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Taxonomic revision of Leopold and Rudolf Blaschkas' Glass Models of Invertebrates 1888 Catalogue, with correction of authorities

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Abstract

The glass models of invertebrates crafted by Leopold and Rudolf Blaschka were made between 1863 and 1889. Production ceased when the glassmakers turned their attention to what is now known as the Ware Collection of Blaschka Glass Models of Plants, created for the Harvard Museum of Natural History. More than 130 years have passed since their last published catalogue of species in 1888 and the nomenclature they applied is now a confusing mix that includes many junior synonyms and unavailable names. This is an issue for many museums and universities which own Blaschka models, as uncertain identifications may compromise interpretation of this rediscovered legacy. Today, many museums and universities hold collections of those glass invertebrates but rely on labels that have outdated taxonomy, or may be misspelled. Here, we provide a valuable resource for curators and enthusiasts alike. We studied and updated the final catalogue of 1888 from the Blaschkas' Dresden-based workshop. We first focused on major taxonomical changes from taxa to species, as well as on an analysis of the acknowledged authorities. We found that only 35.3% of the taxonomic names applied to the 1888 models are currently used, while 3.7% lack any known synonym and their identity remains open to interpretation. Finally, two of the authorities listed in the catalogue, Ernst Haeckel and Philip Henry Gosse, were incorrectly acknowledged as authors for taxa that were applied to an extensive range of models. This study is the first of its kind on the taxonomy used for the 1888 Blaschka catalogue, and it will help in the identification and naming of Blaschka models worldwide.

Keywords: Invertebrate, Blaschka, museum, collection, taxonomy

Introduction

During the 18th century, the Swedish botanist Carl von Linné (Carolus Linnaeus) established a “two-term naming system”, also known as binomial nomenclature to provide a standardised name for each species. This system is now governed by international codes of rules such as the *International Code of Zoological Nomenclature* (ICZN). Binomial nomenclature encompasses terrestrial as well as marine species and became the reference for

describing and naming any new species discovered, including those from terrestrial and marine the expeditions of the 19th century. From François Auguste Péron's jellyfish drawings (Péron, 1816) to Ernst Haeckel's radiolarian engravings (Haeckel, 1887), alongside the massive 35 volumes from the HMS *Challenger* expedition reports (1872–1876), a new world was opened up to the masses.



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This enabled people to see these creatures both in books and in prints. The newly established French and British museums were keen to show what the world had to offer, and exploit (Das and Lowe, 2018), through the display of skeletons and exotic stuffed animals. However, the marine world, other than fishes and dolphins, remained difficult to present as many of those marine species could not withstand taxidermy (e.g. jellyfish) and deteriorated rapidly when preserved in spirit usually fading, or shrinking in preservatives.

One workshop, based in the German town of Dresden, found a solution to the challenge of displaying the newly described marine invertebrates. The lampworkers Leopold and Rudolf Blaschka, father and son, used their knowledge of glass and its translucent qualities, as well as pigments to create artificial jellyfishes and other soft-bodied invertebrates that could be exhibited easily (Reiling, 1998; Reiling 2000). However, they relied on books, lithographs, and sometimes live creatures kept in tanks to produce their models (Dohrn A. 1877). Many different books and monographs were used as source illustrations such as Philip Henry Gosse's *Actinologia Britannica: A History of the British Sea-Anemones and Corals* (Gosse, 1860), Haeckel's *Das System der Medusen* (Haeckel, 1879) or Jean Baptiste Vérany's *Céphalopodes de la Méditerranée* (Vérany, 1851). The Blaschkas manufactured models of invertebrates that they sold worldwide through their own workshop and through three distributors: Robert Damon (United Kingdom and Ireland), Václav Frič (Austria and Hungary), and Henry Augustus Ward (North America). These models are quality representations, and they are often referred to as masterpieces in which their art matches their true biological nature (Sheets-Pyenson, 1988; Dyer, 2008; Callaghan et al., 2014). Since the production of these magnificent models ended in 1889, a wealth of marine biological data has accumulated, and there have been many taxonomic changes. In addition, challenges to established ideas and concepts have led to the extensive reorganization of the Tree of Life (e.g., the Archean Kingdom). However, the name "glass models of invertebrates," which has been consistently applied to the Blaschkas' creations, has never been challenged, presumably because these models were extremely accurate, and little has been published about their taxonomy. Although some work has been done on the origin of their designs and their sources of inspiration, it is often very general and incomplete (Reiling; 1998).

We decided to investigate the taxonomy of the Blaschkas' glass models of invertebrates listed in the two English catalogues (1878; 1888) published

by Ward's Natural Science Establishment. We used archives such as the Rakow Research Library of The Corning Museum of Glass (which contains the archives of the Blaschkas' workshop), as well as the large digitized holdings of the online Biodiversity Heritage Library (BHL). The authority for each species and the taxonomic validity of the original species' name versus the currently established one was assessed through the World Register of Marine Species (WoRMS). We thus established a new version of the Blaschkas' 1888 catalogue, with the correct modern taxonomy and authority for each species, along with a unique set of "Blaschka species" that exist only as models (the species they described are no longer considered valid). Finally, we uncovered a bias toward citing British naturalist Philip Henry Gosse and Ernst Haeckel as recognized taxonomic authorities.

Methods

Archival material

The original catalogues that describe the invertebrate models sold by the Blaschkas' workshop in Dresden were obtained from the following sources: Blaschka workshop early catalogues in German (Three editions between 1871 and 1876) "Wenig Bekannte Seethiere..." The first edition has not been found yet while the second version has been provided to us as a transcript from Chris Meechan, National Museum of Wales while the third Edition has been purchased from the British Library [Identifier: 000373688; UIN: BLL0100037368]; Ward's Natural Science Establishment catalogue in English (1878): Reese Library of the University of California. [online access: <https://babel.hathitrust.org/>]; Blaschka's catalogue in German "Katalog über Blaschka's Modelle von Wirbellosen von Leopold Blaschka" was obtained from the Corning Museum of Glass Library [OCLC Number: 70272726; it was originally obtained from Chris Meechan, National Museum of Wales. It is a copy of a catalogue own by Robert Damon the British Blaschka Dealer and heavily annotated]; Ward's Natural Science Establishment catalogue in English (1888): River Campus Libraries, University of Rochester, Rochester, New York, Henry Augustus Ward Papers (1840–1933), reference A.W23.

Analysis of Data

Because of the extent of the species and phyla covered by the Leopold and Rudolf Blaschka models, as well as the evolution of the taxonomical nomenclature with the passing of time (150 years), we had to work, for the most part, on well-

established and curated online databases to ascertain that each model represented a valid species. All the species names were checked, and the taxonomy, from phylum to species, was updated as much as possible.

The principal databases consulted were: World Register of Marine Species (WoRMS), www.marinespecies.org; Marine Species Identification Portal, species-identification.org; and the Catalogue of Life, www.catalogueoflife.org.

The Biodiversity Heritage Library (www.biodiversitylibrary.org) was also used. This holds scanned original books with chromolithographies, that can be compared to Blaschka drawings and final models to confirm or reject the binomial nomenclature used.

These databases were used consistently and, depending on the final established taxonomy, we applied the following taxonomic terms: “*nomen dubium*” (Latin, “doubtful name,” indicating that the taxonomic validity is uncertain or disputed by various experts); “*nomen nudum*” (Latin, “naked name,” indicating a name that has been published without an adequate description), and “*species inquirenda*” (Latin, “species of doubtful identity, requiring further investigation”). In cases where no matching entry could be found in any of these databases, an online search was conducted to cross-reference other sources, which often clarified the identification or suggested a possible alternative. For several models, despite our best efforts no valid current identification, inclusive of synonymies, could be found. These models are designated as “ND” (No Data) in the updated version of the catalogue.

Results

General Catalogue Analysis

The Dresden Blaschka workshop sold the models by the means of catalogues. Three early catalogues published between 1871 and 1875 were in German and directly distributed by Leopold Blaschka [Third edition: 392 items]. The items were not numbered, but only described by three elements: species name, price and the author. Rarely was there any indication of the number of parts per item (e.g. two polyps). Size, weight, material and so on were never indicated. Numbering of each item available first appeared in the catalogue published by one of their distributors: Henry Augustus Ward in 1878 [630 items]. This catalogue, in English, was sold by Ward Establishment and promoted through their publications. Each item was numbered and this is now commonly referred to as the Ward Number

when describing a Blaschka model. Each number was associated with a species, a reference, a price and sometimes additional indications such as: developmental stages, male, female. There were no indications of the number of parts per item, size, weight, colour, material and additionally there were no drawings, illustrations or sketches. In 1885, the Blaschka workshop published a new version of their improved offer of models in a new German catalogue [697 items] mainly based on taxonomical classification, from Protozoa to Salps while the translated Ward catalogue from 1888 used a numerical ranking from 1 to 704 irrespective of taxonomy [704 items]. This was to be the last ever published catalogue. However, the 1878 and 1888 Ward catalogue have three items which numbers have been duplicated in comparison to the 1885 Blaschka catalogue bringing the total number listed to 707 items:

1885 – Blaschka catalogue in German

- 141. *Cladonema radiatum* (juvenile and adult medusa)
- 191. *Tubularia indivisa*
- 219. *Rhizophysa Eysenhardti*

1878/1888 Ward catalogue in English

- 141. *Cladonema radiatum* (stages of development)
- 141a. *Cladonema radiatum* (adult medusa)
- 191. *Tubularia indivisa* (stages of development)
- 191a. *Tubularia indivisa* (male colony)
- 219. *Rhizophysa Eysenhardti*
- 219a. *Rhizophysa helianthus*

It is important to agree on the terms used to describe the models. We assume that number referred to an item linked to a species and a price as they were models sold through a catalogue. Some items may consist of a number of parts and so one catalogue number may correspond to several sub-elements or parts. For example, some models such as *Caryophylla Smithii* [sic] is either a single polyp or two polyps depending if they are an early model (<1878) or a late model (>1878) but both will be numbered identically (n. 122). Similarly, the *Aurelia aurita* (n. 225) is an item that consists of up to 14 parts. Therefore, the numbers referred to an item in the catalogue regardless of the numbers of parts produced by the Blaschka workshop. Moreover, some species may not be represented by a single number as some species appeared multiple times across the catalogue as adult, juvenile, and developmental stages and even by a dissection. So even though the last catalogue published in 1888 lists 704 items, it does not consist of 704 species and offers more than 704

elements. Based on our practice with various collections, many items have been split and renamed as the curators were not aware of the number of parts per item/number.

The Blaschkas were lampworkers, not taxonomists, and they had to rely on the limited taxonomic literature available at the time and especially chromolithographic plates that helped them produce coloured models. The best-known example are the anemones based on lithographies illustrated by P.-H. Gosse (Gosse; 1860). Henry Ward, who produced his catalogues, was a geologist not a zoologist. At that time, it was customary to assign a specific status to organisms based on minor differences that would today be regarded as a subspecies at best, and therefore some of the items in the catalogues represent “species” that are no longer considered valid. In addition, it is possible that some of the species were incorrectly identified in the first place.

None of the two catalogues follow established taxonomic conventions, in that the generic and specific names are not italicized. Specific names were also capitalized when they referred to persons, as was common practice in the literature of the time (e.g., item n. 30, *Actinoloba Paumotensis*, and item n. 43, *Bunodes Ballii*).

There are spelling errors throughout the German and English catalogues. These may have been a fault of the typesetters, who were not experts in the field (e.g. item n. 20 is listed as *Actinaria* rather than *Actiniaria*). The mistakes may indicate that neither Ward nor the Blaschkas corrected their manuscripts before they were printed.

Analyzing Ward's 1888 Catalogue

We used Henry Ward's 1888 catalogue as the last available catalogue to establish a reference of the complete Blaschka marine invertebrate collection. Seven hundred and four items are sequentially numbered, but three items [ns. 141, 191 and 219] were subdivided into two items each [ns. 141a, 191a and 219a] so the complete set of items offered to customers was 707. However, the distribution is highly variable across phyla, classes, and orders (Table 1).

Of the 707 items, 19 (2.6%) are of varieties no longer considered valid, although three of these are now regarded as full species in their own right where the variety named has been recognized as the species under a different name; 10 (1.4%) represent developmental stages of species (note that there are no adult forms of items 252 and 669 listed in the catalogue); 12 (1.7%) are dissections

presenting the internal anatomy of mainly Gastropoda, three of which are not otherwise included in the catalogue; and four (0.6%) represent male and female specimens of two species. Therefore, the 707 items represent 694 species as recognized at that time.

General Changes in Taxonomy (from the 1888 Ward Catalogue)

At the phylum level, three phyla are still valid (Echinodermata, Mollusca, and Porifera) and two phyla (Coelenterata and Vermes) are obsolete, while Tunicata is now a subphylum of Chordata. The Protozoa, introduced in 1818 as a taxonomic class, has been and remains a problematic area of taxonomy, but is currently considered a subkingdom in the kingdom Protista. Coelenterata now encompasses the current phyla Ctenophora (comb jellies) and Cnidaria. Platyhelminthes, Annelida and Nemertea are now three phyla that cover the obsolete Vermes phylum. (In the catalogues, the term “Phylum” does not appear; instead, the now obsolete “Type” is found.)

At the Class level, eight classes are still valid (Anthozoa, Crinoidea, Asteroidea, Holothuroidea, Gastropoda (originally Gasteropoda), Cephalopoda, Thaliacea, and Turbellaria), and one is obsolete (Gephyrea). However, because of the reorganization of phyla and subphyla, many classes are now assigned to various phyla and subphyla (e.g., Anthozoa is now a class of the phylum Cnidaria) (Table 2). Three classes used names that can be commonly found with different spellings: Hydromedusae (Hydroidomedusae, now accepted as Hydroidolina), Gasteropoda (Gastropoda), and Tethyodea (Tethioidea). This could be based on the original book used for the species' name or eventually some printing errors or transcription.

At the Order level, there have been extensive changes, as noted in Table 2. Three orders are now obsolete (Calycozoa, Hydroidea, and Acalephae), while many orders are now regarded as classes, infraclasses, subclasses, or families. Only two orders remain valid today (Zoantharia and Siphonophorae).

Concerning the Species taxonomic classification of the Blaschka marine invertebrate models, 240 (33.7%) are unchanged, 400 (56.1%) have changed (this includes the variations that are no longer recognized), and 40 (5.6%) have been only tentatively identified. For 25 (3.5%), no data can be located (this includes one model that bears the name of a plant species). Finally, four (0.56%) are described as “*nomen dubium*,” two (0.28%) are termed “*nomen nudum*,” and two (0.28%) are

Table 1: Taxonomic Distribution of Invertebrate Models in Henry Ward's 1888 Catalogue.

Phylum	Class	Order	
Coelenterata (258)	Anthozoa (133)	Alcyonaria (19)	
		Zoantharia (107)	
		Madreporaria (7)	
	Hydromedusae (117)	Hydroidea (71)	
		Siphonophorae (26)	
		Lucernaria (3)	
		Acalephae (17)	
		Ctenophora (8)	
Echinodermata (48)	Crinoidea (4)		
	Asteroidea (11)	Ophiuridae (10)	
	Holothuroidea (33)		
Mollusca (276)	Gasteropoda (226)	Opisthobranchia (158)	
		Prosobranchia (12)	
		Pteropoda (9)	
		Pulmonata (44)	
		Cephalopoda (50)	
Vermes (68)	Platyhelminthes (36)	Turbellaria (6)	
	Gephyrea (3)		
	Annelida (29)		
Tunicata (33)	Tethyodea (24)		
	Thaliacea (9)		
Protozoa (16)	Rhizopoda (16)	Protoplasta (3)	
		Heliozoa (3)	
		Radiolaria (10)	
Porifera (5)	Calurea	Leucosolenida (1)	
	Hexactinellida	Lychniscosida (2)	
		Hexactinosida (2)	
MODELS: 704 items			

regarded as “*species inquirenda*.” Interestingly, 60 items (8.4% of the catalogue) are of species that had been described within the preceding 30 years (i.e., since 1858), and 17 of those (2.4% of the catalogue) had been described within the preceding 20 years (i.e., since 1868).

Authority

According to the International Code of Zoological Nomenclature (ICZN), it is common practice to identify a species using the established binomial name, followed by the “authority”. It is a way of

identifying the person who first published the name, and it is a very important component of the species’ nomenclature. We identified 136 naming authorities, but 22 of these accounted for 64 percent of the names. They include such well-recognized naturalists as Carl von Linné and Jean-Baptiste Lamarck, but also some authors who are regarded as experts in specific branches of invertebrate studies: Louis Agassiz and Edward Forbes (Cnidaria), Jacques Philippe Raymond Draparnaud (Gastropoda), and Otto Friedrich Müller (Actiniaria).

Table 2: Corrected Taxonomic Distribution at the Class and Order Levels of Marine Invertebrate Models in the 1888 Ward Catalogue .

<i>Class</i>	<i>Current Status/Rank</i>	<i>Comments</i>
Anthozoa	Class	Class in Phylum Cnidaria
Hydromedusae (Hydroidomedusae)	Class (Hydroidolina)	Subclass of Hydrozoa, phylum Cnidaria
Crinoidea	Class	Class in Subphylum Crinozoa, phylum Echinodermata
Asteroidea	Class	Class in Subphylum Asterozoa, phylum Echinodermata
Holothuroidea	Class	Class in Subphylum Echinozoa, phylum Echinodermata
Gasteropoda	Class (Gastropoda)	Class in Phylum Mollusca
Cephalopoda	Class	Class in Phylum Mollusca
Gephyrea	Obsolete	Modern sub class Echiura [Phylum: Annelida], Phyla Sipuncula and Priapulida
Tethyodea (Tethioidea)	Division	Division of Subphylum Tunicata
Thaliacea	Class	Class of Subphylum Tunicata
Turbellaria	Class	Class in Phylum Platyhelminthes Some species of this group are now in the Phylum Nemer- tea
Alcyonaria	Subclass (Octocorallia)	Subclass of Anthozoa
Zoantharia	Order	Order of Subclass Hexacorallia, class Anthozoa
Calycozoa	Obsolete	
Hydroidea	Obsolete	
Siphonophorae	Order	Order of Class Hydrozoa
Acalephae	Obsolete	
Ophiuridae	Family	Family of Order Ophiurida
Opisthobranchia	Infraclass	Infraclass of Class Gastropoda
Prosobranchia	Subclass	Infraclass of Class Gastropoda (Prosobranchia is no longer accepted as a valid subclass see Ponder & Lindberg, 1997)
Pulmonata	Infraclass	Infraclass of Subclass Heterobranchia

Philip Henry Gosse, the English naturalist and popular nature writer, is the principal naming authority quoted, with 59 species in the catalogue attributed to him. However, the identification of 50 of these species has been revised. Twelve were reassigned to species already described by Gosse, and 38 were reclassified as species previously identified by other authorities. Only nine were retained as genuinely new species described by Gosse. Another frequently quoted authority is Ernst Haeckel. Twenty-one species are attributed to Haeckel in the catalogue, 13 of which have been reclassified (four as species previously described by Haeckel, and nine as species previously identified by other authorities). The remaining eight are unchanged as genuinely new species described by Haeckel.

Discussion

The Blaschka workshop, based in Dresden, developed a unique series of invertebrate models between 1863 and 1890, using as reference zoological illustrations such as those contained in Gosse's *Actinologia Britannica* or Ludwig Schmarda's *Neue wirbellose Thiere* (1859–1861). Although the current use of Blaschka models by many museums and universities is to highlight invertebrate biology, interpretation of this rediscovered legacy is compromised by uncertain identifications. With the passing of time and new discoveries, the extent of knowledge of the biological world increased, as did the complexity of the Tree of Life and the taxonomic keys required to identify every single species.

We investigated the taxonomy of the Blaschkas' entire zoological production (707 items) to correct any taxonomical inaccuracies that may have occurred over the last 131 years (1888–2019). We established the modern taxonomy of as many models as possible to provide every Blaschka collection curator with a reference table (Appendix 1), to properly label models with accurate taxonomic identification. But this table will not be the final one because we still have a series of models for which only limited information can be located. Two models (0.28%) are “*species inquirenda*” (Table 3). Forty models (5.6%) have been only tentatively identified (Table 4), no data can be located for 25 others (3.5%) (Table 4), four (0.56%) are described as “*nomen dubium*,” two (0.28%) are termed “*nomen nudum*.” All of these will require further research.

It is interesting to note that of the 630 items presented in the 1878 Ward catalogue and the 707 in Ward's 1888 edition, we can identify only 694 species. Because of the invalidation of 25 variations of some species and the paucity of firm data, we could finally retrieve only 621 valid and fully identified species, with 400 (64%) being unchanged since the last catalogue was published in 1888. The occurrence of those variations in the Blaschka catalogue relate biologically to the fact that environmental conditions can exert a significant influence on the physical appearance of some species. In the past, it was common practice to identify and name animals and plants exhibiting these effects as distinct varieties within a species - a practice that is no longer considered valid. For example, item n. 122, *Caryophyllia smithii* var. *clara*, and item n. 123, var. *castanea*, are no longer separated, but are listed as *Caryophyllia smithii* in Appendix 1.

Table 3: Species with no identification information (Note: *Actinia chioococca*, has no number but it is from an earlier catalogue, 91863, which has no number.)

No.	Original Species Name	Authority
12	<i>Renilla violacea</i>	Quoy & Gaimard
15	<i>Sympodium purpurascens</i>	Ehrenberg
60	<i>Edwardsia vestita</i>	Forbes
70	<i>Paractis adhaerens</i>	Ehrenberg
72	<i>Paractis olivacea</i>	Ehrenberg
87	<i>Saccanthus purpurascens</i>	Milne Edwards
148	<i>Cunina campanulata</i>	Eschscholtz
160	<i>Liriope appendiculata</i>	Forbes
168	<i>Obelia sphaerulina</i>	Péron
175	<i>Polyxenia Alderii</i>	Forbes
176	<i>Rhegmatodes (Aequorea) forbesianus</i>	Gosse
190	<i>Trachynema ciliatum</i>	Gegenbaur
194	<i>Turris neglecta</i>	Forbes
196	<i>Zygodactyla crassa</i>	Agassiz
198	<i>Abyla pentagona</i>	Eschscholtz
199	<i>Agalma rigidum</i>	Haeckel
207	<i>Halistemma punctatum</i>	Kolliker
209	<i>Hippopodius gleba</i>	Leuckart
211	<i>Physalia pelagica</i>	Eschscholtz
233	<i>Hologadodes lunulatus</i>	Pennant
368	<i>Aeolis militaris</i>	Alder & Hancock
392	<i>Cratena longibursa</i>	Bergh
442	<i>Facellina Drummondii</i>	Thompson
697	<i>Paludina achatina</i>	Sowb
	<i>Actinia chioococca</i>	Cocks

Table 4: Species with uncertain or tentative identifications

No	Original Species	Original Authority	Potential Identification	Potential Authority	Year
3	<i>Alcyonium stellatum</i>	Milne Edwards	<i>Sarcophyton stellatum</i>	Kükenthal	1910
6	<i>Gorgonia verrucosa</i>	Pallas	<i>Eunicella verrucosa</i>	ND	1766
21	<i>Actinia concentrica</i>	Risso	<i>Actinia cari</i>	Delle Chiaje	1822
30	<i>Actinoloba Paumotensis</i>	(Couthouy) Dana	<i>Heteractis crispa</i>	Hemprich & Ehrenberg in Ehrenberg	1834
71	<i>Paractis erythrosoma</i>	Ehrenberg	<i>Entacmaea quadricolor</i>	Ruppell and Leukart	1828
99	<i>Sagartia rosea</i>	Gosse	<i>Sagartia elegans</i>	Dalyell	1848
100	<i>Sagartia rubus</i>	Drayton	<i>Nemactis rubus</i>	Drayton in Dana	1846
112	<i>Tealia gemma</i>	Drayton	<i>Actinia gemma</i>	Drayton in Dana	1846
120	<i>Balanophyllia italica</i>	Michelin	<i>Balanophyllia europaea</i>	Risso	1826
135	<i>Aequorea violacea</i>	Milne-Edwards	<i>Distichopona violacea</i>	Pallas	1766
145	<i>Clytia aeronautica</i>	Forbes	<i>Phialella quadrata</i>	ND	1848
169	<i>Oceania phosphorica</i>	(Péron) Agassiz	<i>Olindias phosphorica</i>	Delle Chiaje	1848
181	<i>Stomobrachium octocostatum</i>	Sars	<i>Melicertum octostatum</i>	ND	1835
182	<i>Stomotoca dinema</i>	(Forbes) Agassiz	<i>Amphinema dinema</i>	Péron & Lesueur	1810
185	<i>Tiara conica</i>	(Quoy & Gaimard) Agassiz	<i>Pandea conica</i>	Quoy & Gaimard	1827
197	<i>Zygodactyla vitrina</i>	Gosse	<i>Aequorea vitrina</i>	ND	1853
210	<i>Physalia Caravella</i>	Eschscholtz	<i>Caravella maxima</i>	Haeckel	
237	<i>Polyclonia frondosa</i>	(Pallas) Agassiz	<i>Cassiopea frondosa</i>	Pallas	1774
251	<i>Comatula Novae Guineae</i>	Müller	<i>Phanogenia novaeguineae</i>	ND	1841
260	<i>Ophiothrix serrata</i>	Kuhl & Hasselt	<i>Ophiomastus serratus</i>	Mortensen	1936
265	<i>Chiridota purpurea</i>	Lesson	<i>Trachodota purpurea</i>	Pawson	1969
279	<i>Sporadipus impatiens</i>	(c) Semper	<i>Holothuria (Thymiosyca) impatiens</i>	Forsskål	1775
312	<i>Proceros clavicornis</i>	Schmarda	<i>Pseudoceros clavicornis</i>	(Schmarda)	1859
313	<i>Proceros cornutus</i>	Müller	<i>Eurylepta cornuta</i>	(Müller)	1776
314	<i>Proceros latissimus</i>	Schmarda	<i>Pseudoceros latissimus type A</i>	(Schmarda)	1859
315	<i>Proceros viridis</i>	Schmarda	<i>Pseudobiceros viridis</i>	Kelaart	1858
330	<i>Pontobdella vittata</i>	Chamisso	<i>Calliobdella lophii</i>	von Benden & Hesse	1863
335	<i>Hesione Schmardae</i>	Quatrefages	<i>Myriocyclum schmardae</i>	Grube	1880
469	<i>Placobranchus gracilis</i>	Pease	<i>Thuridilla gracilis</i>	Risbec	1928
483	<i>Treveliana cristata</i>	Bergh	<i>Nembrotha cristata</i>	ND	1877
484	<i>Treveliana nigerrima</i>	Bergh	<i>Nembrotha cristata</i>	ND	1877
500	<i>Syphonota punctata</i>	Pease	<i>Aplysia punctata</i>	Cuvier	1803
517	<i>Clausilia bidens</i>	Draparnaud	<i>Papillifera papillaris</i>	Müller	1774
539	<i>Philomycus carolinensis</i>	Binney	<i>Philomycus carolinianus</i>	Bosc	1802
561	<i>Loligo Bianconii</i>	Vérany	<i>Onchoteuthis banksii</i>	Leach	1817
562	<i>Loligo Meneghini</i>	Vérany	<i>Teleoteuthis meneghini</i>	ND	1851
618	<i>Phallusia pustulosa</i>	Alder	<i>Asciadiella aspersa</i>	Müller	1776
619	<i>Phallusia callosa</i>	Stimpson	<i>Ascidia callosa</i>	Stimpson	1852
643	<i>Eucecrophalus schultzei</i>	Haeckel	<i>Lampromitra schultzei</i>	ND	1862
655	<i>Actinoloba senile</i>	de Blainville	<i>Metridium senile</i>	Linnaeus	1761

The Blaschka father and son based their work on illustrations and relied on the book plate legends and descriptions for the names and descriptions, as they were not trained taxonomists. We believe that they simply copied the variations cited in the book without further considerations for the biological debate on species variation and plasticity.

One particularly interesting part of our research is related to the naming authorities cited. In taxonomy, a species name is always linked to the name of the person who originally named it and the year when this occurred. Philip Henry Gosse had always been an important influence on both Blaschkas (Meehan and Reiling, 2002) as a well-established marine invertebrate expert, even though he was not a zoologist, but rather a naturalist and popularizer of natural science. We have noted that the Blaschkas wrongly attributed many species (38 out of 59) to Gosse. Another great influence on the workshop also misidentified some species: Ernst Haeckel. We looked in detail at *Actinologia Britannica*, one of the major books known to have been used by the two glassworkers, and found that the identification of the authority is quite difficult to find and may have been the source of the mistaken identities. In some instances, the Blaschkas listed Gosse himself as the naming authority, but Gosse did not list the actual naming authorities in his illustrations. Wherever a species can be clearly identified, we have retrieved the correct authority (Appendix I).

Our work represents an important step toward establishing a complete descriptive database of the Blaschkas' glass invertebrate models, enabling us to identify models and their names in accordance with both the original documents and current taxonomic knowledge. We have already helped the curators of several European Blaschka collections by correcting identification errors that were usually related to the loss of original labels or the mixing of those labels during curation, repair, or display. Appendix I will likely be updated, because more taxonomists will be able to access the relevant taxonomic information to confirm or correct the identification of the models, and to allow for the taxonomic identification of models for which we have no data (Table 3).

We will continue to use the information gathered during our research to link every model to the original documentation and lithograph used, alongside the drawings held at the Rakow Research Library of The Corning Museum of Glass. We believe that, although the Blaschkas' invertebrate models are often described as unique art pieces, they were originally zoological specimens that

need to be curated taxonomically and clearly identified and labelled, even if the species are no longer recognized. We hope that our work will help the Blaschka-related community to curate their collections in a taxonomically correct manner.

Appendix I:

This is available online. Please visit natsca.org/publications/Callaghan_et_al-2020-AppendixI

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