

Review of the genus *Carinapex* Dall, 1924 with the description of ten new species (Gastropoda: Conoidea: Horaiclavidae) from the Pacific Ocean

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ABSTRACT Material examined in the LACM collection and the author's collection has resulted in ten species of *Carinapex* new to science. Two known *Carinapex* Dall, 1924 species, *Carinapex papillosa* (Garrett, 1873) and *C. minutissima* (Garrett, 1873), are compared with ten new species from the Indo-Pacific, *Carinapex albarnesi* n. sp., *C. alisonkayae* n. sp., *C. amirowlandae* n. sp., *C. cernohorskyi* n. sp., *C. chaneyi* n. sp., *C. johnwiedricki* n. sp., *C. lindseygrovesi* n. sp., *C. mooreorum* n. sp., *C. philippinensis* n. sp. and *C. solomonensis* n. sp.

INTRODUCTION

The species within the turrid genus *Carinapex* Dall, 1924 has been frequently overlooked by previous authors who published on the group. Due to the isolated ranges of some new *Carinapex* species, it is speculated that there are possibly more new species that inhabit the Indo-Pacific complex and are yet to be named. As a case in point, several additional new species were omitted from this paper due to the poor condition of samples taken. Historically, authors have identified specimens and figured them with the assumption that they were either one of the two known species. An array of species exists from this genus and can only be identified by close inspection of material from various locations throughout the Indo-Pacific region. Micromolluscan material taken by Lumun Lumun nets has become a recent trend for Philippine fisheries. The exportation of material to various researchers in recent years has accounted for a myriad of new turrid species new to science by Chino & Stahlschmidt (2009), Chino & Stahlschmidt (2010), Fedosov (2011), Fedosov & Puillandre (2012), and Stahlschmidt, Chino & Kilburn (2012). Additionally, some processed material from the Hawaiian Islands has brought to light additional species described in this paper.

Material examined at LACM from various localities has also been beneficial to this research.

Abbreviations

ANSP: The Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania, U.S.A.

LACM: Natural History Museum of Los Angeles County, California, U.S.A.

SW: collection of the author

SYSTEMATICS

Most recent studies by use of molecular phylogeny of the Conoidea by Bouchet & others (2011) and Puillandre & others (2011) arrange the placement of genera within this complex.

Family **HORAICLAVIDAE** Bouchet, Kantor, Sysoev & Puillandre, 2011

Genus *Carinapex* Dall, 1924

Carinapex Dall, 1924: 88 (as a subgenus of *Daphnobela* Cossmann, 1896). Type species (o. d.): *Drillia minutissima* Garrett, 1873, Viti Isles, Fiji.

Diagnosis. The genus *Carinapex* Dall, 1924 (Type: *Drillia minutissima* Garrett, 1873) was assigned without a description and only a type species designation. Since the original description, authors Hedley (1922), Dall (1924), Wenz (1943), Kuroda & Habe (1952), Cernohorsky (1983), Tröndle & Boutet (2009) have mistakenly placed this genus in a variety of generic and subgeneric headings. Genus resembling a microscopic *Drillia* with nodules, apex bulbous, converging into carinate cords, with ribbing occasionally on remaining portion of whorl. Parietal callus of aperture strong, apertural lip thin, thick bulging rib prior to final lip.

Key to species described and cited

1. Over 5.0 mm*solomonensis*
Under 5.0 mm.....2
2. Erect apex.....3
Bluntly acute apex.....4
3. Dark brown.....*chaneyi*
White, brown marks.....*cernohorskyi*
4. Dark spot on final nodule.....*johnwiedricki*
Dorsal spot absent.....5
5. Over 3.8 mm.....6
Under 3.8 mm.....7
6. Peripheral nodules large.....*albarnesi*
Nodules dash-like.....*papillosa*
7. Color white.....*mooreorum*
Color markings.....8
8. Small, white initial protoconch whorl.....
.....*minutissima*
Protoconch large, bulbous.....9
9. Base color white or tan.....10
Base color brown.....11
10. Small, rhomboid shaped.....*alisonkayae*
Large, shape elongate.....*philippinensis*
11. Color dark brown.....*amirowlandae*
Color red-brown to tan*lindseygrovesi*

***Carinapex solomonensis* n. sp.**

Plate 1, figs. 9-12

Type Material. Holotype, LACM 3290, height 5.5 mm, width 2.4 mm.

Distribution. Known only from the type locality, holotype [LACM 3290], from sand pockets on leeward reef slopes, Kicha Island, east of Nggatokae

Island, south Marovo Lagoon, off southeast side Vangunu Island, Solomon Islands (8° 46' S, 158° 19' E) in 15-20 m, collected by H. W. Chaney, March 23, 1989 [= LACM 89-78].



Image 1. *Carinapex solomonensis* n. sp., holotype

Diagnosis. *Carinapex solomonensis* n. sp. is characterized by its extremely large size, relatively erect protoconch and angulate ribs.

Description. Shell extremely large for genus, slender, rhomboid shaped, color cream with faint, orange tint at upper portion of whorls. Protoconch somewhat erect, first protoconch whorl domed, slightly flattened, distorted to one side, remaining one-and-a-half whorls carinate in middle. Five teleconch whorls, first three with two rows of large nodules, somewhat connected, angulate, forming faint ribs. Proceeding two whorls with three rows of nodules, bottom row weak, faint cords connecting nodules in row, suture heavily indented in all teleconch whorls. Final whorl with two strong nodule rows, followed by eight moderate spiral cords below periphery to anterior. Parietal callus relatively large, aperture elongate, somewhat large.

Discussion. *Carinapex solomonensis* n. sp. is similar to two other new species described herein, *C. albarnesi* n. sp. and *C. cernohorskyi* n. sp. Relative differences in *C. solomonensis* n. sp., heavily

indented suture and extreme size. The smaller, spindle shaped *C. albarnesi* n. sp., exhibits obese peripheral nodules, horizontally ovate, opaque, white with brown bands at suture and base of whorls making them readily separable. The acute, erect protoconch of *C. cernohorskyi* n. sp., bulging, large, pustule-like nodules, caramel color banding, rhomboid shape and slightly brown protoconch also separate it from *C. solomonensis* n. sp.

Etymology. Named in reference to the type locality, Solomon Islands.

***Carinapex chaneyi* n. sp.**

Plate 1, figs. 17-23

Carinapex minutissima.—Bouchet & others, 2011: 294, fig. 17-M.



Image 2. *Carinapex chaneyi* n. sp., holotype

Type Material. Holotype, LACM 3293, height 2.8 mm, width 1.3 mm.

Type Locality. Off exposed side of Karunjou Island, off Marovo Lagoon, east side Vanguna Island, Solomon Islands (8° 39' S, 158° 14' E) in rubble at 20-25 m.

Material Examined. Holotype [LACM 3293], (Pl. 1, figs. 20-23); one specimen from Karunjou Island,

off Marovo Lagoon, east side Vanguna Island, Solomon Islands (8° 39' S, 158° 14' E) in rubble at 20-25 m, collected by H. W. Chaney, March 21, 1989 [= LACM 89-76]; two specimens from northern Punto Engano, Mactan Island, Cebu Province, Philippines in tangle nets at 100-250 m, January 2009 [SW09-33]; one specimen from Linapacan Island, Palawan Province, Philippines in 150 m, April, 2005 [SW05-67]; one specimen from 0.5 km east southeast Zampa-misaki (Bolo Point), Okinawa, Japan (26° 26.1' N, 127° 42.5' E), in sand and coral rubble at 46 m, collected by R. F. Bolland, August 25, 1978 [LACM 78-25]; one specimen from 0.5 km east southeast Zampa-misaki (Bolo Point), Okinawa, Japan (26° 26.1' N, 127° 42.5' E), in sand and coral rubble at 49 m, collected by R. F. Bolland, October 25, 1978 [LACM 78-100].

Distribution. *Carinapex chaneyi* n. sp. is known from Japan, the Philippines, Solomon Islands (type locality), and New Caledonia (Bouchet & others, 2011). Map insert (fig. 1) shows distribution of material recorded from the LACM and SW collections.



Figure 1. Distribution of *Carinapex chaneyi* n. sp.

Diagnosis. *Carinapex chaneyi* n. sp. is characterized by its pupoid shape, dark brown coloration, moderately erect apex, nodules round, evenly spaced.

Description. Mature specimens range from moderately large to small, pupoid shaped, somewhat rhomboid, color dark brown, protoconch cream colored, large cream blotch on periphery of dorsal side on final whorl. Color lighter in worn specimens. Apex erect, narrow, acute, angle progressively consistent downward, four protoconch whorls, first

whorl domed, flattened, proceeding one half whorl carinate at periphery, proceeding whorls with two carinate cords at periphery and near suture, microscopic ribs on vertical wall under peripheral cord. Three-and-a-half to four-and-a-half teleoconch whorls with two rows of large, round, tightly spaced nodules at suture and periphery, sutural row slightly weaker, final whorl with two rows of large, bead-like nodules, followed by four additional smaller, strongly beaded rows at base, progressing anteriorly, two final spiral cords on siphonal canal. Aperature ovate, elongate near anterior, sinus restricted, parietal callus strong and projecting downward.

Discussion. *Carinapex chaneyi* n. sp. is similar to only one other species, *Carinapex lindseygrovesi* n. sp. *Carinapex chaneyi* n. sp. has a rhomboid shape, ovate, pupoid, apex distinctly erect, acutely domed, narrow, nodules exaggerated, round, large, bulbous, final whorl with seven spiral cords. *Carinapex lindseygrovesi* n. sp. has a elongate shape, narrow, turreted, apex domely flattened, projecting to one side, nodules large, widely spaced, rib-like on final whorl, four spiral cords.

Etymology. Named after malacologist Henry W. Chaney of The Santa Barbara Museum of Natural History, who collected the holotype specimen.

***Carinapex cernohorskyi* n. sp.**

Plate 1, figs. 13-16

Clavus papillosus.—Cernohorsky, 1983: 201, fig. 34, 35.

Carinapex papillosus.—Severns, 2011: 386, fig. 2.

Type Material. Holotype, LACM 3294, height 4.2 mm, width 1.9 mm.

Type Locality. 5 km west Tsuken-Jima (= Admiral's Island), Okinawa, Japan (26° 16.1' N, 127° 55.2' E), in sand and coral rubble at 18 m.

Material Examined. Holotype [LACM 3294], (Pl. 1, Figs. 13-16); 5 km west Tsuken-Jima, Okinawa, Japan (26° 16.1' N, 127° 55.2' E), in sand and coral rubble at 18 m, collected by R. F. Bolland, June 3, 1978 [= LACM 78-21]; one specimen from 0.5 km

east southeast Zampamisaki (Bolo Point), Okinawa, Japan (26° 26.1' N, 127° 42.5' E), at 49 m, collected by R. F. Bolland, October 27, 1978 [LACM 78-100]; one specimen 1 km north northwest Oku, Okinawa, Japan (26° 50.8' N, 128° 17.2' E), in sand in channels and caves among coral at 12-20 m, collected by R. F. Bolland, October 8, 1977 [LACM 77-64]; one specimen from Leone Bay, Tutuila Island, American Samoa (14° 20.3' S, 170° 47.06' W) in 15.2 m, collected by G. Hendler, April 26, 1999 [LACM 99-89]; one specimen from outer reef slope, off Arutanga, west side Altutaki, Cook Islands, West Pacific (18° 52.3' S, 159° 47.5' W), in rubble and Halimeda at 18-26 m, collected by J. H. McLean & S. Zinn, May 12-13, 1987 [LACM 87-79]; one specimen from Ahe Atoll, Tuamotu Archipelago, French Polynesia (14° 28' S, 146° 22' W) in 1 m, collected by D. E. Koontz on yacht "Constitution", October 14-15, 1973 [LACM 73-94].



Image 3. *Carinapex cernohorskyi* n. sp., holotype

Distribution. Records from Japan, French Polynesia and Makena Bay, Maui, Hawai'i (Severns, 2011: 386). Map insert (fig. 2) shows distribution of material recorded from the LACM and SW collections.

Diagnosis. *Carinapex cernohorskyi* n. sp. is characterized by its large size, extremely erect protoconch, uniquely large, bulging nodules and distinct caramel coloration.



Figure 2. Distribution of *Carinapex cernohorskyi* n. sp.

Description. Shell large for the genus, rhomboid shaped, stout, inflated, apex extremely erect, acute, color cream-white with caramel banding between nodules at suture, base and faintly between peripheral nodules. Three protoconch whorls, very erect, first whorl domed, sunken into second carinate whorl, keel low, base nearly vertical in last two whorls. First four teleoconch whorls with two rows of large white nodules, lower row more pronounced, rapidly progressing outward as they expand downward. Final two whorls more vertically aligned, whorls previous offset, peripheral nodules obese, expanding past general profile, exaggerated. Final whorl with four rows of nodules, siphonal canal with four thick cords. Parietal callus thick, caramel colored, aperture ovate, small, narrow at anterior.

Discussion. Examination of the drawing by Garrett (1873: 218) of *Carinapex papillosa*, one could easily confuse the specimen figured by Cernohorsky (1983: 201) as synonyms. A comparison of the *C. papillosa* holotype and the figured specimen by Cernohorsky has yielded a variety of different characteristics. Although close in size, the color of *C. cernohorskyi* n. sp. has a caramel brown series of bands at the suture, base and between nodules, bulging, large peripheral nodules, erect protoconch. In *C. papillosa* bands are orange and nodules much less distinct, protoconch acutely domed. The superficially similar, *C. albarnesi* n. sp. is slender, spindle shaped, nodules horizontally ovate, large at periphery, apex widely domed, slightly flattened. *Carinapex solomonensis* in general shape resembles *C. cernohorskyi* but differs in the larger size, less erect apex, less pronounced peripheral nodules and overall shape of ribs and indented suture. Severns

(2011: 386) identified a large *Carinapex* species as *C. papillosus* which is conspecific with the species here described.

Etymology. Named after the late malacologist Walter O. Cernohorsky (New Zealand), a great contributor to the understanding of Indo-Pacific molluscan faunas and who first recognized a specimen of the species now new to science.

***Carinapex johnwiedricki* n. sp.**

Plate 2, figs. 36-38, 45

Carinapex papillosus.—Sysoev in Poppe, 2008: 762, figs. 1-2.



Image 4. *Carinapex johnwiedricki* n. sp.. holotype

Type Material. Holotype, LACM 3296, height 2.7 mm, width 1.2 mm.

Type Locality. Punta Engano, Mactan Island, Cebu Province, Philippines (10° 19' 39.81" N, 124° 0' 50.59" E) in tangle nets at 200-250 m.

Material Examined. Holotype [LACM 3296], (Pl. 2, figs. 36-38, 45); from Punta Engano, Mactan Island, Cebu Province, Philippines (10° 19' 39.81" N, 124° 0' 50.59" E) in tangle nets at 200-250 m, December, 2008 [= SW08-57]; three specimens from Linapacan Island, Palawan Province, Philippines in tangle nets

at 150 m [SW05-67]; one specimen from Mactan Island, Cebu Province, Philippines in tangle nets at 90-100 m, February, 2007 [SW07-70]; four specimens from Mactan Island, Cebu Province, Philippines in 100-250 m [SW09-33].

Distribution. Known only from the Philippine Islands.

Diagnosis. *Carinapex johnwiedricki* n. sp. is characterized by its small size, ovately rhomboid shape, dark brown spot on final two peripheral nodules, strong projecting, tightly spaced peripheral nodules, relatively small parietal callus.

Description. Shell small sized, stout, ovately rhomboid, color light brown with lighter nodules, final whorl with dark blotch on final two peripheral nodules, faint brown mark on lower portion of final lip. First protoconch whorl obese, widely domed, proceeding two whorls smooth with carinate keel slightly below middle of whorl. Three-and-a-half teleoconch whorls with very tightly spaced, strongly projecting peripheral nodules, smaller, subtle, row above near suture, final whorl with two strong nodule rows, connecting with basal row creating long, tightly spaced ribs, following row beaded, four spiral cords on siphonal canal. Aperture ovate, large, one third the size of shell, anterior canal open, slightly curved outward, sinus relatively open, parietal callus relatively small, outward projecting.

Discussion. Due to its small size, finely ornamented sculpture and the dark brown spot on the last peripheral nodules of the final whorl of the dorsal side, *C. johnwiedricki* n. sp. is unlike any other *Carinapex* species. Sysoev in Poppe (2008:762) did not recognize the distinct features of this species and inadvertently misidentified the figured specimens. *Carinapex johnwiedricki* n. sp. is relatively rare in samples studied from tangle nets in the Philippines.

Etymology. Named after my father, John Wiedrick, Huntington Beach, California, who encouraged and fostered my appreciation for conchology/malacology since a young age, has been a travel companion on many malacological excursions abroad, and has been an inspirational support to my studies in the field.

***Carinapex albarnesi* n. sp.**

Plate 2, figs. 27-29, 43

Turridrupa papillosa.—Kuroda & Habe, 1952: 95.—Higo & Goto, 1993: 290.

Carinapex papillosa.—Zhenguo, 1995: 278, pl. 1, fig. 15.—Habe & Tuchiya, 1998: 23.—Higo & others, 1999: 307.—Chang & Wu, 1999: 64, fig. 10.—Chang, 2001a: 10, figs. 5a-d.—Chang & Thorsson, 2001: 8.—Thorsson & Chang, 2001: 192, 3 figs.—Chang & Wu, 2007: 6, fig. 1307A-D.



Image 5. *Carinapex albarnesi* n. sp., holotype

Type Material. Holotype LACM 3298, height 4.8 mm, width 2.0 mm.

Type Locality. Two hundred meters off northeast Mactan Island, Cebu Province, Philippines (10° 20' 4.45" N, 124° 2' 54.27" E) in tangle nets at 90-100 m.

Material Examined. Holotype [LACM 3298], (Pl. 2, figs. 27-29, 43) from Mactan Island, Cebu Province, Philippines (10° 20' 4.45" N, 124° 2' 54.27" E) in tangle nets at 90-100 m, February, 2007 [= SW07-70]; one specimen from Mactan Island, Cebu Province, Philippines in 100-250 m [SW09-33]; one specimen from 1 km southwest of Onna Village, Horseshoe South, Okinawa-jima, Okinawa-shoto, Ryukyu-shoto, Okinawa Prefecture (26° 30' N, 129°

50' E), in sand and coral rubble at 30 m, collected by R. F. Bolland, May 29, 1978 [LACM 1978-20].

Distribution. *Carinapex albarnesi* n. sp. is known from Japan (Kuroda & Habe, 1952; Higo & Goto, 1993; Habe & Tuchiya, 1998; Higo & others, 1999; here cited), Taiwan (Chang & Wu, 1999; Chang & Thorsson, 2001; Chang, 2001a; Thorsson & Chang, 2001; Thorsson & Chang & Wu, 2007) and the Philippines (here cited). Map insert (fig. 3) shows distribution of material recorded from the LACM and SW collections.



Figure 3. Distribution of *Carinapex albarnesi* n. sp.

Diagnosis. *Carinapex albarnesi* n. sp. is characterized by its very large size, spindle-like, rhomboid profile, brown banding, large, horizontally ovate, widely spaced nodules, apex large, wide, obtaining a total height of 0.5 mm (fig. 43).

Description. Shell spindle-like, very large for the genus, wide, somewhat rhomboid shaped, robust, white with dark caramel brown banding between nodules at suture, faintly at base, subtly between nodules at periphery. Protoconch wide, first protoconch whorl flatly domed, expanding widely outward, two proceeding whorls carinate, low in profile, final whorl with backward crescent forms above peripheral keel, protoconch height 0.5 mm. Five teleoconch whorls, two rows obese, horizontally ovate, opaque nodules, widely spaced, subsutural cord fine but heavy in last one-and-a-half whorls, final whorl with eight spiral cords under primary nodules on base anteriorly to siphonal canal, cords projecting out on final lip. Aperture ovate, elongate near anterior, sinus ill-defined, parietal callus moderate, projecting outward.

Discussion. *Carinapex albarnesi* n. sp. is unlike any other *Carinapex* species other than *C. papillosa* which is smaller, slender, with orange colored bands, apex acute, height of protoconch obtaining 0.3 mm, nodules compacted, moderate in size, horizontally dashed whereas *C. albarnesi* is very large, rhomboid shaped, with brown bands, apex wide, domed, height obtaining 0.5 mm, nodules widely spaced, obese.

Etymology. Named after friend Al Barnes, Long Beach, California who has been a fellow diver and is well versed in marine biology and has contributed greatly to my research on malacology. Al has also been a contributor to the Shawn Wiedrick collection and has donated a great deal of material that has been beneficial to my research and this paper.

***Carinapex papillosa* (Garrett, 1873) n. comb.**

Plate 2, fig. 24-26, 42

Drillia papillosa Garrett, 1873: 218, pl. 2, fig. 29. (Type locality: Viti Isles, Fiji).—Tryon 1884: 207, pl. 12, fig. 33.—Paetel, 1888: 68.—Bouge & Dautzenberg, 1914: 134.—Melvill, 1923: 166.—Dautzenberg & Bouge, 1933: 95.

Mangilia (Glyphostoma) dialitha.—Melvill & Standen, 1896: 287, pl. 9, fig. 26.—Melvill & Standen, 1897: 400.

Glyphostoma dialitha.—Bouge & Dautzenberg, 1914: 176.

Ceritoturris papillosa.—Tröndle & Boutet, 2009: 38.

Type Material. Holotype, Liti Levu, Fiji ANSP 15307, height 3.8 mm, width 1.4 mm (Pl. 2, figs. 24-26, 42).

Material Examined. One specimen from Olowalu, Maui, Hawai'i (20° 48.7' N, 156° 37.5' W) in 1.3-2 m, collected by T. Bratcher, January 25, 1972 [LACM 72-11]; one specimen from outer reef slope, north of Matavera, northeast side Rarotonga, Cook Islands (21° 12.7' S, 159° 43.5' W), in rubble at 18-26 m, collected by J. H. McLean, May 18, 1987 [LACM 87-81]; four specimens from outer reef slope, off Arutanga, west side Altutaki, Cook Islands, West Pacific (18° 52.3' S, 159° 47.5' W), in rubble and Halimeda at 18-26 m, collected by J. H. McLean & S. Zinn, May 12-13, 1987 [LACM 87-79]; one

specimen from Diamond seamount, east of Herald Pass, west of Ndravuni Island, inside Great Astrolabe Reef, Kadavu Group, Fiji ($18^{\circ} 45.8' S$, $178^{\circ} 28.3' E$), in 20-25 m, collected by T. Bratcher, June 19, 1991 [LACM 91-188].



Image 6. *Carinapex papillosa* (Garrett, 1873)

Distribution. *Carinapex papillosa* has been listed by various authors (Kuroda & Habe, 1952; Higo & Goto, 1993; Habe & Tuchiya, 1998; Higo & others, 1999; Tröndle & Boutet, 2009) without a figured specimen or a description leaving the exact range questionable. Based on examined *Carinapex* material and the assumption authors had compared specimens to the type specimen, or the original illustration, *C. papillosa* ranges from Fiji (Garrett, 1873), Cook Islands (here cited), French Polynesia (Tröndle & Boutet, 2009) and Hawai'i (here cited). Map insert (fig. 4) shows distribution of material recorded from the LACM and SW collections.

Diagnosis. *Carinapex papillosa* is characterized by its large size, slender spindle-like shape, three rows of tightly spaced, moderately sized, dash-like nodules on final two whorls.



Figure 4. Distribution of *Carinapex papillosa* (Garrett, 1873)

Description. Shell spindle-like, large for the genus, slender, elongate shaped, cream colored with faint, orange bands on suture, base and faintly between sutural nodules. Protoconch acute, narrow, first whorl domed, proceeding one half whorl subtly carinate, following one-and-a-half whorls with strong carination at periphery, final whorl carinate with strong reverse crescent shaped ribs on shoulder, carinate whorl profile 45° on upper portion, lower portion vertical, final carinate whorl terminated at 0.3 mm. Five to six teleoconch whorls, whorl profile elevated, first three whorls with two rows of equally sized, tightly spaced, horizontally ovate, opaque, medium sized, dash-like nodules, final two whorls with three nodulose rows, sutural and basal nodules of equal size. Final whorl with very faint subsutural cord, eight spiral cords on base under primary nodules, aperture ovate, elongate towards anterior end, parietal callus large, anteriorly projecting, sinus restricted.

Discussion. *Carinapex papillosa* (Garrett, 1873) is similar only to *Carinapex albarnesi* n. sp. in which both are spindle-like. *Carinapex papillosa* is large sized, with orange banding, apex acute, narrow, obtaining a height of 0.3 mm (fig. 42), whorl profile elevated at periphery, teleoconch whorls with two equal sized, tightly spaced dash-like nodules, final two whorls with three rows. *Carinapex albarnesi* n. sp. is very large sized, with brown banding, apex wide, first protoconch whorl flatly domed, wide slopes, obtaining a height of 0.5 mm (fig. 43), whorl profile low, sunken, whorls with two widely spaced, large, horizontally ovate nodule rows, sutural row less distinct, peripheral prominent. The description of *Mangilia (Glyphostoma) dialitha* (Melvill &

Standen, 1896) appears to be synonymous with *C. papillosa* based on the original description and with regards to the close proximity of the type locality. Kay (1979), Cernohorsky (1983), Sysoev in Poppe (2008), Cox & others (2009) and Severns (2011) all had inadvertently lumped various new species under the name *C. papillosa* without comparison to the known holotype of *C. papillosa*.

***Carinapex mooreorum* n. sp.**

Plate 2, figs. 39-41, 46



Image 7. *Carinapex mooreorum* n. sp., holotype

Type Material. Holotype, LACM 3291, height 2.1 mm, width 0.8 mm.

Type Locality. 'Anaeho'omalū Point, Kona North District, Hawai'i (19° 55' 3.28" N, 155° 53' 26.38" W) in tide pool rubble at -0.3 m.

Material Examined. Holotype [LACM 3291], (Pl. 2, figs. 39-41, 46) from 'Anaeho'omalū Point, Kona North District, Hawai'i in tide pool rubble at -0.3 m, collected by S. G. Wiedrick, August 7, 2009 [= SW09-17]; one paratype [LACM 3292] from steep coral slope, off Ajer (Gili Air) and Meno Islets, northwest side Lombok, Indonesia (8° 22' S, 116° 04' E) in rubble at 5-20 m, collected by J. H. McLean & H. W. Chaney, April 15, 1988 [= LACM 88-63].

Distribution. Known from the type locality, Hawai'i and Indonesia.

Diagnosis. *Carinapex mooreorum* n. sp. is characterized by its minute size, strong ribbing on convex teleoconch whorls, blunt apex, ovate aperture and final lip which bulges outward.

Description. Shell minute, elongate-ovate in shape, color cream-white. Initial protoconch whorl bluntly domed, proceeding one half whorl with subtle carination and faint densely spaced fine ribbing at base, proceeding two whorls with carination, thick, moderately spaced ribs on suture, fine, densely spaced ribbing on base. Three-and-a-half teleoconch whorls convexly inflated, thick subsutural cord throughout, first two-and-a-half whorls with six fine spiral cords crossing over robust, back turned ribs, generating a cancellate appearance, final whorl with twelve spiral cords. Aperture somewhat ovate, sinus constricted, parietal callus projecting slightly downward, profile of final lip strongly convex as with previous whorls.

Discussion. *Carinapex mooreorum* n. sp. is unlike other *Carinapex* species in that it is minute, has distinctly convex whorls and strong ribbing versus nodules represented in other *Carinapex* species and may prove to be a different genus. Additionally, the profile displays an extreme bulge in the final whorl which is only indicative of this species.

Etymology. Named after friends Kevin and Ashley Moore who reside in Fullerton, California and have hosted me in Hawai'i on several trips which have resulted in the discovery of this species.

***Carinapex minutissima* (Garrett, 1873)**

Plate 3, figs. 47-68

Drillia minutissima Garrett, 1873: 218, pl. 2, fig. 30. (Type locality: Viti Isles, Fiji).—Tryon 1884: 207, pl. 12, fig. 29.—Paetel, 1888: 66.—Bouge & Dautzenberg, 1914: 133.

Iredalea minutissima.—Hedley, 1922: 258.

Daphnobela (*Carinapex*) *minutissima*.—Dall, 1924: 88.

Zetekia (*Carinapex*) *minutissima*.—Wenz, 1943: 1447, fig. 4095.

Carinapex minutissima.—Powell, 1966: 15, fig. C75; 86, pl. 13, fig. 19.—Kay, 1979: 334, 344, fig. 112A, 112G, 114C & 115O.—Vermeij & others, 1983: 48.—Kay, 1990: 83.—Fukuda, 1994: 25, pl. 29, fig. 588.—Kurozumi & Asakura, 1994: 152.—Zhenguo, 1995: 277, pl. 1, fig. 14.—Habe & Tuchiya, 1998: 23.—Kohn, 1998: 848, fig. 15.174G.—Chang & Wu, 1999: 68, fig. 9.—Higo & others, 1999: 307.—Hasegawa & others *in* Okutani, 2000: 641, pl. 319, fig. 105.—Chang & Thorsson, 2001: 8.—Chang, 2001a: 9, fig. 4E.—Chang, 2001b: 206, fig. 19-5a.—Thorsson & Chang, 2001: 191, 4 figs.—Smith, 2003: 267.—Sasaki, 2008: 179.—Bandel & Dockery, 2012: 112.

Carinapex minutissimus.—Taylor, 1975: 431, pl. 72, figs. d-e.—Tröndle & Boutet, 2009: 38.—Thach, 2012: 159, pl. 99, fig. 1165.

Carinapex species 5.—Thorsson, 1997: 20-22.

Carinapex minutissime [*sic*].—Chang & Wu, 2007: 5, fig. 1306B.

Carinapex papillosa.—Cox & others, 2009: 17.

Carinapex sp. 1.—Severns, 2011: 386, pl. 176, fig. 1a & 1b.



Image 8. *Carinapex minutissima* (Garrett, 1873)

Type Material. Syntype, Liti Isles, Fiji ANSP 59232, height 2.2 mm, width 1.0 mm (Pl. 3, fig. 62-64, 68).

Type Locality. Liti Isles, Fiji.

Material Examined. 107 specimens from Jackson Reef, Strait of Tiran, south Sinai Peninsula, north Red Sea, Egypt (28° 01' N, 34° 28' E), in clean sand and coral at 2-3 m, collected by T. Bratcher [LACM 85-111]; 171 specimens from “Amphoras” dive site, off Ras Umm Sid, southeast side of Sinai Peninsula, Egypt (27° 52' N, 34° 20' E), in coral rubble at 18 m, collected by J. H. Golden, July 24, 1988 [LACM 88-119]; 53 specimens from Dunraven Reef, Strait of Tiran, south Sinai Peninsula, north Red Sea, Egypt (27° 12' N, 34° 06' E), in clean sand and coral at 25 m, collected by T. Bratcher, November 1, 1985 [LACM 85-112]; one specimen from steep coral slope, off Ajer (Gili Air) and Meno Islets, northwest side Lombok, Indonesia (8° 22' S, 116° 04' E) in rubble at 5-20 m, collected by J. H. McLean & H. W. Chaney, April 15, 1988 [LACM 88-63]; two specimens from outside reef, north end Mermaid Reef, Rowley Shoals, Western Australia (17° 03' S, 119° 36' E), in 18-20 m, collected by T. Bratcher, August 30, 1986 [LACM 86-250]; one specimen from Mactan Island, Cebu Province, Philippines in 90-100 m [SW07-70]; one specimen from Linapacan Island, Palawan Province, Philippines in 150 m [SW05-67]; two specimens from Aliguay Island, Zamboanga del Norte Province, Philippines in 91 m [SW07-72]; 49 specimens from Mactan Island, Cebu Province, Philippines in 100-250 m [SW09-33]; nine specimens from Mactan Island, Cebu Province, Philippines in 200-250 m [SW08-57]; 14 specimens from Horseshoe Cliffs, 1 km west northwest Onna Village, Okinawa, Okinawa-gunto, Japan (26° 29.6' N, 127° 50.5' E), in sand and coral rubble at 46-55 m, collected by R. F. Bolland, January 3, 1979 [LACM 79-75]; one specimen from east end of land strip, south side Maguro Atoll, Marshall Islands (7° 03.2' N, 171° 14.08' E), in coral and sand at 1 m, collected by P. Cross, January 15, 1990 [LACM 90-7]; three specimens from channel between Wongat Island, and barrier reef at Astrolabe Bay, Madang Province, Papua New Guinea (5° 08.1' S, 145° 50.7' E), in sand at 29-30 m, collected by T. Bratcher, September, 1, 1980 [LACM 80-26]; one specimen from Marion Reef, Coral Sea, off Great Barrier Reef, Queensland, Australia (19° 06' S, 152° 12' E), in 8-16 m, collected by A. J. Ferreira, M/V CORALITA [LACM 77-119]; five specimens from reef slopes

and exposed sand pockets, Matiu Island, Kokoana Passage, Marovo Lagoon, northeast side Vanguu Island, Solomon Islands (8° 29.8' S, 158° 12' E), in rubble at 20-25 m, collected by H. W. Chaney, March 22, 1989 [LACM 89-77]; two specimens from Diamond seamount, east of Herald Pass, west of Ndravuni Island, inside Great Astrolabe Reef, Kadavu Group, Fiji (18° 45.8' S, 178° 28.3' E), in 20-25 m, collected by T. Bratcher, June 19, 1991 [LACM 91-188]; one specimen from Leone Bay, Tutuila Island, American Samoa (14° 20.30' S, 170° 47.6' W), at 15.2 m, collected by G. Hendler, April 26, 1999 [LACM 99-89]; one specimen from outer reef slope, off Arutanga, west side Altutaki, Cook Islands, West Pacific (18° 52.3' S, 159° 47.5' W), in rubble and Halimeda at 18-26 m, collected by J. H. McLean & S. Zinn, May 12-13, 1987 [LACM 87-79]; two specimens from "Norwich City" locality, northwest of Nikumaroro Island, Phoenix Islands, Kiribati (4° 40.8' S, 174° 30.91' W), in 28.3 m, collected by M. J. Adams, R/V NAI'A, July 5, 2002 [LACM 2002-53]; 9 specimens from Prince Kuhio's Cove, Koloa District, Kaua'i, Hawai'i in 3-4 m, collected by S. G. Wiedrick [SW06-98]; 49 specimens from Ha'ena Point, Hanalei District, Kaua'i, Hawai'i (22° 13.77' N, 159° 33.5' W), in coral sand at 0-4.6 m, collected by L. Burns, November, 1990 [LACM 90-397]; 63 specimens from near Lighthouse, Lana'i, Hawai'i (20° 57' N, 157° 00' W), at 12-23 m, collected by T. Bratcher, September 4-5, 1974 [LACM 74-66]; 14 specimens from Kea'au Beach Park, Wai'anae District, O'ahu, Hawai'i (21° 00.4' N, 158° 14.6' W), in dead coral and sand at 5-23 m, collected by D. R. Shasky, October 2, 1986 [LACM 86-425]; 39 specimens from end of School Street, Kahului Harbor, Maui, Hawai'i (20° 53.68' N, 156° 28.50' W), in intertidal rocks and sand, collected by P. & B. LaFollette, April 28-May 3, 1984 [LACM 84-156]; 67 specimens from 'Anaeho'omalua Point, Kona North District, Hawai'i in 2-4 m, collected by S. G. Wiedrick [SW09-26]; 18 specimens from Kailua (Old Airport), Kona North District, Hawai'i in 7-11 m, collected by S. G. Wiedrick [SW09-25]; 19 specimens from Kailua (Old Airport), Kona North District, Hawai'i in 6-13 m, collected by S. G. Wiedrick [SW09-23]; 59 specimens from southern Kailua (Old Airport), Kona North District, Hawai'i in intertidal drift at low tide, collected by S. G.

Wiedrick [SW09-21]; 83 specimens from Sheraton Hotel, Keauhou Bay, Kona North District, Hawai'i in 9-13 m, collected by S. G. Wiedrick [SW09-20]; 33 specimens from 'Anaeho'omalua Point, Kona North District, Hawai'i in intertidal drift at low tide, collected by S. G. Wiedrick [SW09-17]; 77 specimens from Honokohau Harbor, Kona North District, Hawai'i in 8-29 m, collected by S. G. Wiedrick [SW09-19].

Distribution. The exact range of *Carinapex minutissima* (Garrett, 1873) is questionable based on authors who did not illustrate the specimens in question. The synonymy above is based on the assumption the authors compared specimens to the type specimen, or the original illustration and were not aware of another similar species, *Carinapex amirowlandae* n. sp. Records range from Gulf of Aqaba, Red Sea (Bandel & Dockery, 2012: 112); Indonesia (here cited), Australia (Hedley, 1922: 258; here cited), Palau (ANSP 283372), Philippines (Sysoev *in* Severns, 2011: 386; here cited), Vietnam (Thach, 2012), Taiwan (Chang & Wu, 1999; Chang & Thorsson, 2001; Chang, 2001a; Thorsson & Chang, 2001; Chang & Wu, 2007; here cited), Japan (Hasegawa & others *in* Okutani, 2000: 641; Higo & others, 1999: 307; here cited), Bonin Islands (Fukuda, 1994: 25), Guam (Smith, 2003), Marshall Islands (Kay, 1990; here cited), Papua New Guinea (here cited), Queensland, Australia (here cited), New Caledonia (Kay, 1979:344), Solomon Islands (here cited), Fiji (Garrett, 1873; here cited), American Samoa (here cited), Cook Islands (here cited), French Polynesia (Tröndlé & Boutet, 2009: 38), Kiribati (here cited) to Hawai'i (Taylor, 1975: 431; Kay, 1979: 344; Severns, 2011: 386; Chang, 2001a: 9; Chang, 2001b: 206; Thorsson & Chang, 2001: 191; here cited). Map insert (fig. 5) shows distribution of material recorded from the LACM and SW collections.

Diagnosis. *Carinapex minutissima* (Garrett, 1873), is characterized by its small size, on average, in comparison to its allied *C. amirowlandae* n. sp. Protoconch of *C. minutissima* with one-and-a-half translucent white whorls, proceeding whorls brown, profile low, proceeding three protoconch whorls with low carination, teleoconch whorls with two

rows of tightly spaced rows of nodules, four spiral cords on final whorl of siphonal canal.

Description. Shell small to medium sized at maturity, shape ovate pupoid, narrow, color red-brown, occasionally with faint blotch on dorsal side of final whorl. Apex low profile, four protoconch whorls, first one to one-and-a-half whorls translucent white, small, compact round bulbous, proceeding three whorls red-brown with low carinate keel, finely beaded, upper section of final whorl with backward crescent shaped ribs. Three-and-a-half to four teleoconch whorls with two rows of tightly spaced, relatively close in sized nodules, sculpture somewhat clathrate, final whorl with very subtle ribs, beaded row at base, four cords on siphonal canal. Aperture very small, slender, ovate, about one fourth the height of shell, parietal callus very large, projecting outward, sinus extremely restricted, nearly sealed.

Discussion. *Carinapex minutissima* (Garrett, 1873) is a very wide spread Indo-Pacific species in the genus, with records from the Red Sea to the Hawaiian Islands. After studying 118 lots from the LACM and SW collections, which included over 3080 specimens, it was concluded that there were two distinct species from the Indo-Pacific. It was also concluded that specimens from the Hawaiian Islands and the Red Sea proved that populations were ample and void of the new, similar species *Carinapex amirowlandae* n. sp. The omission of figured *Carinapex* specimens in Cox & others (2009) brings to question the authenticity of the identification of the proposed two species *Carinapex minutissima* and *C. papillosa* with regards to the numbers recorded in the table provided. On the account of *C. minutissima*, the extremely low record of this species in comparison to a relatively abundant *C. papillosa* does not seem plausible according to personal observations from material observed from Hawai'i, Maui, O'ahu and Kaua'i. It is speculated and here cited in the synonymy above, and for *C. lindseygrovesi* n. sp. below, that both were incorrectly identified and reversed in the table published by Cox & others (2009). The apex of the *C. minutissima* holotype is worn and has a chalky appearance. Specimens in fine condition from

throughout the Indo-Pacific, and especially from near the type locality (Fiji), match the holotype well and show the very small initial white protoconch whorl.

***Carinapex alisonkayae* n. sp.**

Plate 4, figs. 69-71, 87

Carinapex papillosa.—Kay, 1979: 344, fig. 115P.



Image 9. *Carinapex alisonkayae* n. sp., holotype

Type Material. Holotype, LACM 3297, height 2.7 mm, width 1.2 mm.

Type Locality. Honokohau Harbor, Kona North District, Hawai'i (19° 40' 3.18" N, 156° 1' 48.91" W) by hand dredge in 8-29 m.

Material Examined. Holotype [LACM 3297], (Pl. 4, figs. 69-71, 87); five specimens from Honokohau Harbor, Kona North District, Hawai'i, taken by hand dredge in 8-29 m, collected by S. G. Wiedrick, August 4, 2009 [= SW09-19]; one specimen from Kailua (Old Airport), Kona North District, Hawai'i, taken by hand dredge in 6-13 m, collected by S. G. Wiedrick, August 5, 2009 [SW09-23]; one specimen from 'Anaeho'omalau Point, Kona North District, Hawai'i taken by hand dredge in 3-4 m, collected by S. G. Wiedrick, August 7, 2009 [SW09-26]; two

specimens from Ma'alaea Bay, Maui, Hawai'i (20° 46' N, 156° 30' W), taken on pen shell beds and coral reef at 12-20 m, collected by T. Bratcher, July 17-20, 1975 [LACM 75-64]; one specimen from near Lighthouse, Lana'i, Hawai'i, (20° 57' N, 157° 00' W) at 12-23 m, collected by T. Bratcher, September 4-5, 1974 [LACM 74-66]; one specimen from Ha'ena Point, Hanalei District, Kaua'i, Hawai'i (22° 13.77' N, 159° 33.5' W), in coral sand at 0.0-4.6 m, collected by L. Burns, November, 1990 [LACM 90-397]; four specimens from Leone Bay, Tutuila Island, American Samoa (14° 20.30' S, 170° 47.6' W), at 15.2 m, collected by G. Hendler, April 26, 1999 [LACM 99-89]; one specimen from outside of lagoon, north side Nuapapu Island, Vava'a Group, Tonga (18° 42' S, 174° 06' W), in coral sand at 30 m, collected by A. J. Ferreira, July 27, 1985 [LACM 85-89]; one specimen from steep coral slope, south side Bunaken and Siladen Islets, off Manado, north Sulawesi, Indonesia (1° 36.2' N, 124° 46.0' E), in rubble at 5-20 m, collected by J. H. McLean, April, 9-10, 1988 [LACM 88-55]; 3 specimens from Horseshoe Cliffs, 1 km west northwest Onna Village, Okinawa, Okinawa-gunto, Japan (26° 29.6' N, 127° 50.5' E), in sand and coral rubble at 46-55 m, collected by R. F. Bolland, January 3, 1979 [LACM 79-75]; four specimens from Dunraven Reef, Strait of Tiran, south Sinai Peninsula, northern Red Sea, Egypt (27° 12' N, 34° 06' E), in clean sand and coral at 25m, collected by T. Bratcher, November 1, 1985 [LACM 85-112].

Distribution. Records from the Red Sea, Indonesia, Japan, Hawaiian Islands, American Samoa and Tonga. Map insert (fig. 6) shows distribution of material recorded from the LACM and SW collections.



Figure 6. Distribution of *Carinapex alisonkayae* n. sp.

Diagnosis. *Carinapex alisonkayae* n. sp. is characterized by its small size, somewhat rhomboid shape, strongly projecting nodules and outward projecting callus.

Description. Shell small, somewhat rhomboid shaped, color white to cream, faint orange tint on callus and base of final lip. Protoconch relatively acute in profile, first whorl bulbous, sunken into proceeding whorl, second whorl carinate with fine ribs on base, continuously through third and fourth protoconch whorls. Three-and-a-half teleoconch whorls, first one-and-a-half teleoconch whorls with two rows of widely spaced, projecting nodules, peripheral row strongest, remaining one half row subtly showing third row of nodules at base, final whorl with two rows of projecting nodules followed by four rows of spiral cords, faintly nodulose, continued with three strong cords on base of siphonal canal. Aperture elongate, sinus somewhat open, parietal callus projecting outward.

Discussion. The small sized *Carinapex alisonkayae* n. sp. is unlike any other species. The species appears to be widespread in the Indo-Pacific but is not frequently encountered like *C. minutissima* (Garrett, 1873) and *C. amirowlandae* n. sp. Kay (1979: 344) figured a specimen as *C. papillosa* which appears to be identical to the holotype.

Etymology. Named after the late E. Alison Kay whose contributions to the Hawaiian malacology has greatly improved our understanding of the fauna from this region.

***Carinapex philippinensis* n. sp.**

Plate 2, figs. 30-35, 44

Carinapex sp. 2.—Severns, 2011: 386, fig. 4.

Type Material. Holotype, LACM 3295, height 3.5 mm, width 1.4 mm.

Type Locality. Linapacan Island, Palawan Province, Philippines (11° 29'0.12" N, 119° 50'13.82" E) in tangle nets at 150 m.



Image 10. *Carinapex philippinensis* n. sp., holotype

Material Examined. Holotype [LACM 3295], (Pl. 2, figs. 30-32, 44); 64 specimens from Linapacan Island, Palawan Province, Philippines in tangle nets at 150 m, April, 2005 [= SW05-67]; 28 specimens from Mactan Island, Cebu Province, Philippines in 90-100 m [SW07-70]; three specimens from Bantayan Island, Cebu Province, Philippines in 80-100 m [SW05-68]; one specimens from Bataan Island, Bataan Province, Philippines in 10-15 m [SW06-115]; five specimens from Aliguay Island, Zamboanga del Norte Province, Philippines in 91 m [SW07-72]; 56 specimens from Mactan Island, Cebu Province, Philippines in 100-250 m [SW09-33]; nine specimens from Mactan Island, Cebu Province, Philippines in 200-250 m [SW08-57]; one specimen from Horseshoe cliffs, 1 km west northwest of Onna Village, Okinawa-jima, Okinawa-shoto, Ryukyushoto, Okinawa Prefecture, Japan (26° 29.6' N, 127° 50.5' E), collected by R. F. Bolland, November 12, 1978 [LACM 78-101]; one specimen from Diamond seamount, east of Herald Pass, west of Ndravuni Island, inside Great Astrolabe Reef, Kadavu Group, Fiji (18° 45.8' S, 178° 28.3' E), in 20-25 m, collected by T. Bratcher, June 19, 1991 [LACM 91-188]; one specimen from Leone Bay, Tutuila Island, American Samoa (14° 20.3' S, 170° 47.06' W) in 15.2 m, collected by G. Hendler, April 26, 1999 [LACM 99-89].

Distribution. Records from Japan, Philippines, Fiji, American Samoa and Makena Bay, Maui, Hawai'i (from Severns, 2011: 386). Map insert (fig. 7) shows distribution of material recorded from the LACM and SW collections.



Figure 7. Distribution of *Carinapex philippinensis* n. sp.

Diagnosis. *Carinapex philippinensis* n. sp. is characterized by its medium size, elongate profile, large, round, widely spaced, projecting nodules on periphery, strong spiral cords on base of final whorl.

Description. Shell medium sized, elongate, color light reddish brown with tan band on periphery. First whorl of protoconch bulbously domed, transparent, sunken into second whorl, both smooth, proceeding whorl carinate at periphery, shoulder somewhat tabulate, base nearly vertical, subsequent one half whorl similar, base indented near suture of proceeding whorl. Four-and-a-half teleoconch whorls with translucent nodules, first whorl with two rows of nodules, peripheral row strong, projecting outward, sutural row weak, following two-and-a-half whorls with three nodule rows, peripheral strong, projecting outward, sutural and basal rows weak. Last whorl with weak sutural row, two peripheral rows, lower one somewhat cord-like, seven spiral cords on base of siphonal canal cords, slightly beaded near periphery. Aperture ovate, elongate at anterior end, sinus slightly restricted, parietal callus relatively small, downward pointed.

Discussion. The figured specimen of *Carinapex* sp. 2, from Hawai'i, by Severns (2011) exhibits more closely set nodules but otherwise are conspecific. *Carinapex philippinensis* is unlike other species in the genus by its medium size, slender, ovate profile,

projecting peripheral nodules, profile concavely sloping from nodule to suture and continuing concavely to next whorl nodule.

Etymology. Named after the Philippine Islands as this is where the majority of the samples have been recorded.

***Carinapex amirowlandae* n. sp.**

Plate 4, Figures 72-83, 88-89

Carinapex minutissima.—Chang & Wu, 1999: 64, fig. 7.—Chang, 2001a: 8, fig. 4.

Carinapex minutissimus.—Sysoev in Poppe, 2008: 762, fig. 3 & 4.

Carinapex minutissime [sic].—Chang & Wu, 2007: 5, fig. 1306A.



Image 11. *Carinapex amirowlandae* n. sp., holotype

Type Material. Holotype LACM 3301, height 3.1 mm, width 1.2 mm.

Type Locality. North central Punta Engano, Mactan Island, Cebu Province, Philippines (10° 19' 29.14" N, 124° 1' 45.77" E) in tangle nets at 100-250 m.



Figure 8.

- Exclusively *Carinapex amirowlandae* in relation to *C. minutissima* n. sp.
- 50-99% *Carinapex amirowlandae* in relation to *C. minutissima* n. sp.
- 25-49% *Carinapex amirowlandae* in relation to *C. minutissima* n. sp.
- 1-24% *Carinapex amirowlandae* in relation to *C. minutissima* n. sp.

Material Examined. Holotype [LACM 3301], (Pl. 4, figs. 75-77, 88); 965 specimens from Mactan Island, Cebu Province, Philippines, in tangle nets at 100-250 m, January 2009 [= SW09-33]; two specimens from Hellville, south side Nosy Be, Antseranana Province, Madagascar, (13° 27' S, 48° 15' E) near coral heads and gorgonians at 14 m, collected by J. H. McLean, April 15, 1989 [LACM 89-55]; four specimens from steep coral slope, off Ajer (Gili Air) and Meno Islets, northwest side Lombok, Indonesia (8° 22' S, 116° 04' E) in rubble at 5-20 m, collected by J. H. McLean & H. W. Chaney, April 15, 1988 [LACM 88-63]; one specimen from outside reef, north end Mermaid Reef, Rowley Shoals, Western Australia (17° 03' S, 119° 36' E), in 18-20 m, collected by T. Bratcher, August 30, 1986 [LACM 86-250]; three specimens from between Culebra Island and Malajiboomanoc Island, east of Maricaban Island, Batangas Province, Luzon, Philippines (13° 37.8' N, 121° 57.4' E), in coral and rock bottom at 15-20 m, collected by T. Bratcher, January 11, 1984 [LACM 84-162]; three specimens from Cavile Reef, out of Puerto Princessa, Palawan, Philippines (9° 43' N, 118° 47' E), in intertidal sand and rocks, collected by T. Bratcher, June 1982 [LACM 82-62]; 27 specimens from Mactan Island, Cebu Province, Philippines in 90-100 m [SW07-70]; 52 specimens from Linapacan Island, Palawan Province, Philippines in 150 m [SW05-67]; six specimen from Olango Island, Cebu Province, Philippines in 25-45 m [SW07-71]; four specimens from Bantanyan Island, Cebu Province, Philippines in 80-100 m [SW05-68]; two specimens from Bataan Island, Bataan Province, Philippines in 10-15

m [SW06-115]; eight specimens from Aliguay Island, Zamboanga del Norte Province, Philippines in 91 m [SW07-72]; 164 specimens from Mactan Island, Cebu Province, Philippines in 200-250 m [SW08-57]; one specimen from southeast side Pitou Chiao (=Pitou Nankow), east of Chi-lung (=Keelung), Taipei County, Taiwan (25° 08.0' N, 121° 55.0' E), in rocky intertidal tide pool at 3 m, collected by C. C. Coney and P. F. Liu, May 10, 1988 [LACM 88-80]; 11 specimens from Horseshoe Cliffs, 1 km west northwest Onna Village, Okinawa, Okinawa-gunto, Japan (26° 29.6' N, 127° 50.5' E), in sand and coral rubble at 46-55 m, collected by R. F. Bolland, January 3, 1979 [LACM 79-75]; three specimens from channel between Wongat Island, and barrier reef at Astrolabe Bay, Madang Province, Papua New Guinea (5° 08.1' S, 145° 50.7' E), in sand at 29-30 m, collected by T. Bratcher, September, 1, 1980 [LACM 80-26]; 12 specimens from reef slopes and exposed sand pockets, Matiu Island, Kokoana Passage, Marovo Lagoon, northeast side Vangunu Island, Solomon Islands (8° 29.8' S, 158° 12' E), in rubble at 20-25 m, collected by H. W. Chaney, March 22, 1989 [LACM 89-77]; two specimens from Diamond seamount, east of Herald Pass, west of Ndravuni Island, inside Great Astrolabe Reef, Kadavu Group, Fiji (18° 45.8' S, 178° 28.3' E), in 20-25 m, collected by T. Bratcher, June 19, 1991 [LACM 91-188]; eight specimens from outer reef slope, off Arutanga, west side Altutaki, Cook Islands, West Pacific (18° 52.3' S, 159° 47.5' W), in rubble and Halimeda at 18-26 m, collected by J. H. McLean & S. Zinn, May 12-13, 1987 [LACM 87-79]; 11 specimens from outside reef off Point Hauru (Tehau), Moorea, Society Islands, (17° 29.1' S, 149° 55.2' W), in 18-24 m, collected by D. R. Shasky, July 25-August 5, 1977 [LACM 77-114]; one specimen from Ahe Atoll, Tuamotu Archipelago, French Polynesia (14° 28' S, 146° 22' W), in 1 m, collected by D. E. Koontz, yacht "Constitution", October 14-15, 1973 [LACM 73-94].

Distribution. Records range from Madagascar (here cited), Indonesia (here cited), Australia (here cited), Philippines (Sysoev *in* Poppe, 2008: 762; here cited), Taiwan (Chang & Wu, 1999; Chang, 2001a; Chang & Wu, 2007; here cited), Japan (here cited), Papua New Guinea (here cited), Solomon Islands (here

cited), Fiji (Garrett, 1873; here cited), Cook Islands (here cited), Society Islands (here cited) and French Polynesia (here cited). Map insert (fig. 8) shows distribution of material recorded from the LACM and SW collections.

Diagnosis. *Carinapex amirowlandae* n. sp. is characterized by its tall, somewhat erect apex, symmetrical, elevated keel, peripheral nodules of teleoconch whorls, widely spaced, robust, heavy ribs on final whorl, white blotch on dorsal side of final whorl, dark brown band below, three spiral cords on siphonal canal.

Description. Shell medium sized, seldomly small or minute specimens occur, shape elongate, ovate, sturdy, squat, color light brown to peach, distinct light tan or cream blotch on dorsal side of final whorl, followed below by a dark patch on base. Apex profile tall, acute, somewhat erect, symmetrical, steep angle, about 0.5 mm height, four translucent protoconch whorls, first two whorls large, wide, bulbously domed, brown, proceeding two whorls light with elevated carinate finely beaded cord, low, projecting. Four teleoconch whorls with two rows of widely spaced, large nodules, peripheral row larger, final row with strong ribs, beaded row at base, three spiral cords on siphonal canal. Aperture ovate, one third the length of shell, parietal callus large, sinus slightly restricted, anterior canal twisted outward, siphonal canal long.

Discussion. *Carinapex minutissima* (Garrett, 1873) is historically known as the most widely spread Indo-Pacific species in the genus, with records from Madagascar (here cited) east to Japan through the Pacific to French Polynesia, but no records from Hawai'i. Records of *C. amirowlandae* n. sp. range throughout the Indo-Pacific but there is no evidence the species exists in the Hawaiian Islands. As previously mentioned, it is speculated Cox & others (2009) misidentified *Carinapex papillosa* (Garrett, 1873) and it was described above as *Carinapex lindseygrovesi* n. sp. As for the name *C. minutissima*, it appears the name was used as a substitute to the species described above now known as *Carinapex amirowlandae* n. sp. Hawaiian *Carinapex* material studied appears to support the hypothesis that Cox & others (2009) inadvertently

reversed the numbers in the table according to trends in frequency of occurrence within the Hawaiian Island chain. *Carinapex minutissima* is similar in general appearance to *C. amirowlandae* n. sp. and can be readily separated by an analysis of the average sizes, differing protoconchs, coloration, sculptural differences and general shape. Despite morphological features, distribution records indicate a correspondence between *C. minutissima* and *C. amirowlandae* n. sp. although their respective ranges don't completely overlap and the species is absent from some extreme ends of the range.

Etymology. Named after the uniquely charismatic and powerful friend and work supervisor, Ami Rowland, Irvine, California, whose inspirational support and flexibility enabled the ability for much material to be collected and processed during a three week excursion to O'ahu, Maui and Kaua'i (Hawaiian Islands) that revealed a variety of research material which heavily contributed to the completion of this paper.

***Carinapex lindseygrovesi* n. sp.**

Plate 4, figs. 84-86, 90

Carinapex minutissima.—Thorsson, 1997: 16-19, 23.—Chang & Wu, 1999: 64, fig. 8.—Chang, 2001a: 9, figs. 4b-d.—Chang, 2001b: 206, fig. 19-5b.—Severns, 2011: 386, pl. 176, figs. 3a-b.

Carinapex minutissima.—Cox & others, 2009: 17.

Type Material. Holotype, LACM 3299, height 3.3 mm, width 1.3 mm.

Type Locality. Near Lighthouse, Lana'i, Hawai'i (20° 57' N, 157° 00' W) at 12-23 m.

Material Examined. Holotype [LACM 3299], (Pl. 4, figs. 84-86, 90); seven paratypes LACM 3300 from near Lighthouse, Lana'i, Hawai'i, (20° 57' N, 157° 00' W) at 12-23 m, collected by T. Bratcher, September 4-5, 1974 [= LACM 74-66]; three specimens from Kea'au Beach Park, Wai'anae District, O'ahu, Hawai'i in dead coral and sand at 5-23 m, collected by D. R. Shasky, October 2, 1986 [LACM 86-425]; one specimen from 'Anaeho'omalu Point, Kona North District,

Hawai'i in 3-4 m, collected by S. G. Wiedrick [SW09-26];



Image 12. *Carinapex lindseygrovesi* n. sp., holotype

two specimens from 'Anaeho'omalu Point, Kohala District, Hawai'i in intertidal drift at low tide, collected by S. G. Wiedrick [SW09-17]; five specimens from Kailua (Old Airport), Kona North District, Hawai'i in 6-13 m, collected by S. G. Wiedrick [SW09-23]; four specimens from Sheraton Hotel, Keauhou Bay, Kona North District, Hawai'i in 9-13 m, collected by S. G. Wiedrick [SW09-20]; ten specimens from Honokohau Harbor, Kona North District, Hawai'i in 8-29 m, collected by S. G. Wiedrick [SW09-19]; two specimens from northwest end of Lana'i, Hawai'i, (20° 55' N, 157° 03' W) at 18 m, collected by T. Bratcher, September 6, 1974 [LACM74-67]; one specimen from off Molokini Island, south side Maui, Hawai'i (20° 38' N, 156° 30' W) at 12.5 m, collected by A. Tiedeman, August, 1959 [LACM59-16]; one specimen from Prince Kuhio's Cove, Koloa District, Kaua'i, Hawai'i in 3-4 m, collected by S. G. Wiedrick [SW06-98]; three specimens from Welles Harbor, off west side Sand Island, Midway Islands (28° 12.5' N, 177° 24.3' W) under dead coral at 2-8 m, collected by D. R. Shasky, October 4, 1985 [LACM85-117].

Distribution. *Carinapex lindseygrovesi* n. sp. is known to inhabit the Hawaiian Island chain and Midway Atoll.

Diagnosis. *Carinapex lindseygrovesi* n. sp. is characterized by its moderately large size, flattened apex, projecting to one side, large, widely spaced nodules, dark chocolate brown color and elongate aperture.

Description. Shell moderately large sized, slender, elongate-oblong shaped, turreted, color dark chocolate brown, protoconch orange-brown colored, large orange-brown blotch on periphery of dorsal side on final whorl. Color lighter in worn specimens. First whorl of protoconch domed, flattened, distorted to one side, sunken into second whorl, proceeding two whorls carinate at periphery, shoulder with strong, well spaced backward crescent shaped ribs, base with tightly condensed ribs. Four to four-and-a-half teleoconch whorls with two rows of large, widely spaced nodules at suture and periphery, sutural row weaker, final whorl with four rows of cords creating nodules resembling ribs, four strong, beaded cords below larger rows, descending anteriorly down siphonal canal. Aperture elongate, sinus restricted, parietal callus strong and projecting downward.

Discussion. *Carinapex lindseygrovesi* n. sp. is distinguished by its moderately large size, dark coloration, round, well spaced, large sized nodules, protoconch large, general profile wide and tall, first whorl domed, flattened, distorted to one side, angulate thereafter, subtly ornamented. Although in color, *C. chaneyi* n. sp. and *C. lindseygrovesi* n. sp., have great similarities, *C. chaneyi* n. sp. is squat, pupoid, protoconch, acute, erect with round, tightly spaced, large sized nodules on teleoconch whorls. *C. lindseygrovesi* n. sp. has erroneously been identified by authors Thorsson (1997), Chang & Wu (1999), Chang (2001a; 2001b), Severns (2011) as *C. minutissima* (Garrett, 1873). Superficially, *C. minutissima*, *C. lindseygrovesi* n. sp. and *C. amirowlandae* n. sp. all appear to be similar with little differences. As pointed out by Thorsson (1997), the two Hawaiian species can readily be separated upon close inspection. This is a result of *C. minutissima* having drastically different

morphological features than that of *C. lindseygrovesi* n. sp. In contrast, *C. lindseygrovesi* n. sp. and *C. amirowlandae* n. sp. share some similarities and are separable by their protoconchs, color and general shape. Cox & others (2009) did not figure *Carinapex papillosa* (Garrett, 1873) rather provided the name in a table. It is hypothesized that this species recorded is actually the same species described as *Carinapex lindseygrovesi* n. sp. due to the few specimens reported and common trends within over 100 Hawaiian *Carinapex* lots observed. *C. papillosa* is known from only one Hawaiian specimen and is extremely rare in comparison to *C. lindseygrovesi*. The abundance of *C. minutissima* and scarcity of *C. lindseygrovesi* n. sp. allows me to conclude it is very likely that Cox & others (2009) reversed the numbers in the table provided. Hawaiian *Carinapex* material researched by myself supports this conclusion.

Etymology. Named after malacologist/paleontologist Lindsey T. Groves, Collections Manager of Malacology (LACM) and who has contributed to the science of malacology and paleontology in addition to my personal growth in the field.

ACKNOWLEDGMENTS

I thank Lindsey T. Groves (LACM) for his permission to study specimens and relevant literature at LACM in addition to his exhaustive efforts to locate essential literature and his helpful criticism which has greatly improved this paper. I am also grateful to LACM Chief Librarian, Richard Hulser who assisted in the Inter-Library Loan of some much needed literature and Daniel Geiger (Santa Barbara Museum of Natural History) for his assistance in some literature pagination.

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(Plates 1 through 4 follow)

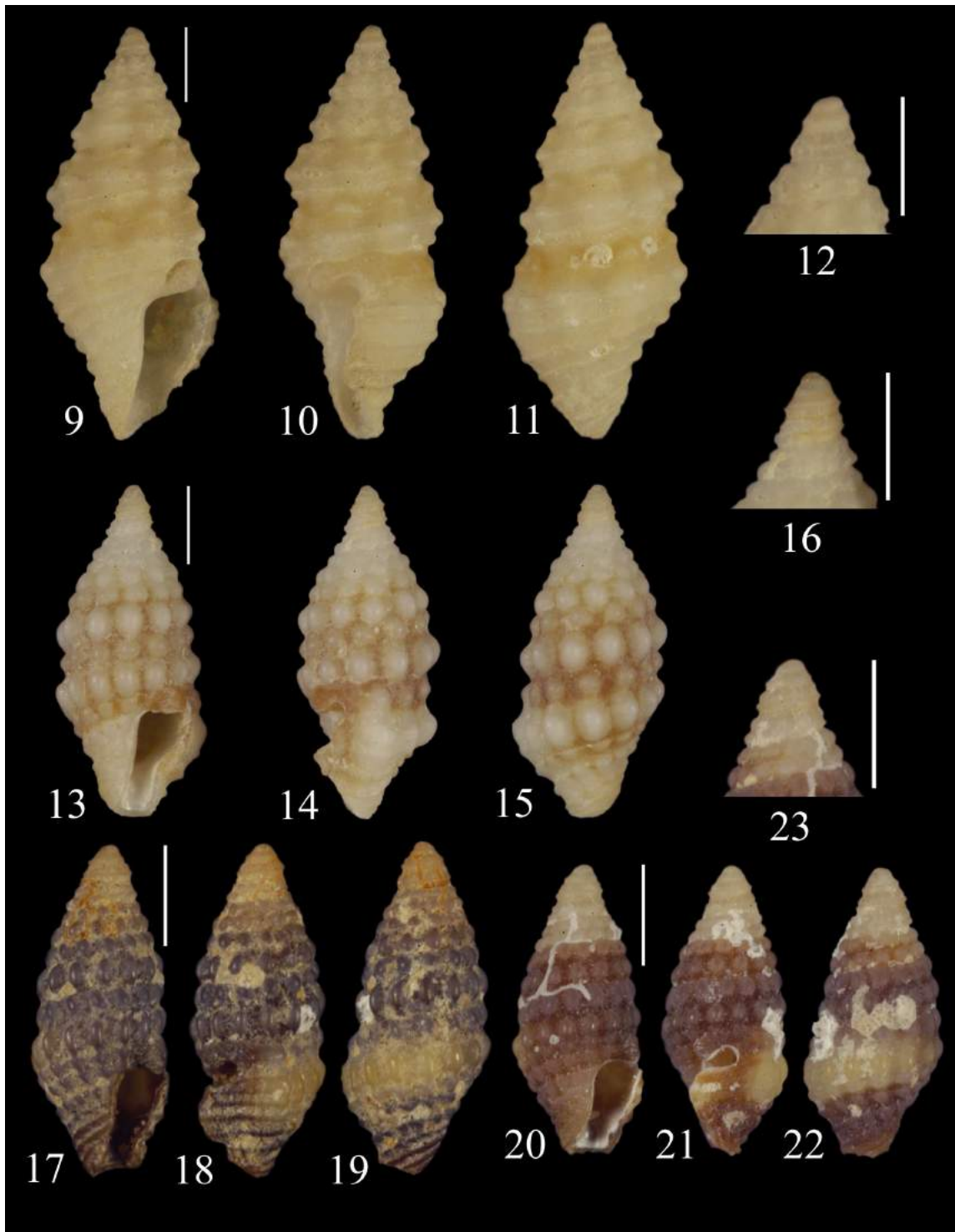


Plate 1, Figures 9-23. 9-12. *Carinapex solomonensis* n. sp., Kicha Island, Solomon Islands, holotype [LACM 3290], 15-20 m [9-11. Height 5.5 mm, width 2.4 mm, 12. Protoconch, scale bar = 1 mm]. 13-16. *Carinapex cernohorskyi* n. sp. west Tsuken-jima, Okinawa, Japan, holotype [LACM 3294], 18 m [13-15. Height 4.2 mm, width 1.9 mm, 16. Protoconch, scale bar = 1 mm]. 17-19. *Carinapex chaneyi* n. sp., Mactan Island, Cebu Province, Philippines, [SW09-33], 100-250 m, height 3.3 mm, width 1.4 mm, scale bar = 1 mm. 20-23. *Carinapex chaneyi* n. sp., Karunjou Island, Solomon Islands, holotype [LACM 3293], 20-25 m [20-22. Height 2.8 mm, width 1.3 mm, 23. Protoconch, scale bar = 1 mm].

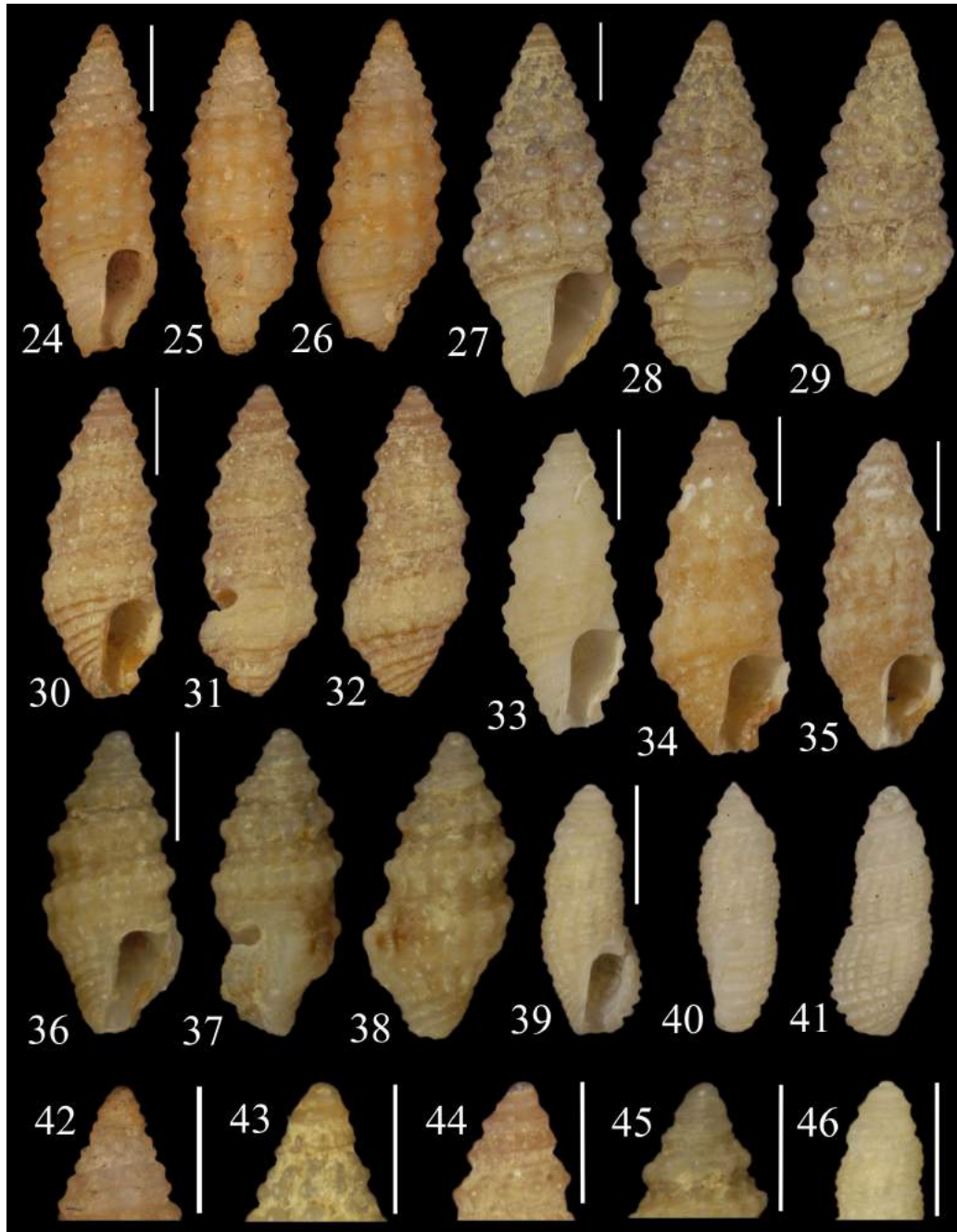


Plate 2, Figures 24-46. 24-26, 42. *Carinapex papillosa* (Garrett, 1873), Liti Isles, Fiji, holotype [ANSP15307]. 24-26. height 3.8 mm, width 1.4 mm, 42. Protoconch, scale bar = 1 mm. 27-29, 43. *Carinapex albarnesi* n. sp. Mactan Island, Philippines, holotype [LACM 3298], 90-100 m, [27-29. Height 4.8 mm, width 2.0 mm, 43. Protoconch, scale bar = 1 mm]. 30-32, 44. *Carinapex philippensis* n. sp., Linapacan Island, Philippines, holotype [LACM 3295], 150 m, [30-32. Height 3.5 mm, width 1.4 mm, 44. Protoconch, scale bar = 1 mm]. 33. *Carinapex philippinensis* n. sp., Horseshoe Cliffs, Okinawa, Japan, [LACM 78-101] 58 m, height 3.4 mm, width 1.3 mm. 34. *Carinapex philippensis* n. sp., Diamond seamount, Great Astrolabe Reef, Fiji, [LACM 91-188] 20-25 m, height 3.7 mm, width 1.5 mm. 35. *Carinapex philippensis* n. sp., Tutuila Island, American Samoa, [LACM 99-89] 15.2 m, height 3.5 mm, width 1.4 mm. 36-38, 45. *Carinapex johnwiedricki* n. sp., Mactan Island, Cebu Province, Philippines, holotype [LACM 3296], in tangle nets at 200-250 m, [36-38. Height 2.7 mm, 1.2 mm, 45. Protoconch, scale bar = 1 mm]. 39-41, 46. *Carinapex moorei* n. sp., 'Anaeho'omalū Bay, Hawai'i, holotype [LACM 3291], in beach drift, [39-41. Height 2.1 mm, width 0.8 mm, 46. Protoconch, scale bar = 1 mm].

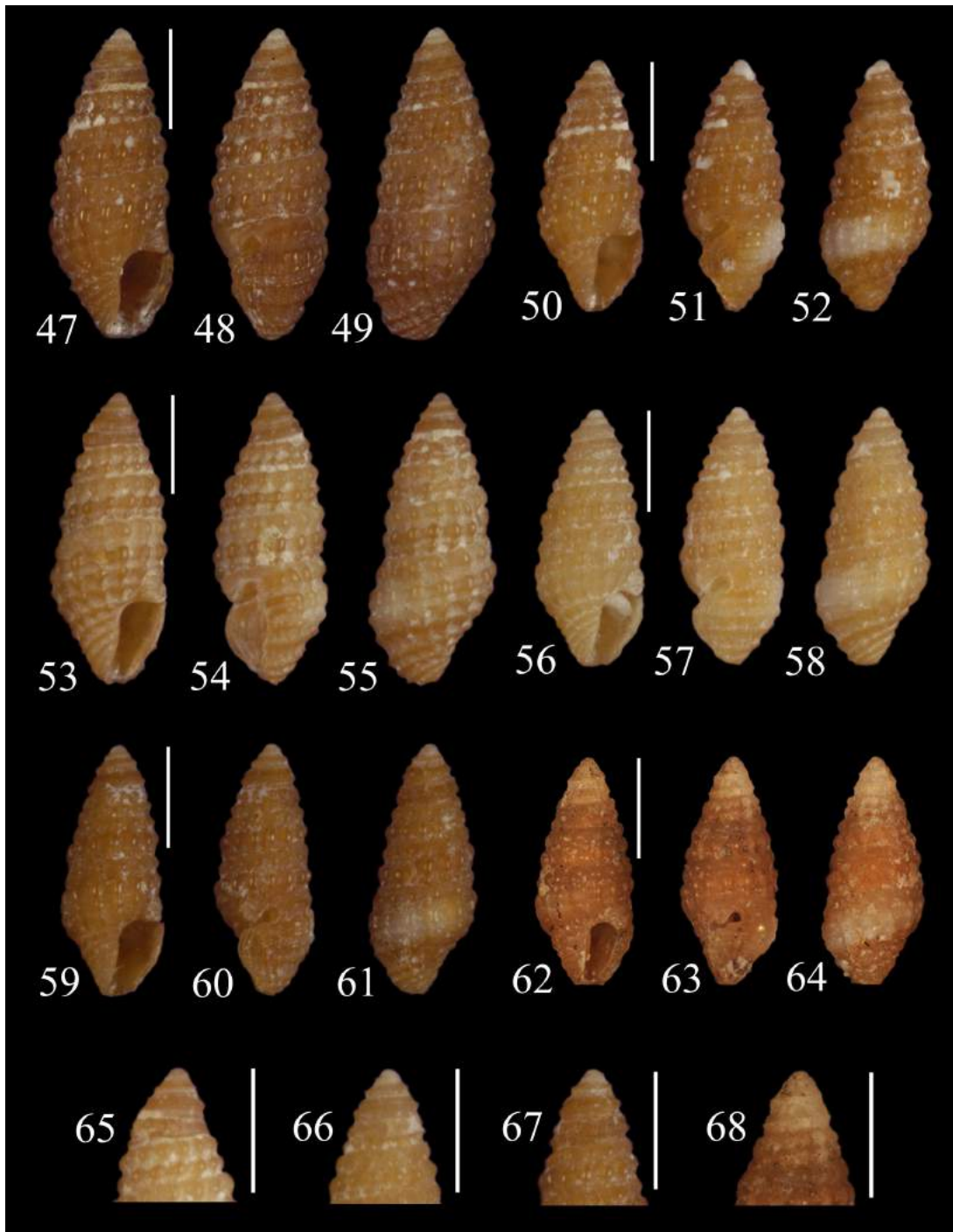


Plate 3, Figures 47-68. 47-49. *Carinapex minutissima* (Garrett, 1873), 'Anaeho'omalu Bay, Kona North District, Hawai'i, [SW09-26], 2-4 m, height 3.1 mm, width 1.2 mm, scale bar = 1 mm. 50-52. *Carinapex minutissima*, Nikumaroro Island, Phoenix Islands, Kiribati, [LACM 2002-53] 28.3 m, height 2.5 mm, width 1.1 mm, scale bar = 1 mm. 53-55, 65. *Carinapex minutissima*, Pitou Nankow, Taipei County, Taiwan, [LACM 88-80], 0-3 m [53-55. Height 2.9 mm, width 1.2 mm. 65. Protoconch, scale bar = 1 mm]. 56-58, 66. *Carinapex minutissima*, Mermaid Reef, Western Australia, [LACM 86-250], 18-20 m. [56-58. Height 2.6 mm, width 1.1 mm. 66. Protoconch, scale bar = 1 mm]. 59-61, 67. *Carinapex minutissima*, Coral Gardens, N. Red Sea, Egypt, [LACM 85-114], 10-15 m [59-61. Height 2.5 mm, width 1.0 mm. 67. Protoconch, scale bar = 1 mm]. 62-64, 68. *Carinapex minutissima* (Garrett, 1873), Liti Isles, Fiji, syntype [ANSP59232]. [62-64. Height 2.2 mm, width 1.0 mm. 68. Protoconch, scale bar = 1 mm].

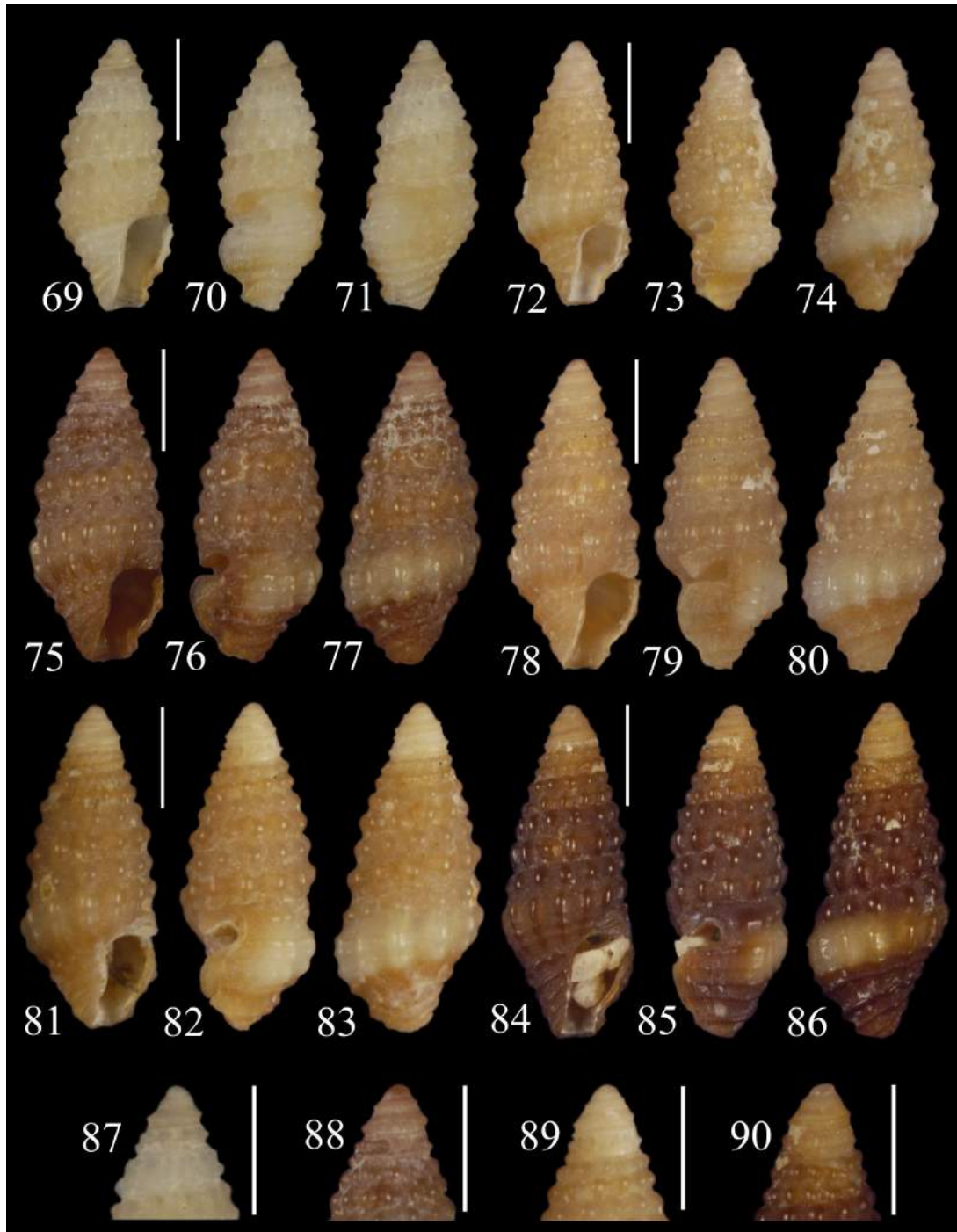


Plate 4, Figures 69-90. 69-71, 87. *Carinapex alisonkayae* n. sp., Honokohau Harbor, Kona North District, Hawai'i, holotype [LACM 3297], 7-12 m, [69-71. Height 2.7 mm, width 1.2 mm, 87. Protoconch, scale bar = 1 mm]. 72-74. *Carinapex amirowlandae* n. sp., Pisok Point, North Celebes, Indonesia, [LACM 82-39] 8-40 m, height 2.6 mm, width 1.2 mm, scale bar = 1 mm. 75-77, 88. *Carinapex amirowlandae* n. sp., Mactan Island, Philippines, holotype [LACM 3301], 100-250 m, [75-77. Height 3.1 mm, width 1.2 mm, 88. Protoconch, scale bar = 1 mm]. 78-80. *Carinapex amirowlandae* n. sp., Nakijin Motobu Peninsula, Japan, [LACM 78-22], 30 m, height 3.1 mm, width 1.3 mm, scale bar = 1 mm. 81-83, 89. *Carinapex amirowlandae* n. sp., Hellville, Antseranana Province, Madagascar, [LACM 89-55] 14 m [81-83. Height 3.2 mm, width 1.3 mm. [89. Protoconch, scale bar = 1 mm]. 84-86, 90. *Carinapex lindseygrovesi* n. sp., Lana'i, Hawai'i, holotype [LACM 3299], 12-23 m, [84-86. Height 3.3 mm, width 1.3 mm, 90. Protoconch, scale bar = 1 mm].