

***Canarium urceus* (Linné, 1758) Studies Part 1: The Recircumscription of *Strombus urceus* Linné, 1758 (Neostromboidae: Strombidae)**

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ABSTRACT *Strombus urceus* Linné, 1758 is a gastropod species that is one of the most variable and well documented through the centuries. However, we found the present identity of *Strombus urceus* misleading. Abbott (1960) designated the type locality, and confirmed type specimen, based on the microfiche of the Uppsala University, Museum of Evolution Zoology Section Collection, which formed the basic reference set for the *Museum S:æ R:æ M:tis Luovicæ Ulricæ* (1764), Linné's primary set of organisms from which he ordered the species in the *Systema Naturae*. This review resolves the taxonomic identity of *Strombus urceus* Linné, 1758 (= *Canarium urceus* (Linné, 1758)) through conforming the type and explicitly defining a range for that phenotype, and this then provides the basis for future work that will deal with the greater *Strombus urceus* Linné, 1758 diverse phenotypic complex and its currently assigned regional forms and varieties by the present authors.

KEY WORDS Strombidae, *Canarium ureus*, phenotypic complex

INTRODUCTION

There are major dilemmas facing the review of any complex group of taxa. The treatment of existing taxonomy, the ordering of precedence and the assessment of validity are challenges faced in any systematic review. This is often because early authors principally based their nomenclature on observable differences in illustrations (Linné 1758; Gmelin 1791; Röding 1798), which lacked the proper descriptive power that could help with the identification of the species. These non-illustrated works often required the hand processing of textural illustrations from earlier pictorial works, and consequently led to a great variation in the interpretation of those illustrations in the finished product between authors (Linné 1758; Gmelin 1791; Röding 1798). This can cause confusion when the species being dealt with has many morphological variations, or is close to another species in form, or the illustration of the specimen that was described is vague or even

unclear. Notwithstanding, these sometimes-enigmatic early descriptions are taxonomically valid under the applicable ICZN rules. The primary consideration as to whether a species has been deemed to be described is dependent on the level of consistency in the hand drawn illustration. An early description can only be resolved if the illustration and descriptions enable one species to be clearly distinguished from the others, and the location of the population is properly reported. The primary concern ought to be whether there is a supporting type specimen, does the overall series of illustrations show the characters that are unique to what is now considered one species, and do the illustrations have variations that are exhibited in more than one currently accepted species that could lead to confusion of the author's original intent. All these obscurities affect the determination of the true identity and complicate the revision of historically described taxa. There is requirement for an individual interpretation to be made by the reviewing

taxonomist.

Strombidae is a tropical marine family that are globally distributed and have had a great many revisions of their taxonomy through time (Hanley 1855; Sowerby 1839; Duclos 1844; Swainson 1823; Tryon 1883, 1885; Abbott 1960). Within the Strombidae, *Canarium* represents a collection of small strombs that have often confounded these reviewers, particularly in relation to the taxonomic irregularities surrounding Linné's "urceus" species. The "urceus" irregularities have been explicated by earlier workers such as Hanley (1855), Dodge (1946, 1956) and Abbott (1960). However, these revisions lacked the full gamut of evidence that technological advances provide to the modern reviewer, such as access to rare literature online, rapid communications between institutions, and the ability to draw on material held in collections world-wide with ease from the comfort of a desk. Therefore, where once the taxonomic complexity to determine the meaning of what is "urceus" led to a capitulation into either a belief of insolvability, or a tactical resolution to enable taxonomic continuity; both of which are without a mindset of absolute correctness (Dodge 1946; Abbott 1960). Therefore, this recircumscription seeks to bring a satisfactory resolution to this taxonomic conundrum.

While *Canarium urceus* (Linné, 1758) has challenged taxonomists through the centuries, and remains an enigma up to today in terms of the understanding of the relationships between the distinctive regional forms that appear to be aggregated in certain regions of the Indo-Pacific, for example the central Philippines. It is this aggregation of what could be definable and distinctive forms, which has led to the reluctance of many taxonomists to recognize the various regional names that have been historically erected (Schumacher 1817; Anton 1939; Duclos 1844; Dodge 1946).

Canarium urceus can be considered a model species as it also meets the five rationales for a species in need of revision (Schlick-Steiner *et al.* 2010, p. 429): **1) Long standing taxonomic**

dispute: the understanding of what Linné intended to be "urceus" has been debated for over 150 years with conclusions ranging from it being invalid to the now broad inclusivity of a large range of phenotypes, often with distinct regional forms (Hanley 1855; Dodge 1946, 1956; Abbott 1960); **2) Ambiguous delimitation in morphology based on primary exploration:** the distinctive regional forms and high degree of variability has led to much confusion of the true nature of the species resulting in both lumping and splitting of the complex based on the personal nuanced explanation of the taxonomist (Link 1807; Schumacher 1817; Wood 1828; Anton 1839; Watson 1885; Dodge 1946); **3) Pronounced life history variability or broad geographic or ecological space occupied by nominal species:** while little is known of the variability in life history across the range of *C. urceus*, it has a wide range from the west coast of Thailand through to the central South Pacific, with many regions acting as unique disconnected refugia glacial maxima, or having stable island-based populations that have largely been free of the global sea-level upheavals through time; **4) Occupies biodiversity hotspots:** the range of *C. urceus* occupies the central Indo-Pacific, which is universally recognised for its concentration of marine diversity and complex evolutionary history (Santini and Winterbottom 2002; Spalding *et al.* 2007; Carpenter *et al.* 2011; Borsa *et al.* 2016; Kulbicki *et al.* 2013; Veron *et al.* 2015; Yang *et al.* 2016; Wainwright *et al.* 2018); and **5) Outstanding importance of organisms to progress in other fields:** resolving the phylogeography and taxonomy will help shape our understanding of the broader evolutionary history that has given rise to the biodiversity of the Indo-Pacific through provision of new evidence for radiation patterns and biogeographic dispersal influences on marine organisms and, in particular, molluscs.

To address historical methodological failing, it is necessary to examine the complete type records, and review the collective assumptions and errors that have been applied to the determinations of what is "urceus". These assumptions and errors may be in terms of

failure to recognise the duplicity of the Linnaean types, often only having observed one and not the other, or reflect a taxonomic imperative to enable the completion of a broader revision (Hanley 1855; Dodge 1956; Abbott 1960), or assigning type material and locality based on an acquiescence to the taxonomic understanding of what “*urceus*” is at that time, rather than what it ought to be (Abbott 1960).

This review takes the first step in resolving the taxonomic conundrum that is *Strombus urceus* Linné, 1758 (= *Canarium urceus* (Linné, 1758)) through identifying the type and explicitly defining a range for that phenotype by first principles. This is achieved by bringing together the physical type material and lectotypes to provide a sound resolution to the taxonomical enigma of what Linné’s (1758, 1764, 1767) intended when describing “*urceus*”, and to review its synonymy in the context of modern systematic understanding. Future work will deal with what constitutes the greater *Strombus urceus* Linné, 1758 diverse phenotypic complex and all its currently assigned regional forms and varieties.

METHODS

This type revision involved two primary steps. The first step comprised the obtaining of images of the type material held in two Linnaean collections linked to *C. urceus*; Uppsala University Museum of Evolution Zoology Section no. 685, MLU, no. 288 and no. 1225 a-e; and the Linnaean Society of London box LSL. 440, Dance label: P-Z 0010875. The second step involved a complete examination of each of the iconotypes listed under “*urceus*” in the *Systema Naturae* editions (Linné 1758, 1764, 1767; Gmelin 1791), as well as the translation and examination of the descriptive text that accompanied these references. The type specimens and iconotypes were then identified and classified, with species level identification based on the current accepted taxonomy (Abbott 1960, WoRMS: www.marinespecies.org). After this identification process, the holotype was identified from the Uppsala University Museum

of Evolution Zoology (Abbott 1960). Once identified, the type was compared to a series of “*urceus*” specimens from across its known range. The type locality was then corrected to the region where the phenotype represented a form consistent with the type morphology.

ABBREVIATIONS

LSC - Linnaean Collection of the Linnaean Society of London

MLU - Museum Ludovice Ulricae

SMC - Stephen Maxwell Collection

UZM - Uppsala University Museum of Evolution Zoology Section

SYSTEMATICS

Phylum	Mollusca Linné, 1758
Superorder	Caenogastropoda Cuvier, 1797
Order	Sorbeoconcha Ponder & Lindberg, 1987
Superfamily	Stromboidea Rafinesque, 1815
Epifamily	Neostromboidae Maxwell, Dekkers, Rymer & Congdon, 2019

Family Strombidae Rafinesque, 1815

Type. The type genus for Strombidae is *Strombus* Linné, 1758 (type: *Strombus pugilis* Linné, 1758).

Diagnosis. Shell with thickened and flaring outer lip on maturation, typically with an anterior notch on the outer lip. Eyes are located on the end of peduncles, which have the cephalic tentacles attached at the distal ends (Abbott 1960; Walls 1980; Bandel 2007; Maxwell *et al.* 2019).

Genus *Canarium* Schumacher, 1817

Type. The type species is *Strombus urceus* Linné, 1758.

Diagnosis. Shell small and robust. Columella well defined. Outer lip not flared, but typically thickened, with no spines or protuberances. Stromboidal notch well developed. Aperture finely lirate in most taxa. Spire ribbed, although this may be reduced or rudimentary. Apex of

spire acute. Shoulder of body whorl typically with knobs. There is a high degree of variability in colour and form within the genus. Rachadian tooth with five cusps, middle largest, laterals with basal peg. Operculum with numerous well-developed serrations.

Canarium urceus (Linné, 1758)

Type. Type: UZM - *Strombus urceus* lot no. 685 (Linné 1767, *Museum S:æ R:æ M:tis Luovicæ Ulricæ*, n. 288), selected by Abbott (1960, p. 66) based on image no. 300 on the Microfiche of that collection. The neotype is slightly juvenile which is reflected in the development and colouration of the aperture (Figure 1). Linné described the species in 1758, but it was not until the Linné redescription in 1764 that reference was made to specimens in his working material.



Figure 1. The Linnaean assigned type for “urceus”: Neotype - Uppsala University Museum of Evolution Zoology Section no. 685 (= *C. urceus*) MLU. no. 288, (63 mm).

Type Locality. The type locality designated as Cebu Island, Philippines by Abbott (1960, p. 66) is rejected and the type locality is re-designated as Singapore. This re-designation of the type to Singapore reflects the shells from the eastern population to which the type specimen most closely resembles, and is in congruence with the distribution given by Gmelin (1791).

Historical Synonymy.

Systema Naturae

1758 *Strombus urceus* Linné, *Systema Naturae*, 10th edition, p. 745, no. 440. The name “urceus” appears in the Linné (1758) *Systema Naturae* as no. 440 with a description that consists of three clauses: *S. testæ labro attenuato retuso brevi striato* [The shell lip diminished, recurved with short striations], *ventre spiraque plicato-nodosis* [the spire and ventral body whorl plicated and nodulated], *apertura bilabiata inerni* [aperture with two lips and no armature (translations SM)]. The first clause describes the general shape: a shell that does not have the expanded outer-lip, is recurved and the outer lip lirated, this characteristic is shared by many in the genera *Canarium*, particularly *C. erythrinum*, *C. labiatum*, *C. mutabile* and *C. urceus*. However, it is only with *C. urceus* that we find the lirations short and diminished. The second clause implies a plicate and nodulated spire and body whorl. There are three members of the *Canarium* that fit into this description *C. erythrinum*, *C. labiatum* and *C. urceus*. The third clause seeks to separate this species from the similar *Tridentarius dentatus*, which shared similar features used to describe “urceus” but has distinct serrations on the outer lip lacking in *C. urceus*. Furthermore, added to this description are three lectotype citations. First, “Rumph. Mus. t. 37, f. T”, or Rumphius (1705) *Thesaurus Imaginum Piscium Testaceorum; Concheorum; Conchyliæ, et Mineralia*, plate 37, figure T, an image of *C. labiatum* (Figure 2). The second reference is to “Pet. Gaz. t. 98, f. 19” refers to Petiver (1712) *Gazophylactium Nature et Artis*, plate 98, figure 19, which I have not been able to locate on the plate as the figure numbers do not extend past figure 18. However, figure 14c is *C. labiatum*, and similar to the Rumphius illustration cited (Figure 2). Furthermore, the other Strombids

illustrated are not members of the clade *Canarium* but rather fall within *Doxander*, *Laeviostrombus*, and *Conomurex*. The third citation that Linné provides is “Gualt. Test. t. 32, f. G”, or Gualtieri (1742) *Index Testarum Conchyliorum*, Plate 32, figure G, which is *Ministrombus minimus* (Linné, 1771).

- 1764 *Strombus urceus* Linné, *Museum S:æ R:æ M:tis Luovicæ Ultricæ*, p. 624, no. 288 (the type designate). The definition provided by Linné (1764) in the *Museum Ludovicæ Ultricæ* provides a more detailed description of the taxa than contained in the *Systema Naturæ* 10th edition (Linné 1758). While citing and repeating the same description as found in the *Systema Naturæ* 10th edition, Linné (1767) and further adds to the description in four sections: *TESTA facie & habitu antecedentium quatour; dorso nodis 3 s. 4, compressis* [Shell ventral face similar in ornamentation to earlier coiling; dorsal knobs three or four and compressed]; *SPIRA testa brevior, plicato-subnodosa* [Shell spire short, with plications that have a small nodule]; *LABIUM exterius dorso elevatum, transverse striatum – internius reflexum and adnatum* [The outerlip is raised from the dorsum, with transverse striations – innerlip reflexed and blubiform]; *FAUX utrinque striata* [Aperture sides striated]. This additional description clearly indicates a shell with three or four dorsal knobs and a ventral body whorl that is similar to the spire, both characteristics of which are indicative of *C. labiatum*. Two illustrative references were provided. These two, Rumphius (1705, 1711) and Gualtieri (1742), are the same offered in the *Systema Naturæ* 10th edition (Linné 1758) (Figure 2). However, the *Museum Ludovicæ Ultricæ* omits the Petiver (1712) *Gazophylactium Nature et Artis* reference found in the *Systema Naturæ* 10th edition (Linné 1758). From the additional description and refined reference list, it can be deduced that Linné had *C. labiatum* as the most probable taxon

intended when writing this description and matched the series of specimens in Uppsala University Museum of Evolution Zoology Section (no. 1225a-e; Figure 3)

- 1767 *Strombus urceus* Linné, *Systema Naturæ* 12th edition, p. 1212, no. 512. The name “*urceus*” appears in the Linné (1767) *Systema Naturæ* as no. 512, with same description provides in the 10th edition (Linné 1758). Linné (1767) also provides an additional reference to the “M.L.U. p. 624, n. 288”, the *Museum Ludovicæ Ultricæ* (Linné 1764). The *Museum Ludovicæ Ultricæ* includes a more expanded descriptive text of “*urceus*” than is contained in this repeated 10th edition text (Linné 1758, 1764). Petiver (1712) *Gazophylactium Nature et Artis* is again reinstated after an absence in the *Museum Ludovicæ Ultricæ* (Linné 1764). As well as the three references provided in 1758, a further five more illustrative examples are cited and all drawn from “Seb. Mus. 3” or Seba (1758) *Locupletissimi Rerum Naturalium Thesauri*, III. Two representatives are drawn from plate 60, figs. 28 and 29. The Seba (1758) figure 28 is an example of *C. klineorum* (Abbott, 1960) while figure 29 is *C. labiatum* (Figure 2). A further three more illustrations are drawn from Seba (1758): plate 62, figures 41, 45 and 47, all of which illustrate examples of *C. labiatum*.
- 1791 *Strombus urceus* Gmelin, *Systema Naturæ*, 13th edn., p. 3518; no. 29. The name “*urceus*” appears in the Gmelin (1791) *Systema Naturæ* as no. 29, with same description provided in the 10th edition (Linné 1758). However, Gmelin (1791) extensively expands the list of references and highlights eight forms, while the main textual references contain a mixture of *C. labiatum*, *C. urceus* and *C. mutabile* (Figure 2). Gmelin (1791) in recognising these eight forms highlights the growing awareness of morphological differences within the growing “*urceus*” aggregation. More importantly, the forms represent two species for the most part *C. mutabilie* and *C. labiatum* indicating a

move to isolate what is now *C. urceus* as the species intended as species no. 29 of Gmelin (1791). There are three groups within the Gmelin (1791) *C. urceus*: first the forms that contain a mixed species composition form α which contains both *C. mutabile* and *C. urceus*; second forms β , δ and η that illustrate *C. mutabile*; and third forms γ , ϵ , ζ and ϑ which show representations of *C. labiatum* (Figure 2).

Post Systema Naturae

- 1758 *Canarium urceus* Linné
 = *Strombus* var. *urceus* Linné – Kiener, 1843, p. 60, pl. 30, fig. 3.
 = *Strombus (Strombidea) urceus* Linné – Chenu 1859, p. 257, fig. 1606.
 = *Strombus urceus* Linné – Reeve 1851, pl. 11, spc. 24c. Reeve 1860, p. 94. Hanley 1860, p. 74. Abbott and Dance 1982, p. 77.
 = *Strombus (Canarium) urceus* Linné – Tryon 1885, p. 118, pl. 6, fig. 65. Bandel 2007, p. 150, fig. 19A.
 = *Canarium urceus* Linné – De Bruyne 2003, pp. 91 and 92.
- 1777 *Alata canarium muricatum* Martini, p. 98, pl. 78, fig. 803; this image has the overall shape, shell colouration shell, and aperture associated with *C. ustulatum* from the continental Asian coast. The accompanying text to this illustration contained a mixture references that include *C. urceus*, *C. mutabile* and *C. labiatum*.
 = *Strombus (Canarium) muricatus* Martini – Horst and Schepman 1908, p. 218. Adam and Leloup 1938, p. 114.
 = *Strombus (Canarium) muricatus* Watson 1885, p. 417. Wagner and Abbott 1978, p. 09-655. Adam and Leloup 1938, p. 114. Abbott 1960, p. 65.
 = *Strombus muricatus* Martini - Beets 1950, p. 244. = *Strombus muricatus* Watson – Walls 1980, p. 189.
- 1778 *Strombus urceus* Born, p. 281. Born (1778) erred in citing “Linn. S. N. 312” (= *Cypraea moneta* Linné, 1758). The references that Born (1778) used, that Linné (1758, 1767) overlooked were in part incorporated into Gmelin (1791). These references are an aggregation of many now established species including: *C. klineorum*, *C. urceus*, *C. labiatum* and *C. mutabile* following the synonymy of Linné (1758, 1767).
- 1798 *Lambis urceus* Gmelin – Röding, p. 63, no. 807. Röding (1798) provided four lectotypes drawn from Martini’s (1777): the first, pl. 78, f. 803 (= *C. urceus*); the second, pl. 78, f. 806 which is the dorsal view of *C. labiatum*; and figures 804-805 were used to define Röding’s (1798) sp. 23 *Lambis labiata* (= *C. labiatum*).
- 1807 *Lambis urceus* Linn. Gm., – Link, p. 108. Link (1807) listed Gmelin (1791) species no. 3518 (= *C. urceus*), and followed Röding’s (1798) taxonomy with the use of the genus *Lambis* and Link (1807) cited Martini pl. 78, fig. 805 (= *C. labiatum*). Link (1807) also described *L. reticulata* Link, 1807 and provided Martini pl. 77 fig. 806 (= *C. labiatum*).
- 1817 *Canarium ustulatum* Schumacher, p. 219. Schumacher (1817) cites two references to support his species: “Martin. 3. pag. 98 Tab.78. fig. 803.805”. Figure 803 is the *C. urceus ustulatum* of modern authors (Abbott 1960), while 805 is considered *C. labiatum* and was one of Röding (1798) types for that species. Schumacher (1817) recognised that description and references to “*urceus*” of Linne (1758) was best suited to the *C. labiatum*, and that therefore, what is now considered *C. urceus* was deemed an invalid name. Through time, *C. urceus ustulatum* has grown to be associated with specimens of “*urceus*” with a black aperture due to the use of the Martini fig. 803 reference (Schumacher 1817). This feature is also shared by a significant cline and the name has often been associated with shells from the eastern Asian continental coast, which is reflective of the Gmelin (1791).
 = *Strombus urceus* form *ustulatus* Linné – Abbott 1960, pl. 20, fig. 29.
- 1844 *Strombus dentatus* Duclos in Chenu, pl. 4 figs. 8 and 9.

Diagnosis. The shell is elongated and fusiform and may appear biconic. The spire and body whorl have a distinctive rounded nodulated shoulder, that may become acute towards the anterior of the shell as the nodulation become finer, more acute and denser. The anterior canal is often well formed and acute in nature, being slightly reflected dorsally. The posterior of the body whorl is stained, and this staining continues to the dorsum, where it remains along the outerlip marginal fold and onto the dorsal whorl proper. The spire is always nodulated, with the knobs varying from acute in some populations to more rounded and less pronounced in others. The aperture is margined in all cases with dark staining. The inner aperture with dark lirations over a rosy white base colour. The columella is midnight black, sometimes with some traces of deep plum that flush the posterior. The lirations of the columella while present, are indistinct.

Distribution. Locality Records: *China* (Abbott 1960); Hong Kong Rocky Harbour, Tai She Wan (Abbott 1960). *Thailand* Bandon Bight (Abbott 1960); Koh Chang (Abbott 1960); Bangbert Bay (Abbott 1960); Hualpa Island (Abbott 1960); Koh Samet (Abbott 1960); Koh Samui (Abbott 1960); Koh Tao (Abbott 1960). *Singapore* (Chim *et al.*, 2009); Tanah Merah Besar (Abbott 1960). *Malaysia* Pankor Laut (Johnson, 1964); Jesselton North Borneo (Saul 1962); and Merambong Shoal, Johor Straits (Cob *et al.* 2009).

Material Examined. Singapore: Tanah Merah (53 mm, Trevor and Marguerite Collection); Changi Beach (49.7 mm, Stephen Maxwell Collection no. U1.001; 53.7 mm, SMC no. U1.002); Pulau Islands (48.2 mm, SMC no. U1.003; 48.5 mm, SMC no. U1.004). Malaysia: Tioman Island (40.3 mm, SMC no. U1.005), Rawa Island (30.9 mm, SMC no. U1.006; 31.6 mm, SMC no. U1.006; 33.2 mm, SMC no. U1.008). East Thailand: South of Pan Phé (43.5 mm, SMC no. U1.009; 42.7 mm, SMC no. U1.010; 41.5 mm, SMC no. U1.011; 40.1 mm, SMC no. U1.012).

DISCUSSION

The “*urceus*” type material is contained in two Linnaean collections, the Linnaean Collection of the Linnaean Society of London (LSC), and the Linnaean collection held in the Uppsala University Museum of Evolution Zoology Section (UZM). In total there are three lots attributed to “*urceus*”: UZM – *Strombus urceus* no. 685, donated by Gustav IV (MLU, Linné 1767: No. 288, neotype) (Figure 1a), which reflects the modern understanding of *C. urceus*; LSC – *S. urceus*, box LSL. 440, Dance label: P-Z 0010875 contains a single shell (= *C. mutabile*) (Figure 3a); and UZM – *S. urceus*; no. 1225, donated by Gustav IV/Karl XIII, is a mixture of both *C. labiatum* (Röding, 1798) (3 a-d) and *C. erythrinum* (Figure 3e).

Hanley (1856, p. 275) argued that Linné intended *C. mutabile* based on the LSC, and note that the suspicious “*urceus*” of contemporary authors was not in the Linnaean Cabinet. In contrast, Abbott (1960) based his understanding of “*urceus*” on the microfiche type numbered specimen no. 300 from the UZM, which he rightly asserted illustrates Linné (1764), *Museum S:æ R:æ M:tis Luovicæ Ulricæ* n. 288, and which reflects a specimen in the broad phylotypic understanding of *Strombus urceus* (s.l). The specimen n. 288 is an example typical of those from Singapore, a major historical trading hub of that period (Figure 4). Interestingly, evidence indicates that Linné actually owned the specimen referred to in the *Systema Naturae*: “Rumph. Mus. t. 37, f. T” (= *C. labiatum*), and is supposed to have written “bene” on that shell’s tag (Schumacher 1817). While this type duplicity may seem problematic at first, this duplicity is removed if we consider the philosophical state of current taxonomic resolution at the time Linné and Gmelin worked. Things were arranged into like kinds, with no evolutionary necessity, and all of nature was viewed as immutable and set (Linné 1758).

The collection of type species all share some distinctive similarities: all have lirations in the aperture, a varying level of spiral plication, and dorsal shoulder nodules, thus forming a natural

aggregable kind. Consequently, the choice of type by Abbott (1960) reflects not only the modern synthesis of *C. urceus* maintaining the current level of taxonomic stability, but also recognises a level of pragmatism when dealing with inclusivity and exclusivity in the context of the natural consequence of taxonomic advancement where natural kinds are reviewed and split further, such as with the erection of *C. labiatum*, *C. mutabile*, and *C. wilsoni* (Abbott, 1960).

The inclusion of *Ministrombus minimus* (Linné, 1771) resolves some of the issues in the *Systema Naturae* 10th edition of *C. urceus* where the iconography did not fit the description provided (Linné 1758), particularly with regard to the aspects of the flaring nature of the outer lip, and the lack of distinctive spire nodulations and plications. It is not unexpected that as the non-binominal literature is surveyed for subsequent editions of the *Systema Naturae*, and given this is occurring during a period of infancy in the taxonomic revisionary process, that the names contained within Linné (1758) would form the framework upon which an aggregation of close taxa would be made. This undifferentiated aggregation is reflected in the species diversity with the type collections (Figure 3). The effect of increasing diversity with this aggregation was not lost on Gmelin (1791) who clearly sought to reorder the synonymy of *C. urceus* with the recognition of eight forms within the complex representing predominately two species, *C. mutabile* and *C. labiatum* with one example each of *C. incisum* and *C. klineorum*.

FURTHER RESEARCH

The next stage of the revision of *C. urceus* will involve a morphometric analysis of specimens from the regions within the complete range, leading to the formulation of a hypothesis on the division of the now aggregated complex against the type series circumscribed herein. This will then enable the identification of new taxa based on morphologically distinctive regional populations and forms. The robustness of these new taxa can then be tested in the third stage of the revision using molecular methodologies.

CONCLUSION

This review deems *C. urceus* to be valid. This conclusion is based on the type material, associated literature and illustrated iconotypes. What is currently accepted as “*urceus*”, is much broader than the designated type material and the type locality designated by Abbott (1960) which is not concordant with Gmelin’s (1791) mentioned locality (Indian Ocean and Indonesia), although this is all caveated in that Linné did not distinguish between members of the *Canarium* by colour or pattern, and used “*urceus*” in terms of a chest of all small species, where at least five recognized species were incorporated under “*urceus*” by the final edition of the *Systema Naturae* (Gmelin 1791).

There is an author intent that is reflected in the increasing synonymy as the *Systema Naturae* goes through revisions from Linné (1758, 1767) to Gmelin (1791). This intent is demonstrated with clear trends in morphology evidenced in the description: first, a spire that was plicated and sub-nodulose, second, an aperture in which both sides were lirate and third, a relatively small shell, with most specimens being less than five centimetres. These early descriptions of the species best match *C. urceus*, and this species is featured in most Linnaean reference illustrations. Furthermore, there is a clear differentiation in the UZM type collection between the lot containing the single *C. urceus* (no. 685), and the mixed lot (no. 1225) of *C. labiatum* and *C. erythrinum*. This paper provides the first stage to now ground “*urceus*” in a stable phenotypic form and location which provides consistency with possible reported specimens, and in doing so paves the way for a more thorough revision of this wide ranging and variable species.

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Figure 2. The “*urceus*” Iconotypes used within the editions of the *Systema Naturae* (1758, 1767; 1791). Linné (1758, no. 440) – Rumphius (1705, 1711, 1741): (1) pl. 37, fig. T (= *C. labiatum*). Petiver (1713): (2) pl. 98, fig. 19? (14c illustrated) (= *C. labiatum*). Gualtieri (1742): (3) pl. 32, fig. G (= *Ministrombus minimus*). Linné (1767) – Seba (1758): (4) pl. 60, fig. 28 (= *C. klineorum* Abbott); (5) pl. 60, fig. 29 (= *C. labiatum*); (6) pl. 62, fig. 41 (= *C. labiatum*); (7) pl. 62, fig. 45 (= *C. labiatum*); (8) pl. 62, fig. 47 (= *C. labiatum*). Gmelin (1791) – Lister (1688): (9) pl. 857, fig. 13 (= *C. erythrinum*). Knorr (1768): (10) p. 13, fig. 5 (= *C. labiatum*?). Gualtieri (1742): (11) pl. 32, fig. E (= *C. urceus*). Valentijn (1726): (12) pl. 7, fig. 65 (= *C. urceus*). Bonanno (1684): (13) no. 144 (= *C. urceus*). Seba (1758): (14) pl. 61, fig. 24 (= *C. labiatum*); (15) pl. 61, fig. 25 (= ?); (16) pl. 61, fig. 26 (= *C. mutabile*); (17) pl. 61, fig. 27 (= *C. mutabile*); (18) pl. 61, fig. 30 (= *C. urceus*); (19) pl. 61, fig. 31 (= *C. urceus*); (20) pl. 61, fig. 57 (= *C. erythrinum*); (21) pl. 61, fig. 58 (= *C. erythrinum*); (22) pl. 61, fig. 59 (= *C. urceus*); (23) pl. 61, fig. 62 (= *C. urceus*); (24) pl. 61, fig. 63 (= *C. urceus*); (25) pl. 61, fig. 64 (= *C. urceus*); (26) pl. 61, fig. 66 (= *C. urceus*); (27) pl. 61, fig. 67 (= *C. klineorum*); (28) pl. 61, fig. 68 (= *C. labiatum*); (29) pl. 62, fig. 46 (= *C. labiatum*). Gottwald (1714): (30) pl. 28, fig. 193 (= *C. labiatum*); (31) pl. 28, fig. 194 a (= *C. labiatum*); (32) pl. 28, fig. 196 a (= *C. urceus*); (33) pl. 28, fig. 196 b (= *C. urceus*); (34) pl. 28, fig. 196 c (= *C. urceus*); (35) pl. 28, fig. 196 d (= *C. urceus*); (36) pl. 28, fig. 197 (= *C. urceus*); (37) pl. 28, fig. 198 a (= *C. urceus*); (38) pl. 28, fig. 198 b (= *C. urceus*); (39) pl. 28, fig. 198 c (= *C. erythrinum*?); (40) pl. 28, fig. 198 d (= *C. labiatum*); (41) pl. 28, f. 198 e (= *C. labiatum*). Martini (1777): (42) pl. 78, fig. 803 (= *C. urceus*); (43) pl. 78, fig. 804 (= *C. urceus*); (44) pl. 78, fig. 805 (= *C. urceus*); (45) pl. 78, fig. 806 (= *C. labiatum*). Gmelin (1791) forms – α – Gottwald (1714): (46) pl. 28, fig. 194b (= *C. mutabile*). Martini (1777): (47) pl. 80, fig. 870 (= *C. urceus* juvenile). β – Rumphius (1705, 1711, 1741): (48) pl. 37, fig. W (= *C. mutabile*). γ – Seba (1758): (49) pl. 61, fig. 28 (= *C. labiatum*); (50) pl. 61, fig. 29 (= *C. labiatum*); (51) pl. 61, fig. 36 (= *C. labiatum*); (52) pl. 61, fig. 37 (= *C. labiatum*). δ – Seba (1758): (53) pl. 61, fig. 32 (= *C. mutabile*); (54) pl. 61, fig. 33 (= *C. mutabile*). ϵ – Seba (1758): (55) pl. 61, fig. 35 (= *C. labiatum*). ζ – Seba (1758): (56) pl. 61, fig. 38 (= *C. labiatum*); (57) pl. 61, fig. 39 (= *C. labiatum*). η – Seba (1758): (58) pl. 61, fig. 50 (= *C. mutabile*). θ – Seba (1758): (59) pl. 61, fig. 60 (= *C. klineorum*); (60) pl. 61, fig. 61 (= *C. labiatum*).

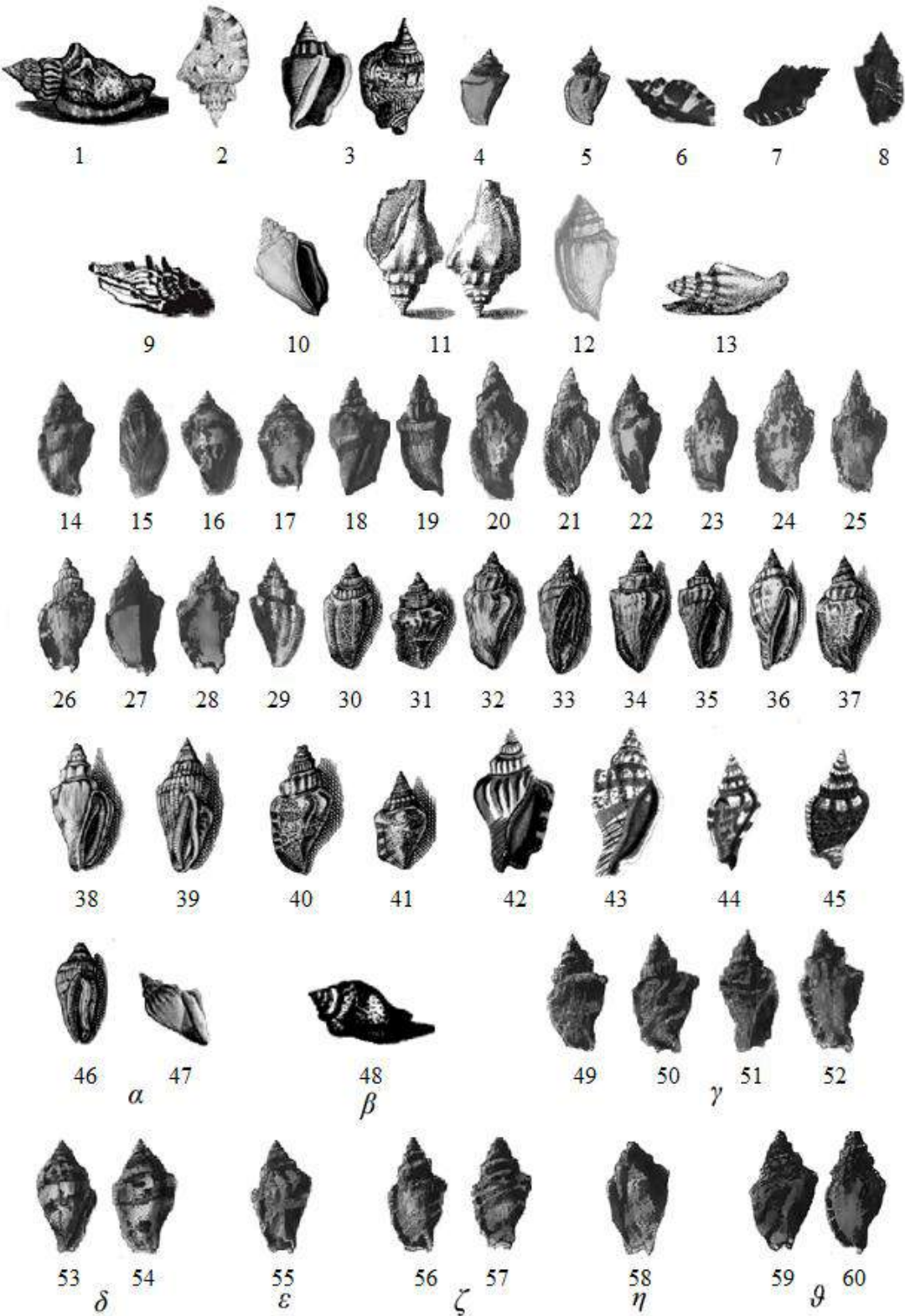


Figure 2. (figure legend on p. 124)

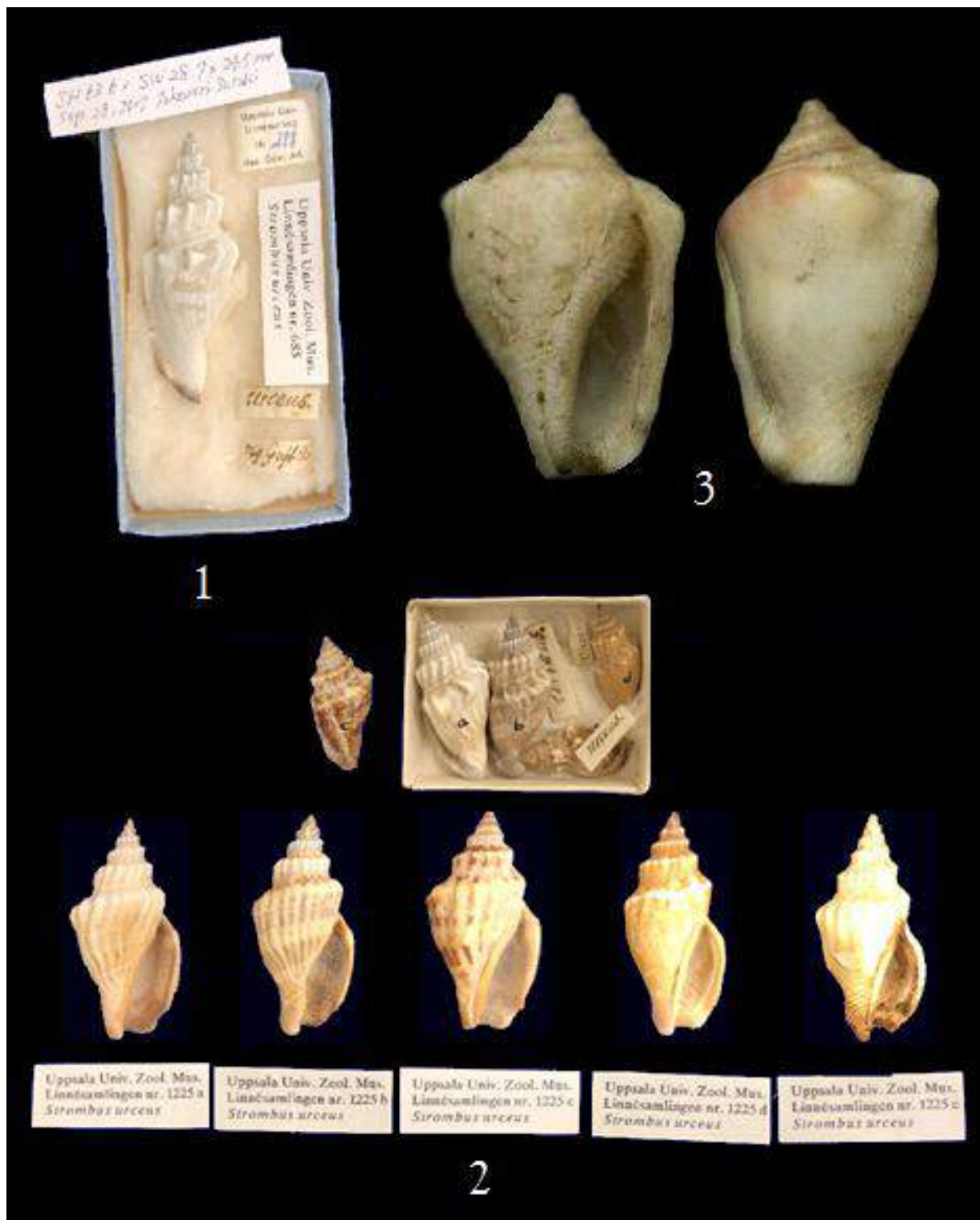


Figure 3. The Linnaean collections linked to “urceus” (1) Uppsala University Museum of Evolution Zoology Section no. 685, MLU. no. 288 (Holotype - *C. urceus*); (2) Uppsala University Museum of Evolution Zoology Section no. 1225a-e (= *C. labiatum* (a-d); = *C. erythrinum* (e)); (3) Linnaean Society of London box LSL.440, Dance label: P-Z 0010875 (= *C. mutabile*).

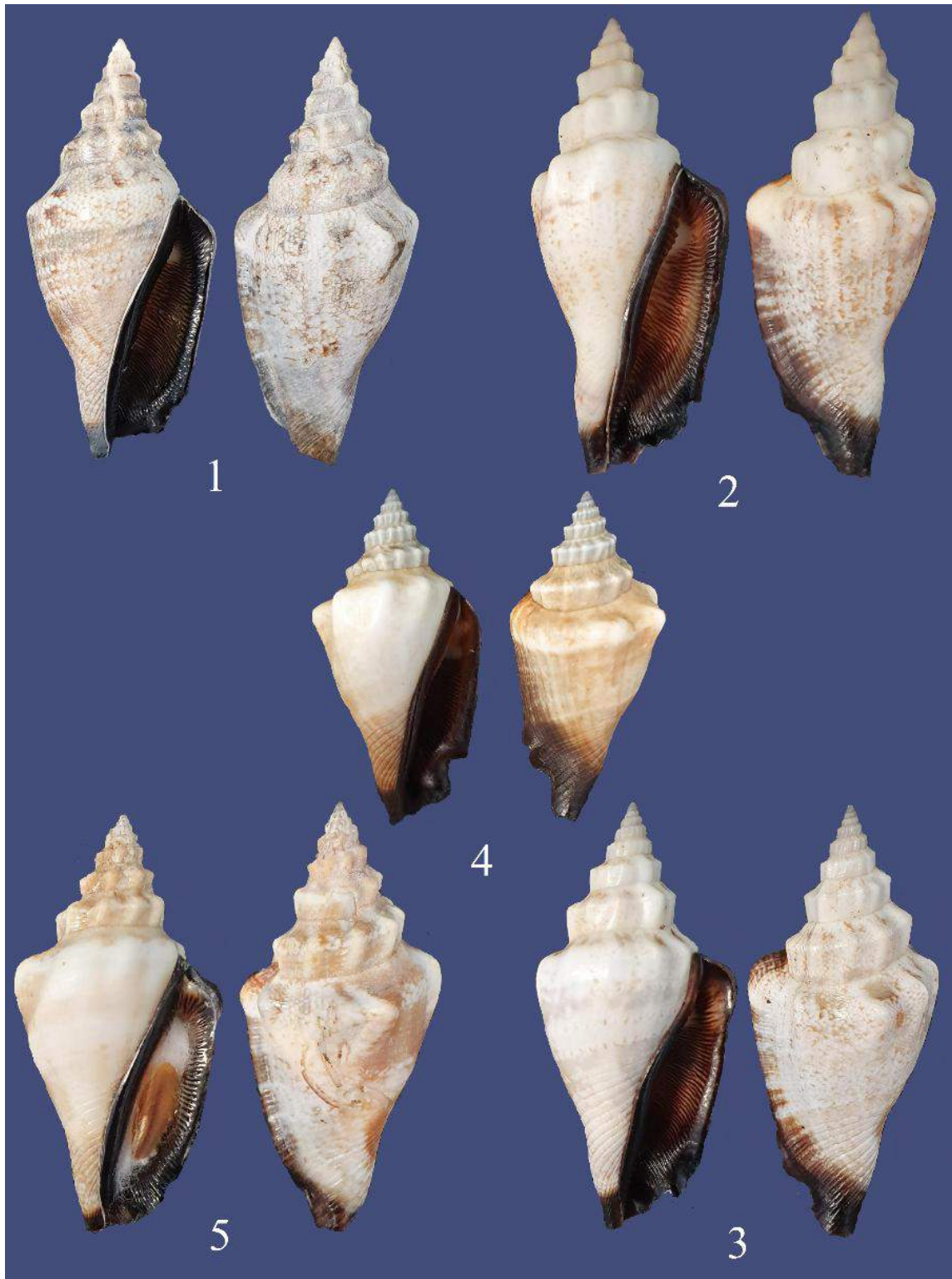


Figure 4. Examples of *C. urceus*: (1) Changi Beach, Singapore, 53.7 mm, Stephen Maxwell Collection no. U1.002; (2) Pulau Islands, Singapore, 48.5 mm Stephen Maxwell Collection no. U1.004; (3) Pulau Islands, Singapore, 48.2 mm, Stephen Maxwell Collection no. U1.003; (4) Rawa Island, Malaysia, 31.6 mm Stephen Maxwell Collection no. U1.006; (5) South of Pan Phé, East Thailand, 41.5mm Stephen Maxwell Collection no. U1.011.