Fundamenta Botanica* (published 1736a), *Critica Botanica* (1737) and *Genera Plantarum* (1737a) each stand as a botanical equivalent of a part of the *Ichthyologia* written soon after its completion. It may be that the coincidence stemmed from the planned division of labour between the two, but the evidence of the dates suggests that Linnaeus was inspired by Artedi's work to produce comparable botanical publications. If this is so, and there are pointers towards it, then Artedi had a stronger influence on Linnaeus and the development of systematic botany than has been acknowledged. Linnaeus's later development of binominal nomenclature, was certainly his own invention, but the philosophical approach to the characters to be used in defining the various levels of taxa, and the aphorisms by which he laid down the rules of nomenclature would seem to be more in keeping with Artedi's known reflective disposition and analytical temperament.

It is possible therefore that Peter Artedi's contribution to the development of nomenclature, taxonomy, and systematics across the whole field of natural history has been obscured. However, it is undeniable that he established the modern discipline of ichthyology, including most of the methods still in use, two hundred and fifty years ago.

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