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Strombidae (Mollusca: Gastropoda) of a Quaternary emerged coral terrace at Gebel Tanka, eastern side of the Gulf of Suez

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THIS WORK reports the occurrence of six species of the gastropod family Strombidae belonging to 5 genera collected from a Quaternary emerged coral terrace at Gebel Tanka, eastern side of the Gulf of Suez. Four species are reported for the first time from the Pleistocene coral terraces of the Gulf of Suez; i.e., *Canarium erythrinum* (Dillwyn, 1817), *Canarium fusiforme* (G. B. Sowerby II, 1842), *Dolomena?* sp. and *Lambis truncata sebae* (Kiener, 1843). One species– *Gibberulus albus* (Mörch, 1850)– was reported in the Mediterranean. The six species were systematically discussed, and their geographical distribution and habit and habitat outlined. The studied outcrop is assigned by several authors to Marine Isotope Stage 5e (~ 125 ky ago).

Keywords: Gebel Tanka, Pleistocene terrace, Quaternary emerged coral terrace, Strombidae, Gulf of Suez.

Introduction

This paper reports the fossil fauna of the gastropod family Strombidae Rafinesque, 1815 collected from a Quaternary emerged coral terrace at Gebel Tanka, north of Abu Zenima, eastern side of the Gulf of Suez (text-fig. 1). It contributes to the macrofossil record of the Pleistocene coral terraces in the Red Sea.

The Quaternary, a geologic time period spanning the last 2.6 million years, is divided into two epochs: the Pleistocene (2.58 million years ago to 11.7 thousand years ago) and the Holocene (11.7 thousand years ago to today) (Cohen et al., 2013). During the Quaternary, fringing coral reef systems extended along the coasts of tropical and subtropical seas, including the Red Sea. Former interglacial reef systems in the Gulf of Suez are today exposed above sea level due to tectonic uplift and sea level fluctuations during the Pleistocene (Bosworth et al., 2019).

Many studies have reported strombid species from the Quaternary reef terraces on the coastal plains of the Red Sea, the Gulf of Suez and the Gulf of Aqaba (Issel, 1869; Newton, 1900; Abrard, 1942; Abou Khadrah & Darwish, 1986; Khalil, 2012; Abu-Zied & Bantan, 2018; El-Sorogy et al., 2020). However, Pleistocene coral terraces along the eastern Gulf of Suez are poorly documented, resulting in a limited knowledge of their paleontological content.

Two studies, by Abed (1982) and Gameil (1999), discussed the emerged coral terrace dealt with in the present work. Abed reported 37 species, including 12 bivalves, 17 gastropods, 4 echinoids, and 4 corals. Abed mentioned that his specimens were collected from two terraces: the first being 50 m from the shore at 11 m above sea level, while the second lies exposed 1 km east of the first terrace and 28 m above sea level. From the lower terrace, Gameil (1999) reported 25 molluscan species– 11 bivalves and 14 gastropods. Only two species of the family Strombidae were reported by Abed (1982): *Conomurex fasciatus* (Born, 1778) and *Gibberulus albus* (Mörch, 1850), while Gameil (1999) reported only one species of Strombidae: *Conomurex fasciatus* (Born, 1778). Abou Khadrah & Darwish (1986) studied the sedimentology of the raised beach sediments in the area between Hammam Faraun and Abu Zenima and cited few macrofossils but no strombids.

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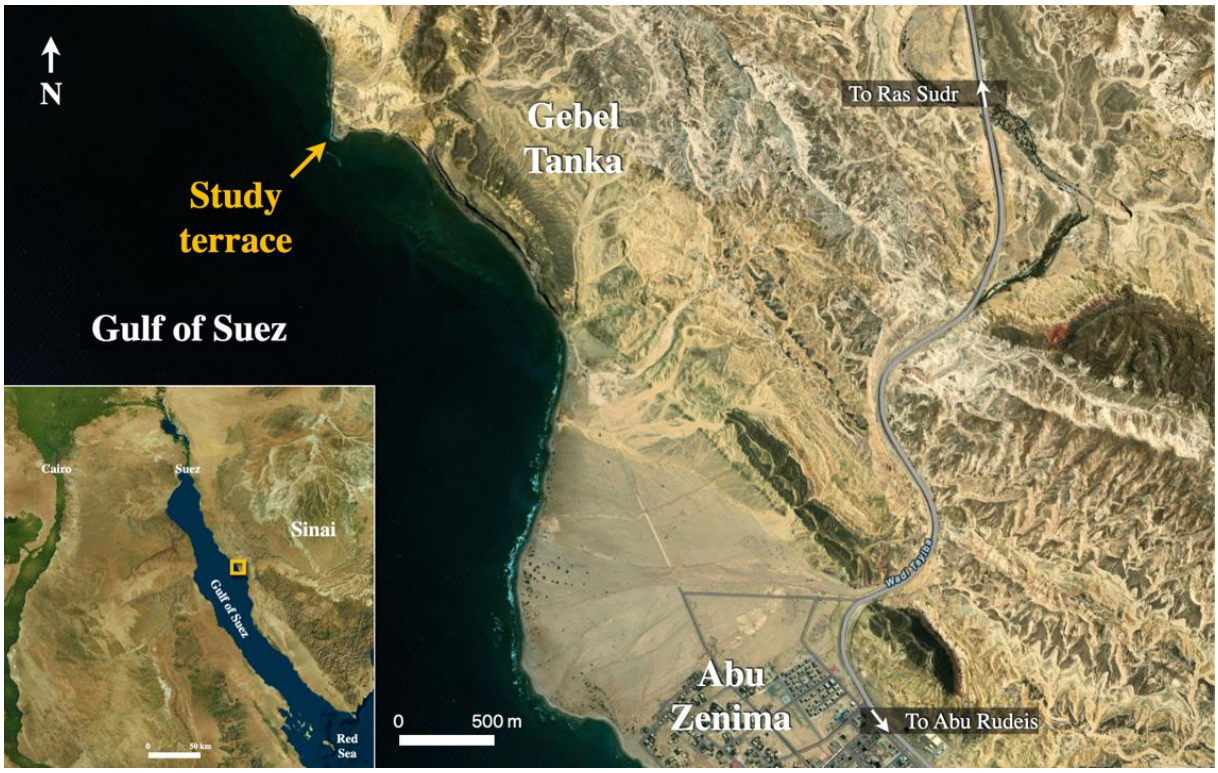


Text-fig. 1. Satellite images showing the location of the study terrace. (from Apple maps).

Two field trips to Gebel Tanka in 2020 and 2021 resulted in collecting over 1000 specimens representing no less than 160 species of macroinvertebrates (corals, serpulids, crustaceans, bivalves, gastropods, echinoids). The collection, however, is largely dominated by molluscs, indicating a richer assemblage than previously reported by Abed (1982) and Gameil (1999).

Quaternary Strombidae of the Red Sea

Issel (1869) discussed the post-Pliocene fossil fauna from the emerged terraces of the Red Sea coast, in which he reported 5 strombs: *Strombus columba* Lamarck, 1822, *Strombus mauritianus* Lamarck, 1822, *Strombus fasciatus* Born, 1778, *Strombus ruppelli* Reeve, 1850, and *Strombus fusiformis* G. B. Sowerby II, 1842.

Newton (1900) reported some Pleistocene fossils from the raised beach deposits of the Red Sea and the western shores of the Gulf of Suez and the Gulf of Aqaba. He reported 7 strombs including *Strombus fasciatus* Born, 1778, *Strombus floridus* Lamarck, 1822, *Strombus fusiformis* G. B. Sowerby II, 1842, *Strombus tricornis* (Lightfoot, 1786), *Canarium dentatum* var. *erythrynum* (Chemnitz, 1795), *Canarium gibberulum* (Linnaeus, 1758), and *Pterocera millepeda* (Linnaeus, 1758).

Nardini (1934) studied the fossil fauna from raised beaches in the Sudanese and Eritrean coasts. He identified 5 strombs, namely *Strombus tricornis* Lamarck 1822, *Strombus muricatus* Martini, 1777, *Strombus fasciatus* Born, 1778, *Strombus (Canarium) gibberulus* (Linnaeus, 1758), and *Strombus terebellatus* G. B. Sowerby II, 1842.

Abrard (1942) studied the Pleistocene fossil fauna of Djibouti and reported 6 strombids: *Pterocera* cf. *millepeda* (Linnaeus, 1758), *Strombus (Monodactylus) tricornis* (Lamarck, 1822), *Strombus (Gallinula) deformis* (Gray, 1833), *Strombus (Canarium) elegans* (Sowerby, 1842), *Strombus (Canarium) floridus* (Lamarck, 1822), and *Strombus (Canarium) gibberulus* (Linnaeus, 1758). We excluded *Rostellaria curvirostris* Lamarck, 1822 reported by Abrard as a species of the family Strombidae since it belongs to the family Rostellariidae Gabb, 1868.

Khalil (2012) studied the stratigraphy and macrofauna of the Pliocene-Pleistocene of Farasan Islands, Saudi Arabia. He reported 3 species of Strombidae: *Strombus (Canarium) plicatus* (Lamarck, 1816), *Strombus (Canarium) gibberulus* (Linnaeus, 1758), and *Strombus fasciatus* Born, 1778.

Abu-Zied & Bantan (2018) reported the gastropod fauna of a late Pleistocene raised terrace south of Sharm Obhur, Jeddah, Saudi Arabia. The reported strombids include 8 species: *Canarium erythrinum* (Dillwyn, 1817), *Canarium mutabile* (Swainson, 1821), *Conomurex fasciatus* (Born, 1778), *Conomurex persicus* (Swainson, 1821), *Gibberulus gibberulus albus* (Mörch, 1850), *Lambis lambis* (Linnaeus, 1758), *Terestrombus terebellatus* (Sowerby II, 1842), and *Tricornis tricornis* (Lightfoot, 1786).

El-Sorogy et al. (2020) studied the Pleistocene micro and macrofauna of the northwest Saudi Arabia and reported 6 strombid species: *Canarium gibbosus* (Röding, 1798), *Gibberulus sp.*, *Strombus fasciatus* Born, 1778, *Strombus gibberulus* Linnaeus, 1758, *Strombus erythrinus* Dillwyn, 1817, and *Strombus tricornis* Lightfoot, 1786.

Strombidae of the present study

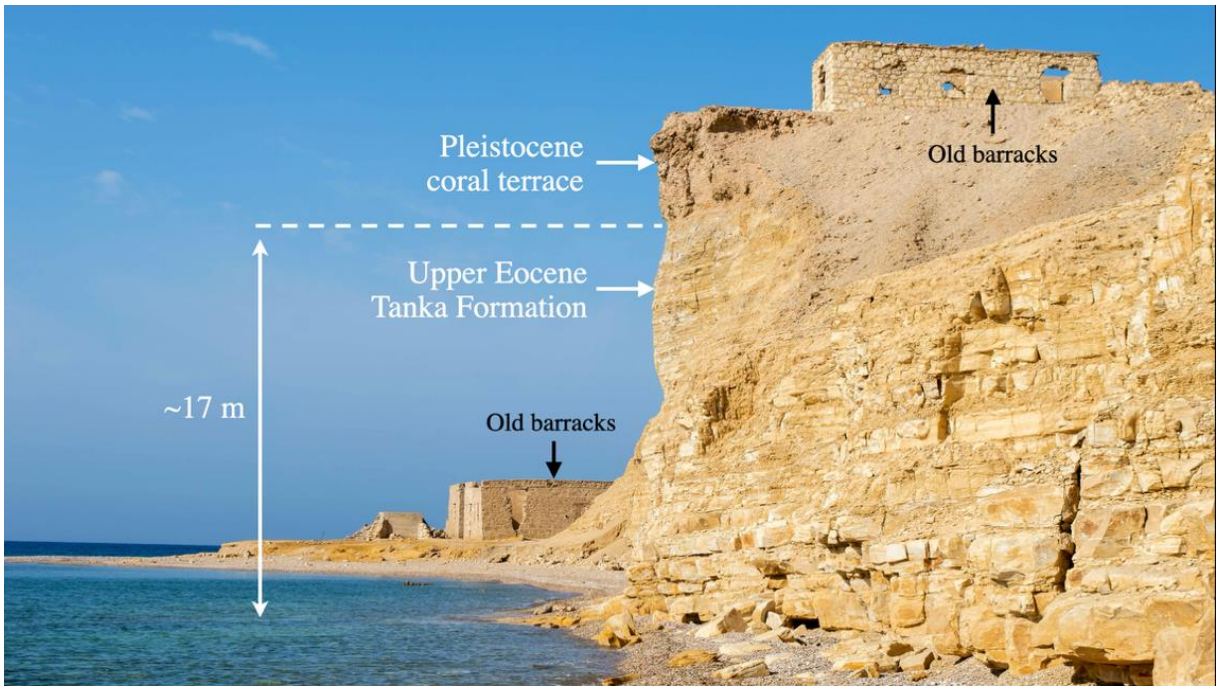
We here report 6 species belonging to 5 genera of the family Strombidae, all of which are reported still living in the Red Sea: *Canarium erythrinum* (Dillwyn, 1817), *Canarium fusiforme* (G. B. Sowerby II, 1842), *Conomurex fasciatus* (Born, 1778), *Dolomena?* sp., *Gibberulus albus* (Mörch, 1850), and *Lambis truncata sebae* (Kiener, 1843).

This collection is compared to a notable study (van Gemert, 2005) covering 11 species of Strombidae presently living in the Red Sea. It is also compared to the fossil fauna reported from other locations in the Red Sea (Table 1).

Study terrace

Our collection was handpicked from an emerged coral terrace northwest of Abu Zenima, on the eastern side of the Gulf of Suez, Sinai (29°05'601"N, 33°03'963"E). The terrace lies at the foot of Gebel Tanka area by the beachline, where old barracks are observed (text-fig. 2). We accessed the outcrop from the beach. The terrace lies unconformably over an uneven surface of the Upper Eocene Tanka Formation. The coralline terrace varies in thickness from 1.5 m to slightly over 2 m, with its base at 14–18 m above current sea level. Bosworth et al. (2019) assigned our outcrop to Marine Isotope Stage (MIS) 5e (~ 125 ky from the latest interglacial cycle). They also declared that the Quaternary terrace of Gebel Tanka "is the highest recorded elevation for a MIS 5e terrace in the Gulf of Suez."

Abed (1982) assigned the terrace to the Pleistocene. Gameil (1999) proposed an age of about 125 ky for the same terrace based on correlation with similar coral reef terraces in southern Sinai and Gebel Zeit.



Text-fig. 2. The emerged coral terrace at Gebel Tanka area.

Table 1. Pleistocene and recent species of the family Strombidae reported from the Red Sea.

Pleistocene Strombidae in the Gulf of Suez (This study)	Pleistocene Strombidae in the Red Sea (From literature)	Recent Strombidae in the Red Sea (After van Gemert, 2005)
Canarium erythrinum (Dillwyn, 1817)	*Canarium erythrinum* (Dillwyn, 1817)	*Canarium erythrinum erythrinum* (Dillwyn, 1817)
Canarium fusiforme (Sowerby II, 1842)	*Canarium fusiforme* (Sowerby II, 1842)	*Canarium fusiformis* (Sowerby, 1842)
-	*Canarium labiatum* (Röding, 1798) (Khalil, 2012)*	-
-	*Canarium mutabile* (Swainson, 1821)	*Canarium mutabile mutabile* (Swainson, 1821)
-	*Conomurex decorus* (Röding, 1798) (Issel, 1869)*	-
Conomurex fasciatus (Born, 1778)	*Conomurex fasciatus* (Born, 1778)	*Conomurex fasciatus* (Born, 1778)
-	*Dolomena columba* (Lamarck, 1822) (Issel, 1869)*	-
Dolomena? sp.	*Dolomena plicata* (Röding, 1798)	*Dolomena plicata plicata* (Röding, 1798)
-	-	*Euprotomus aurora* Kronenberg, 2002
-	*Gibberulus gibberulus* (Linnaeus, 1758) (Khalil, 2012)*	-
-	*Gibberulus gibbosus* (Röding, 1798) (El-Sorogy et al., 2020)*	-
Gibberulus albus (Mörch, 1850)	*Gibberulus albus* (Mörch, 1850)	*Gibberulus gibberulus albus* (Mörch, 1850)
-	*Terestrombus terebellatus* (Sowerby II, 1842)	*Terestrombus terebellatus terebellatus* (Sowerby, 1842)
-	*Tricornis tricornis* (Lightfoot, 1786)	*Tricornis tricornis* (Lightfoot, 1786)
-	-	*Tridentarius dentatus* (Linnaeus, 1758)
-	*Lambis lambis* (Linnaeus, 1758) (Abu-Zied & Bantan, 2018)*	-
-	*Lambis millepeda* (Linnaeus, 1758) (Newton, 1900)*	-
Lambis truncata sebae (Kiener, 1843)	-	*Lambis (Lambis) truncata sebae* (Kiener, 1843)

** Single records of fossil strombs, with their sources stated.*

Materials and methods

103 specimens of strombid shells were handpicked from the study area. They were mostly of very good preservation, with some showing original colors. The specimens were not found in their life position. The collected specimens were washed and cleaned in the laboratory using tap water then dried. They were later classified and numbered. All figured specimens are deposited at Ain Shams University Geological Museum.

The studied specimens were mostly identified using Sharabati (1984), Rusmore-Villaume (2008), Janssen et al. (2011), and Abu-Zied & Bantan (2018). Taxonomic classification followed the World Register of Marine Species (WoRMS), which primarily relies on the classification of Bouchet & Rocroi (2005) that incorporates DNA and RNA molecular characteristics of the taxa. Non-strombid gastropods and other groups collected during the course of this work were kept for future studies. The best representative specimens of the identified strombid species were photographed using a Nikon digital camera.

Systematic Paleontology

Class Gastropoda Cuvier, 1795

Family Strombidae Rafinesque, 1815

General overview of the family

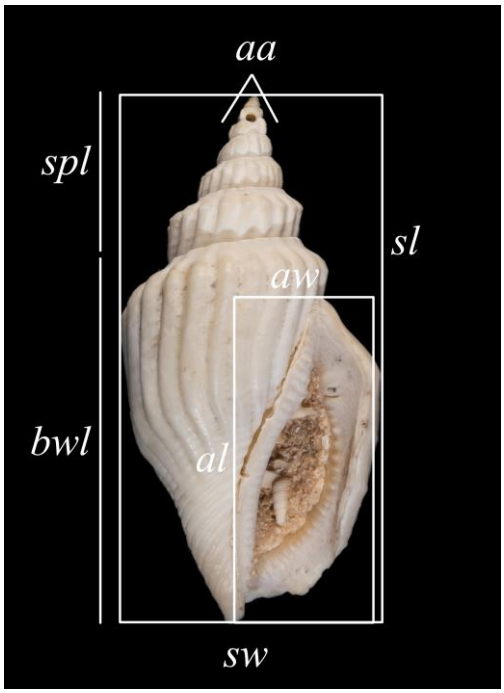
Adult shells with thick, flared, outer lip with a U-shaped stromboid notch near anterior end, where the animal's right eye peeps out. Most species show sexual dimorphism, with males usually being smaller (Kreipl & Poppe, 1999: 7).
The first forms of the genera *Prestrombus* Douville, 1929 and *Pugnellus* Conrad, 1860 appeared during the Upper Cretaceous (about 95–65 million years ago); they are generally accepted as the origin of the genus *Strombus* Linnaeus, 1758 despite the lack of phylogenetic relationships. True *Strombus* started appearing about 48 million years ago during the Eocene (Kreipl & Poppe, 1999: 5).

Geographic distribution. Strombids are tropical to subtropical and occur in the Indo-Pacific and the western Atlantic. Most strombids inhabit the Indo-Pacific areas, with 8 species known to be restricted to the western Atlantic and a single species known from the African Atlantic coast (Beesley et al., 1998: 766; Kreipl & Poppe, 1999: 6).

Ecology. Members of Strombidae are highly specialized herbivores or detritus-feeders (Robertson, 1961: 7). Most strombids live in warm shallow waters from the tideline to 10 m depth, with a few extending to several hundred meters. They inhabit well illuminated sandy or muddy bottoms, or dead coral rubble (Bandel, 2007: 98; Kreipl & Poppe, 1999: 6). They have a strong foot used for movement, with most genera having a long, sharp operculum used as a defensive weapon against predators (Kreipl & Poppe, 1999: 7).

Measurements

All specimens were measured using a digital vernier, with the apical angle measured under the microscope. Measurements abbreviations are as follows (text-fig. 3): apical angle (aa); aperture length (al); aperture width (aw); body whorl length (bwl); shell length (sl); shell thickness (st); shell width (sw); spire length (spl).



Text-fig. 3. General measurements guidelines and abbreviations.

Institutional abbreviations

ASUGM: Ain Shams University Geological Museum.

Canarium erythrinum (Dillwyn, 1817)

Plate 1, fig. 1–5; text-fig. 4

1817 *Strombus erythrinus* Dillwyn, p. 673
1842 *Strombus elegans* Sowerby, *Strombus*, p. 30, no. 25, pl. 7, fig. 43, 48
1851 *Strombus Ruppellii* Reeve, *Strombus*, pl. 8, species 13, fig. 13a, b
1885 *Strombus dentatus* var. *erythrinus:* Tryon, p. 119, pl. 6, fig. 69 (non fig. 71)
1869 *Strombus Ruppelli:* Issel, p. 131, no. 272; p. 270, no. 117
1869 *Strombus elegans:* Issel, p. 132, no. 277
1876 *Strombus erythrinus:* Issel & Tapparone Ganefri, p. 351, 365
1900 *Canarium dentatum* var. *erythrynum:* Newton, p. 508
1942 *Strombus (Canarium) elegans:* Abrard, p. 63, pl. 6, fig. 37
1960 *Strombus erythrinus elegans:* Abbott, p. 79, pl. 20, fig. 1, 2
1960 *Strombus erythrinus erythrinus:* Abbott, p. 79, pl. 20, fig. 3–5
1984 *Strombus erythrinus:* Beltagi & Ghamrawy, p. 429, fig. 5: 31
1984 *Strombus erythrinus:* Sharabati, pl. 8, fig. 6, 6a, 6b
1999 *Strombus (Canarium) erythrinus:* Kreipl & Poppe, p. 34, pl. 60, fig. 1–8; pl. 61, fig. 1–6
2000 *Canarium erythrinum:* Dekker & Orlin, p. 21
2002 *Canarium erythrinum erythrinum:* Raven, p. 7, pl. 1, fig. 1a–c
2005 *Canarium erythrinum erythrinum:* van Gemert, p. 120, fig. 3 (cum. syn.)
2008 *Canarium erythrinum:* Rusmore-Villaume, p. 50, fig.
2011 *Canarium erythrinum:* Janssen et al., p. 424, pl. 20, fig. 2, 3

2014 *Canarium erythrinum:* Picardal & Dolorosa, p. 87, fig. 13: 84a, b
2018 *Canarium erythrinum:* Abu-Zied & Bantan, p. 78, fig. 8s, t
2020 *Strombus erythrinus:* El-Sorogy et al., p. 1004
2021 *Canarium erythrinum:* Abu ElEinin et al., p. 105, fig. 2: Strombidae (a)

Material. ASUGM 23275: 26 specimens in good to perfect condition.

Dimensions. (in mm)

n=26	*Mean*	*Range*
Shell Length (sl)	27.8	18.1−34.2
Spire Length (spl)	8.7	5.8−11
Body Whorl Length (bwl)	19	12.4−23.5
Shell Width (sw)	14.4	9.9−16.9
Shell Thickness (st)	11.7	8−14.2
Aperture Length (al)	16.9	11.4−19.4
Aperture Width (aw)	5.9	3.6−7.9
Number of Whorls	7.3	6−8
Number of Axial Ribs on Body Whorl	12.3	9−15
Apical Angle (aa)	48.4°	43°−55.6°

Remarks. Chemnitz (1795) was the first to name this species *Strombus erythrinus* (p. 146, pl. 195 A, fig. 1874, 1875). ICZN's opinion 184 (ICZN, 1944: 34) regarded all specific and subspecific trivial names published in volumes 1 to 11 of *Neues Systematisches Conchylien-Cabinet* (1769–1795) unavailable nomenclaturally, even if they are binomial in form. Dillwyn's *erythrinus* is based upon Chemnitz's specimen which was collected from the Red Sea− its type locality.

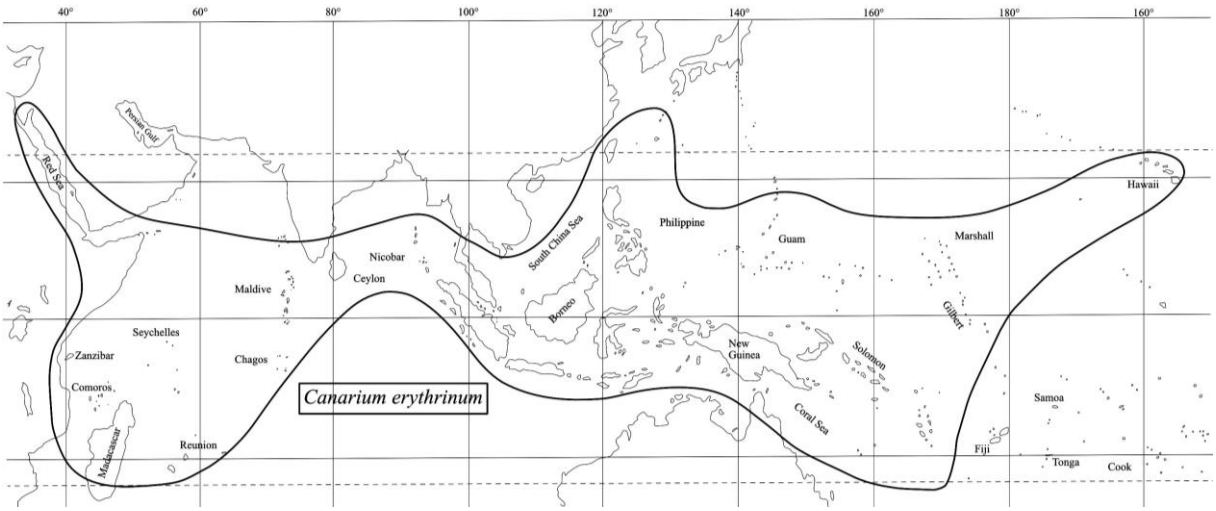
The specimen illustrated in Chemnitz (1795) is unclear. According to Chemnitz, this specimen's ventral side is completely smooth and lacks any wrinkles, which differs from the specimens in our collection and from figures by different authors, e.g., Abbott (1960: pl. 20, fig. 1–5), Rusmore-Villaume (2008: 50, fig.) and Janssen et al. (2011: pl. 20, fig. 2, 3). Our adult specimens have wrinkled ventral sides, which vary from strong wrinkles (Pl. 1, fig. 1c) to weak wrinkles or tubercles (Pl. 1, fig. 3–5).

Tryon (1885: 119) correctly considered *Strombus elegans* Sowerby, 1842 to be a synonym to *C. erythrinum*. However, the figure the author provided (pl. 7, fig. 71) shows a more slender and weakly shouldered shell that resembles neither *elegans* of Sowerby nor *erythrinum*.

Geographic distribution. *Recent:* According to Abbott (1960: 79), this species is usually uncommon but widespread from the Red Sea and East Africa to south Japan and to Hawaii and Ellice Islands (text-fig. 4). According to Rusmore-Villaume (2008: 50), in the Egyptian Red Sea, *C. erythrinum* is common in the Gulf of Aqaba and from Hurghada to Shalatein, and occasional in the Gulf of Suez.

Fossil: Multiple authors reported fossil specimens of this species: Issel (1869: 270, no. 117) from the emerged terraces of the Red Sea; Newton (1900: 508) from a raised beach 20 feet (6 m) above sea at Gharib lighthouse; Abrard (1942: 63) from the Pleistocene of Djibouti, and Abu-Zied & Bantan (2018: 78) from a raised reefal limestone terrace around 5 m above sea level south of Sharm Obhur (Jeddah) of the late Pleistocene.

Habit and habitat. This species occurs in sand between coral patches and in sand and muddy sand with seagrass (Janssen et al., 2011: 425).



Text-fig. 4. The distribution of *Canarium erythrinum* (Dillwyn, 1817). Modified from Abbott (1960: 79).

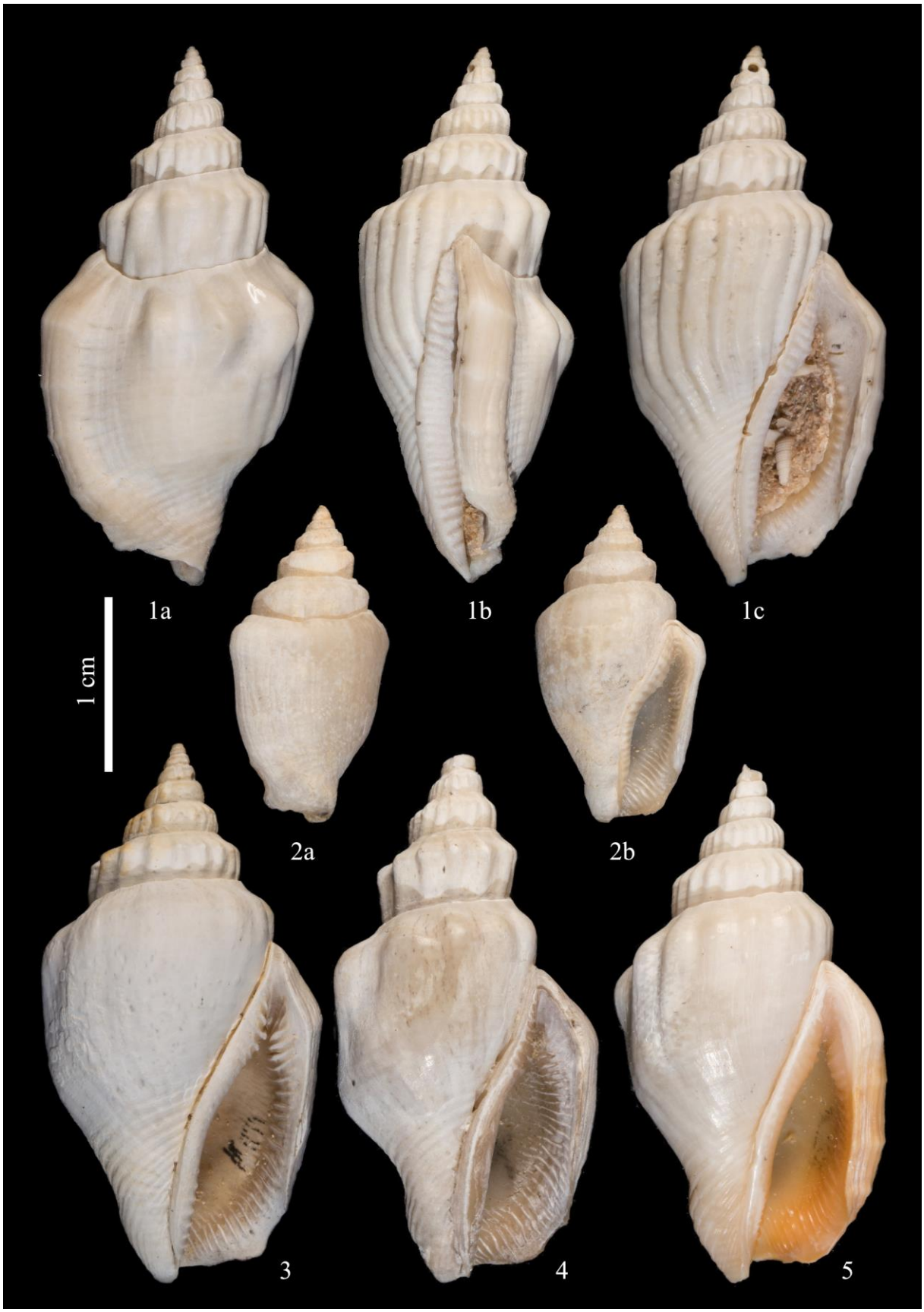


Plate 1. ***Canarium erythrinum*** **(Dillwyn, 1817). Fig. 1a–c: 30.8 mm; Fig. 2a, b: 18.1 mm; Fig. 3: 30.9 mm; Fig. 4: 30.2 mm; Fig. 5: 29.7 mm; ASUGM 23275. Scale bar = 1 cm.**

***Canarium fusiforme* (G. B. Sowerby II, 1842)**

Plate 2, fig. 1a–c

1842 *Strombus fusiformis* Sowerby, *Strombus*, p. 31, no. 28, pl. 9, fig. 91, 92
1851 *Strombus fusiformis:* Reeve, *Strombus*, species 7, pl. 5, fig. 7a, b
1869 *Strombus fusiformis:* Issel, p. 131, no. 273; p. 270, no. 118
1876 *Strombus fusiformis:* Issel & Tapparone Ganefri, p. 354, 365
1885 *Strombus fusiformis:* Tryon, p. 117, pl. 6, fig. 58
1900 *Strombus fusiformis:* Newton, p. 508
1960 *Strombus fusiformis:* Abbott, p. 78, pl. 20, fig. 30
1984 *Strombus fusiformis:* Sharabati, pl. 8, fig. 3, 3a
1999 *Strombus (Canarium) fusiformis:* Kreipl & Poppe, p. 34, pl. 62, fig. 1–6
2000 *Canarium fusiformis:* Dekker & Orlin, p. 21
2005 *Canarium fusiformis:* van Gemert, p. 121, fig. 4 (cum. syn.)
2008 *Canarium fusiformis:* Rusmore-Villaume, p. 50, fig.
2011 *Canarium fusiforme:* Janssen et al., p. 425, pl. 20, fig. 4a, b

Material. ASUGM 23276: A single specimen in a good condition.

Dimensions. (in mm)

Shell Length (sl)	= 26.9
Spire Length (spl)	= 8.3
Body Whorl Length (bwl)	= 18.6
Shell Width (sw)	= 12.6
Shell Thickness (st)	= 9.2
Aperture Length (al)	= 21.9
Aperture Width (aw)	= 6.3
Number of Whorls	= 7
Number of Axial Ribs on Body Whorl	= 3
Apical Angle (aa)	= 41.5°

Remarks. This species characteristically has an outer lip that extends posteriorly over the penultimate whorl and a long posterior canal. We follow the traditional allocation of this species to *Canarium* Schumacher, 1817.

Geographic distribution. *Recent:* This species inhabits the Red Sea and the western Indian Ocean (Abbott, 1960: 78). It is rare in the Egyptian Red Sea (Rusmore-Villaume, 2008: 50).
Fossil: Issel (1869: 270, no. 117) reported 11 specimens of this species from the emerged beaches of the Red Sea.

Habit and habitat. This species occurs on sandy coral bottoms from 1 to 34 fathoms (1.8 to 62.2 m) and is rarely found in very shallow water (Abbott, 1960: 78; Sharabati: pl. 8). In the Red Sea, this species was found in muddy sand and muddy sand with seagrass in 40 and 52 m water depth (Janssen et al., 2011: 425).

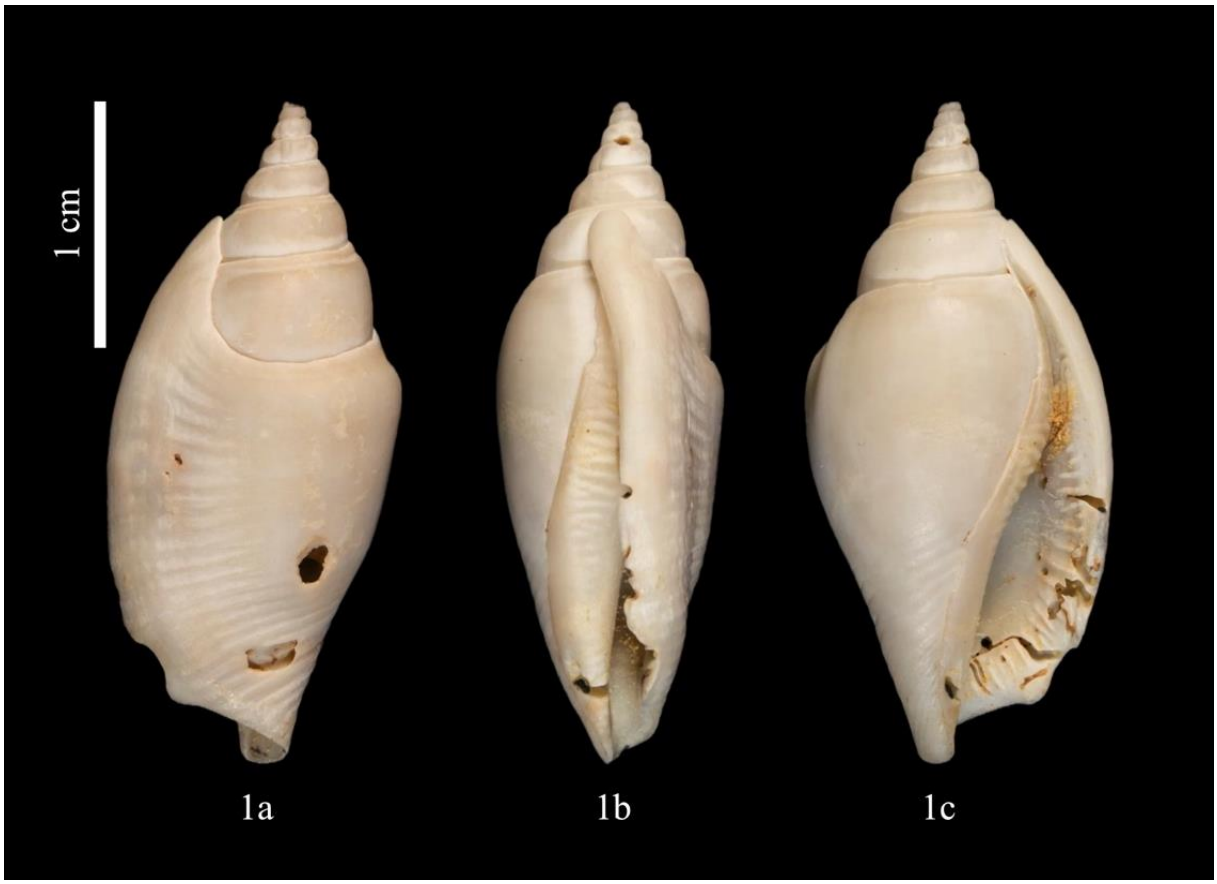


Plate 2. *Canarium fusiforme* (G. B. Sowerby II, 1842). Fig. 1a–c: 26.9 mm; ASUGM 23276. Scale bar = 1 cm.

***Conomurex fasciatus* (Born, 1778)**

Plate 3, fig. 1–9

1778 *Strombus fasciatus* Born, p. 274
1788 *Strombus polyfasciatus* Chemnitz, vol. 10, p. 209, pl. 155, fig. 1483, 1484
1822 *Strombus lineatus* Lamarck, p. 211, no. 29
1842 *Strombus lineatus:* Sowerby, *Strombus*, p. 29, no. 15, pl. 7, fig. 32, 33
1851 *Strombus fasciatus:* Reeve, *Strombus*, species 56, pl. 19, fig. 56
1869 *Strombus fasciatus:* Issel, p. 131, no. 271; p. 270, no. 116
1876 *Strombus fasciatus:* Issel & Tapparone Ganefri, p. 350, 365
1885 *Strombus fasciatus:* Tryon, p. 120, pl. 7, fig. 82 (non fig. 77)
1900 *Strombus fasciatus:* Newton, p. 508, pl. 20, fig. 3
1926 *Strombus fasciatus:* Pallary, p. 72, pl. 4 (8), fig. 25–27
1934 *Strombus fasciatus:* Nardini, p. 221, pl. 16, fig. 11–14
1960 *Strombus fasciatus:* Abbott, p. 121, pl. 14, fig. 16, 17
1982 *Strombus fasciatus:* Abed, p. 274, pl. 8, fig. 6
1984 *Strombus fasciatus:* Beltagi & Ghamrawy, p. 429, fig. 5: 32
1984 *Strombus fasciatus:* Sharabati, pl. 7, fig. 2, 2a
1999 *Strombus fasciatus:* Gameil, p. 536, pl. 1, fig. 12, 13
1999 *Strombus (Lentigo) fasciatus:* Kreipl & Poppe, p. 48, pl. 100, fig. 1–7; pl. 130, fig. 4
2000 *Conomurex fasciatus:* Dekker & Orlin, p. 21
2005 *Conomurex fasciatus:* van Gemert, p. 124, fig. 6 (cum. syn.)
2008 *Conomurex fasciatus:* Rusmore-Villaume, p. 52, fig.
2011 *Conomurex fasciatus:* Janssen et al., p. 426, pl. 20, fig. 7, 8; pl. 28, fig. 7
2020 *Strombus fasciatus:* Khalil, p. 1227, fig. 9: 13, 14
2018 *Conomurex fasciatus:* Abu-Zied & Bantan, p. 78, fig. 8w, x
2018 *Conomurex persicus:* Abu-Zied & Bantan, p. 78, fig. 8y, z (non Swainson, 1821)
2020 *Strombus fasciatus:* El-Sorogy et al., p. 1000, fig. 7g
2021 *Conomurex fasciatus:* Abu ElEinin et al., p. 105, fig. 2: Strombidae (b)

Material. ASUGM 23277: 63 specimens in good to perfect condition.

Dimensions. (in mm)

n=63	*Mean*	*Range*
Shell Length (sl)	35.6	15.3−47.6
Spire Length (spl)	7.6	3.7−10.5
Body Whorl Length (bwl)	28.1	11.4−38
Shell Width (sw)	19.7	7.9−26.8
Shell Thickness (st)	16.4	6.9−23.3
Aperture Length (al)	29.7	20.5−35.3
Aperture Width (aw)	12.6	8.8−17.2
Number of Whorls	7.1	5−9
Number of Spiral Strips on Body Whorl	6.1	3−9
Number of Axial Tubercles on Body Whorl	3.8	0−10
Apical Angle (aa)	59.4°	44.2°−87.7°

Remarks. The specimens of this species show a wide morphological variation as shown in Pl. 3. Notably, the shoulder sculpture varies from smooth surface to weak knobs to prominent tubercles (Pl. 3, fig. 1–4). A few specimens have smoother, more inflated, ovate shells with reduced, pointy tubercles (Pl. 3, fig. 8, 9). Subadult and juvenile shells are smooth and more elongated (Pl. 3, fig. 5–7). The inner lip of this species is straight, smooth in most specimens, with very weak lirae in a few specimens, most visible in the posterior side (Pl. 3, fig. 3a).

Born's *fasciatus* is based upon Martini's species *Alata sagittis lineata* (Martini, 1777: Vol. 3, p. 97, pl. 78, fig. 800–802) which is regarded unavailable nomenclaturally according to the aforementioned ICZN's opinion 184.

Tryon (1885: 120) reported that the specimen illustrated in pl. 7, fig. 77 is worn with indistinct markings; hence we cannot assign it to *C. fasciatus* with certainty. Abu-Zied & Bantan (2018: 78, fig. 8y, z) reported *Conomurex persicus* Swainson, 1821 from a raised beach in Jeddah; however, the figures show a smoother variety of *C. fasciatus*.

Moolenbeek & Dekker (1993: 8) placed *Strombus fasciatus* within the subgenus *Conomurex* Fischer, 1884 which is characterized by a conical shell and short spire (Fischer, 1884: 670). Bandel (2007: 148) differentiated between his new subgenus *Decostrombus* (Type species *S. fasciatus*) and *Conomurex* by having short ribs or nodes on the shoulder. Kronenberg et al. (2009: 666) considered *Decostrombus* as a junior synonym to *Conomurex* based on the variation of shoulder knobs in *C. fasciatus* and the lack of differences in overall shape, structure of the outer lip, and biogeographical distribution.

Geographic distribution. *Recent:* This species is endemic to the Red Sea (Abbott, 1960: 121; Rusmore-Villaume, 2008: 52).

Fossil: Many authors reported fossil specimens of this species; Newton (1900: 508) from a Pleistocene raised beach 80 feet (24.4 m) above sea in Wadi Gueh, west of Quseir, Hall & Standen (1907: 67) from a Pleistocene raised coral reef in Port Sudan, and Nardini (1934: 221) who reported it from Port Sudan and Eritrea. Abed (1982) collected this species from the same raised terrace we studied at Gebel Tanka area 55 m away from the shore and 11 m above sea level. Abed also reported it from a second terrace 1 km east of the first terrace and 28 m above sea level. Gameil (1999: 536) collected 6 specimens of this species from the same raised terrace we studied at Gebel Tanka area. Abu-Zied & Bantan (2018: 78) reported it from a raised reefal

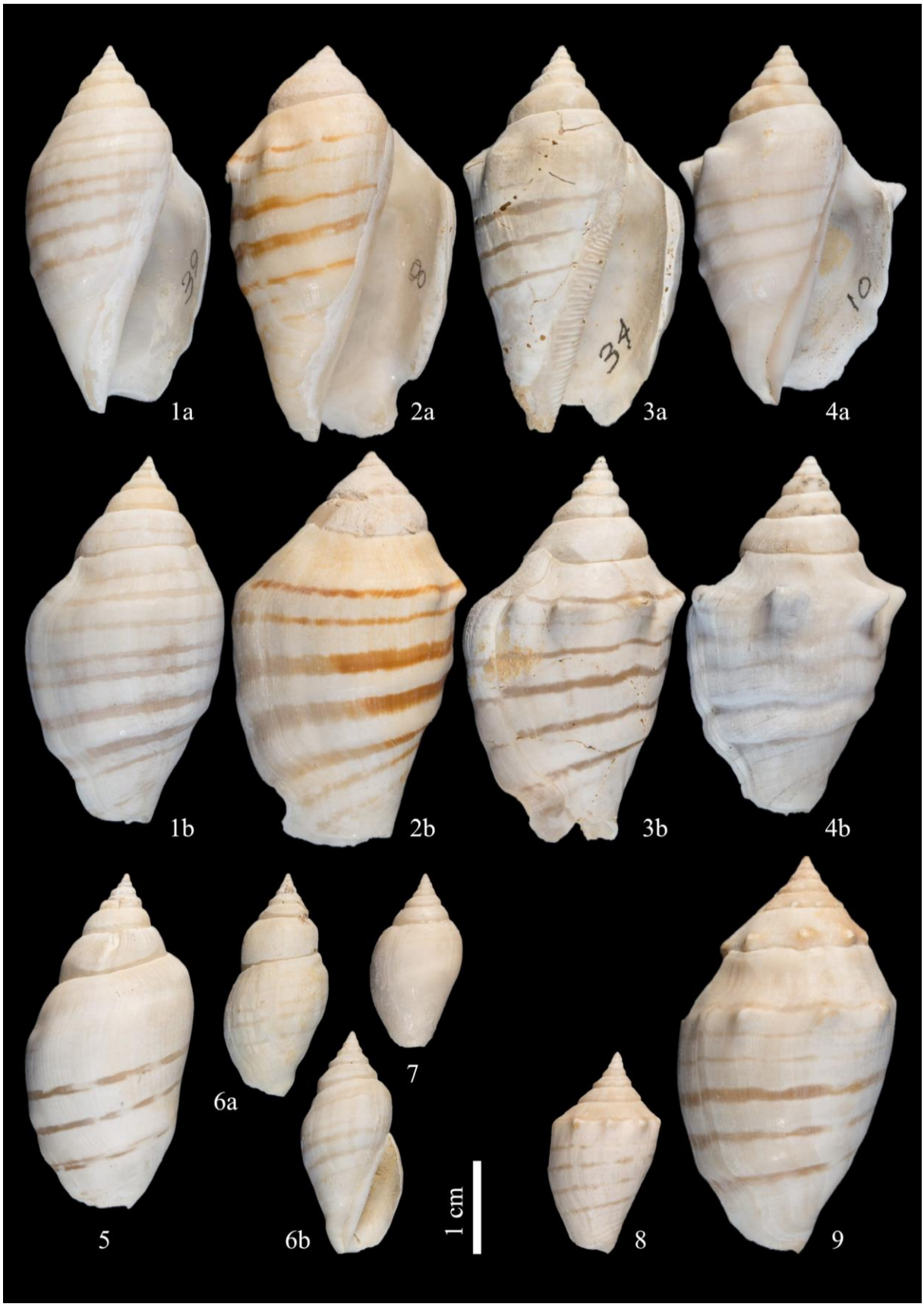


Plate 3. ***Conomurex fasciatus*** **(Born, 1778). Fig. 1a, b: 39.5 mm; Fig. 2a, b: 42.4 mm; Fig. 3a, b: 41.3 mm; Fig. 4a, b: 38.5 mm; Fig. 5: 36 mm; Fig. 6a, b: 24 mm; Fig. 7: 18.2 mm; Fig. 8: 21.7 mm; Fig. 9: 42.5 mm; ASUGM 23277. Scale bar = 1 cm.**

limestone terrace around 5 m above sea level south of Sharm Obhur (Jeddah) of the late Pleistocene.

Habit and habitat. This species inhabits sand between coral patches, sand with seagrass, and mangrove channels with dead shells found on rocky intertidal and on reef slope, from 1 to 10 m deep (Janssen et al., 2011: 426). *C. fasciatus* grazes on detritus and algae in tropical waters. It possesses a strong foot that enhances its mobility by jumping short distances of about 30–40 cm depending on currents (Hausmann et al., 2021: 22).

***Dolomena?* sp.**

Plate 4, fig. 1a, b

Material. ASUGM 23278: A specimen in a good condition but with a broken outer lip.

Dimensions. (in mm)

Shell Length (sl)	= 18.2
Spire Length (spl)	= 5.5
Body Whorl Length (bwl)	= 12.6
Shell Width (sw)	= 9
Shell Thickness (st)	= 7.8
Number of Whorls	= 7
Apical Angle (aa)	= 50°

Description. Shell fusiform, fragile, somewhat glossy, with length of 18.2 mm, width of 9 mm, and apical angle of 50°. **Apical whorls** inflated, round, smooth and glossy. **Spire** short, consists of 6 shouldered whorls, and axially sculptured with 21 elongated, closely spaced, axial plicae. **Suture** incised. Spire exhibits a weak subsutural spiral strap, hardly visible in earlier whorls. **Body whorl** large, 0.7 of shell length, and axially sculptured with 15 longitudinal, closely spaced axial plicae, extending along the upper half of body whorl. Spiral sculpture of numerous, uniform, spiral threads, covering the lower 2/3 of body whorl. **Aperture** elongated, large, and opens anteriorly into a short, wide siphonal canal.

Plate 4. ***Dolomena?*** **sp. Fig. 1a, b: 18.2 mm; ASUGM 23278. Scale bar = 5 mm.**

Remarks. This single specimen closely resembles the specimen photographed in Janssen et al. (2011: pl. 21, fig. 2a, b). It is probably a juvenile of *Dolomena plicata* (Röding, 1798) which is the only recent species of *Dolomena* Wenz, 1940 in the Red Sea. However, it cannot be assigned to *Dolomena* with certainty as its expanded outer lip– a defining characteristic of *Dolomena*– is broken.

***Gibberulus albus* (Mörch, 1850)**

Plate 5, fig. 1–4

1842 *Strombus gibberulus:* Sowerby, *Strombus*, p. 31, no. 27, pl. 6, fig. 18, 19, 24–26
1850 *Strombus albus* Mörch, p. 11, no. 264
1851 *Strombus gibberulus:* Reeve, *Strombus*, species 15, pl. 8, fig. 15a, b
1869 *Strombus gibberulus:* Issel, p. 131, no. 274
1876 *Strombus gibberulus:* Issel & Tapparone Ganefri, p. 349, 365
1885 *Strombus gibberulus:* Tryon, p. 121, pl. 8, fig. 85
1900 *Canarium gibberulum:* Newton, p. 509, pl. 20, fig. 2
1934 *Strombus (Canarium) gibberulus:* Nardini, p. 222
1942 *Strombus (Canarium) gibberulus:* Abrard, p. 64, pl. 6, fig. 39
1960 *Strombus gibberulus albus*: Abbott, p. 144, pl. 14, fig. 27
1970 *Strombus gibberulus albus:* Coomans & Amsterdam, p. 114, fig. 5
1982 *Strombus gibberulus:* Abed, p. 275, pl. 7, fig. 3
1984 *Strombus gibberulus albus:* Beltagi & Ghamrawy, p. 429, fig. 6: 33
1984 *Strombus gibberulus albus:* Sharabati, pl. 7, fig. 7, 7a, 7b
1999 *Strombus (Gibberulus) gibberulus albus:* Kreipl & Poppe, p. 54, pl. 118, fig. 1–3
2000 *Gibberulus gibberulus albus:* Dekker & Orlin, p. 21
2005 *Gibberulus gibberulus albus:* van Gemert, p. 128, fig. 8 (cum. syn.)
2008 *Gibberulus gibberulus albus:* Rusmore-Villaume, p. 54, fig.
2011 *Gibberulus gibberulus albus:* Janssen et al., p. 427, pl. 21, fig. 3–6
2016 *Gibberulus gibberulus albus:* Ounifi-Ben Amor et. al., p. 126, fig. 4a
2018 *Gibberulus gibberulus albus:* Abu-Zied & Bantan, p. 78, fig. 8a', b'
2021 *Gibberulus albus:* Maxwell et al., p. 92, fig. 3

Material. ASUGM 23279: 8 specimens, of good to perfect condition.

Dimensions. (in mm)

n=8	*Mean*	*Range*
Shell Length (sl)	44.1	39.7−60.7
Spire Length (spl)	8.5	7.2−11.5
Body Whorl Length (bwl)	35.6	31.6−49.2
Shell Width (sw)	24	21.6−32
Shell Thickness (st)	18.6	16.5−24.1
Aperture Length (al)	32.6	28.8−48.5
Aperture Width (aw)	13.1	10.6−18
Number of Whorls	7.1	5−9
Apical Angle (aa)	56.1°	45.2°−60.3°

Remarks. This Red Sea species appears in most literature as a subspecies of *Gibberulus gibberulus* (Linnaeus, 1758). According to Abbott (1960: 35), *G. albus* is geographically isolated and differs from the typical Indian Ocean *G. gibberulus* in being smaller and paler. Maxwell et al. (2021: 90) consider the 3 subspecies of *Gibberulus*– *G. albus*, *G. gibberulus*, and *G. gibbosus*– to be full species. Mörch's *albus* is based upon Martini's *Alata canarium gibbosum album* (Martini, 1777: Vol. 3, p. 97, pl. 77, fig. 797, 798).

Geographic distribution. *Recent:* This species is limited to the Red Sea and Gulf of Aden (Abbott, 1960: 35; Rusmore-Villaume, 2008: 54). Maxwell et al. (2021: 95) extended its geographic range to the Arabian coast and the Gulf of Oman.
Ounifi-Ben Amor et al. (2016: 132) reported one specimen of *G. albus* for the first time in the Mediterranean Sea in the Gulf of Gabès off the coast of Tunisia.
Fossil: Newton (1900: 509) reported this species in a Pleistocene raised beach 80 feet (24.4 m) above sea in Wadi Gueh, west of Quseir. Nardini (1934: 222) reported this species from Port Sudan; Dahlak Islands; Mombasa, Kenya; Tanga, Tanzania; and the Arabian Gulf, while Abrard (1942: 64) reported it from Pleistocene beds in multiple locations in Djibouti. Abed (1982: 275, pl. 7, fig. 3) reported this species from a raised terrace at Gebel Tanka area 1 km east of the shore and 28 m above sea level. Abu-Zied & Bantan (2018: 78) also reported this species in a raised reefal limestone terrace around 5 m above sea level south of Sharm Obhur (Jeddah) of the late Pleistocene.

Habit and habitat. According to Janssen et al. (2011: 427), this species inhabits sand between coral patches and sand with seagrass, and on conglomerate, between 1 and 30 m deep. According to Eisawy & Sorial (1976: 261), the animal has a strong foot that it uses in moving by a series of jerking leaps and in righting itself if turned over on its back.

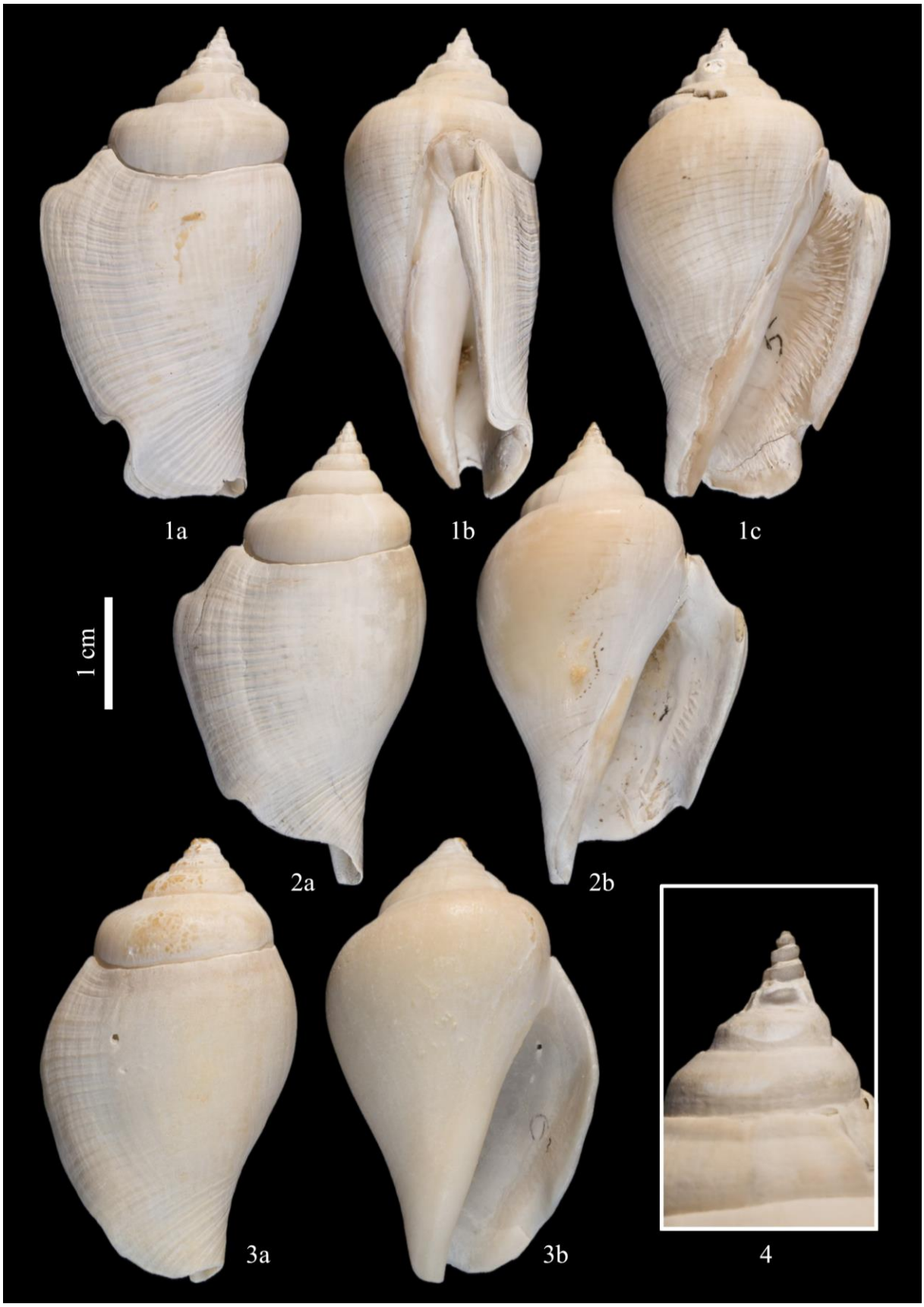


Plate 5. ***Gibberulus albus*** **(Mörch, 1850). Fig. 1a–c: 41.9 mm; Fig. 2a, b: 41 mm; Fig. 3a, b: 39.7 mm; Fig. 4: apical whorls; ASUGM 23279. Scale bar = 1 cm.**

***Lambis truncata sebae* (Kiener, 1843)**

Plate 6, fig. 1, 2; text-fig. 5

1842 *Pterocera truncatum:* Sowerby, *Pterocera*, p. 41, no. 1, pl. 11, fig. 13
1843 *Pterocera Sebae* Kiener, p. 4, pl. 2; pl. 4, fig. 2
1885 *Pterocera bryonia:* Tryon, p. 124, pl. 8, fig. 4; pl. 9, fig. 8
1869 *Pterocera Sebae:* Issel, p. 133, no. 281
1876 *Pterocera truncata:* Issel & Tapparone Ganefri, p. 355
1961 *Lambis truncata sebae*: Abbott, p. 156, pl. 121, fig. 9; pl. 122, fig. 1
1984 *Lambis truncata Sabae* [sic!]*:* Beltagi & Ghamrawy, p. 429, fig. 5: 30
1984 *Lambis truncata sebae:* Sharabati, pl. 9, fig. 1, 1a, 1b
1999 *Lambis (Lambis) truncata sebae:* Kreipl & Poppe, p. 20, pl. 14, fig. 1–3; pl. 15, fig. 2; pl. 33, fig. 1, 4; pl. 34, fig. 2, 3
2000 *Lambis truncata sebae:* Dekker & Orlin, p. 21
2002 *Lambis truncata sebae:* Raven, p. 21
2005 *Lambis (Lambis) truncata sebae:* van Gemert, p. 132, fig. 11 (cum. syn.)
2008 *Lambis truncata sebae:* Rusmore-Villaume, p. 56, fig.
2011 *Lambis truncata sebae:* Janssen et al., p. 427, pl. 21, fig. 7, 8; pl. 28, fig. 8

Material. ASUGM 23280: 2 specimens strongly eroded.

Dimensions. (in mm)

	Adult	*Subadult*
Shell Length (sl)	176.5	125.6
Spire Length (spl)	43.1	25.4
Body Whorl Length (bwl)	133.4	100.2
Shell Width (sw)	111.7	-
Shell Thickness (st)	77.9	55.2
Aperture Length (al)	176.5	-
Aperture Width (aw)	61.2	-
Number of Whorls	5	6

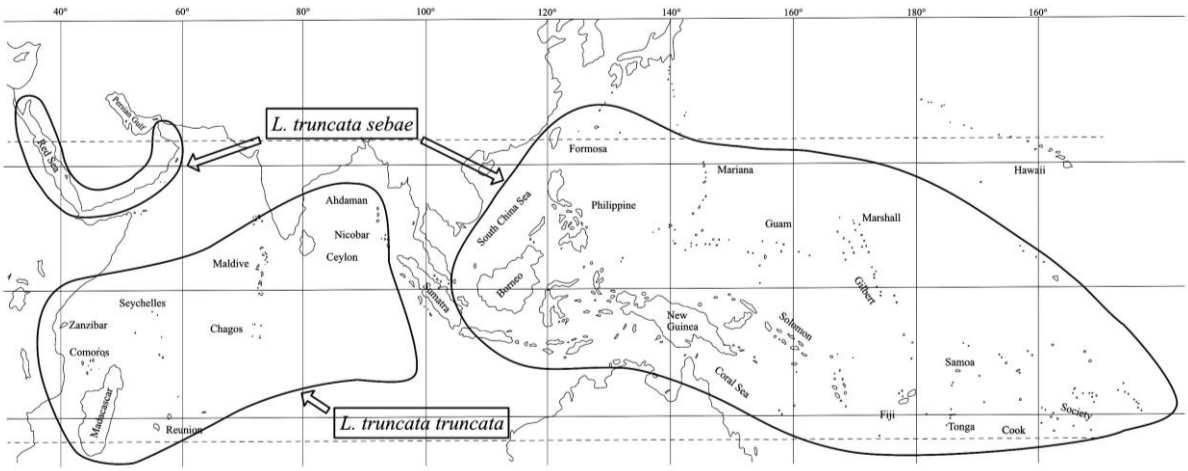
Remarks. The heavy adult specimen is intensely eroded with remnants of the bases of 7 fingers (protrusions) and a strong stromboid notch between the two ventral-most fingers.

The juvenile and subadult forms of this species differ from its adult shell. Abbott (1961: pl. 122, fig. 1) provided a figure for a juvenile specimen with a large spiral ridge on body whorl shoulder. Kiener (1843: pl. 4, fig. 2), Kreipl & Poppe (1999: pl. 33, fig. 1, 4) and Janssen et al. (2011: pl. 21, fig. 7) provided figures of likely subadult specimens, which closely resemble our subadult specimen (Pl. 6, fig. 2).

The subspecies *Lambis truncata sebae* (Kiener, 1843) differs from the typical *L. truncata truncata* (Lightfoot, 1786) of the Indian Ocean in having a pointed, rather than a truncate apex (Abbott, 1961: 156).

Geographic distribution. According to Abbott (1961: 156), *Lambis truncata sebae* (Kiener, 1843) has a curious distribution in two distinctive separated areas; the Red Sea and the tropical Pacific Ocean from the East Indies to eastern Polynesia (text-fig. 5). Abbott explained this distribution by at least two possibilities: "Either, two morphologically similar forms have evolved independently of one another, or the once continuous distribution has recently been broken by the invasion of a geographically intervening race of flat-topped Indian Ocean specimens. The fossil record is too poorly known to settle this matter." According to Rusmore-Villaume (2008: 56), in the Egyptian Red Sea, this subspecies is occasional in the Gulf of Aqaba and from Hurghada south and not found in the Gulf of Suez.

Habit and habitat. This species lives in colonies on sandy, algal and coral rubble bottoms in the vicinity of coral reefs (Abbott, 1961: 156) and on reef flat and conglomerate (Janssen et al., 2011: 427).



Text-fig. 5. The distribution of *Lambis truncata sebae* (Kiener, 1843) and *Lambis truncata truncata* (Lightfoot, 1786). Adapted from Abbott (1961, p. 155).

Plate 6. ***Lambis truncata sebae*** **(Kiener, 1843). Fig. 1a, b: Adult specimen, 176.5 mm; Fig. 2a, b: Immature specimen, 125.6 mm; ASUGM 23280. Scale bar = 5 cm.**

Conclusion

The Pleistocene emerged coral terrace of Gebel Tanka on the eastern side of the Gulf of Suez preserves a well-represented assemblage of 6 species of the gastropod family Strombidae, all of which inhabit the Red Sea today. This terrace, with a thickness ranging from 1.5 m to a little over 2 m, rests on the Upper Eocene Tanka Formation, with its base at 14–18 m above sea level. According to Bosworth et al. (2019), the age of the terrace is about 125 ky, corresponding to MIS 5e. The species identified in this study are *Canarium erythrinum* (Dillwyn, 1817), *Canarium fusiforme* (G. B. Sowerby II, 1842), *Conomurex fasciatus* (Born, 1778), *Dolomena?* sp., *Gibberulus albus* (Mörch, 1850), and *Lambis truncata sebae* (Kiener, 1843). Among them, *C. fasciatus* is endemic to the Red Sea, while *G. albus*, traditionally restricted to the Red Sea and Gulf of Aden, has its range expanded to the Arabian coast and the Gulf of Oman, with a single shell reported from the Mediterranean coast of Tunisia (Ounifi-Ben Amor et al., 2016: 132). This fossil assemblage provides valuable insight into past marine environments and the biogeographical history of Strombidae in the Gulf of Suez and the Red Sea.

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فصيلة الدولع (الرخويات: البطنقدميات) من شرفة غنية بالشعاب المرجانية من الفترة الرباعية في جبل تنكا بالجانب الشرقي لخليج السويس

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يسجل هذا العمل وجود ستة أنواع من فصيلة الدولع (Strombidae Rafinesque, 1815) من البطنقدميات، والتي تنتمي إلى خمسة أجناس، جُمعت من شرفة غنية بالشعاب المرجانية تعود إلى الفترة الرباعية في جبل تنكا على الجانب الشرقي من خليج السويس. تم تسجيل أربعة أنواع منها لأول مرة من الشرفات الغنية بالشعاب المرجانية من عصر البليستوسين في خليج السويس، وهي: *Canarium erythrinum* (Dillwyn, 1817) و *Canarium fusiforme* (G. B. Sowerby II, 1842) و *Dolomena?* sp. و *Lambis truncata sebae* (Kiener, 1843). كما تم تسجيل نوع واحد –*Gibberulus albus* (Mörch, 1850) – من البحر الأبيض المتوسط. تمت مناقشة الأنواع الستة من الناحية التصنيفية، مع توضيح توزيعها الجغرافي وخصائصها وموائلها.