

THE PHILIPPINE POND SNAILS OF THE GENUS VIVIPARA.

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In the present paper all of the species of this genus heretofore known from the Philippine Islands have been considered, as well as a host of new forms which were collected by Maj. Edgar A. Mearns, U. S. Army, and presented by him to the U. S. National Museum.

VIVIPARA ANGULARIS Müller.

Plate X, fig. 1.

Helix angularis MÜLLER, Hist. Verm., Pt. 2, 1774, p. 187.

Shell quite large, conic, light to dark olive green. Whorls increasing very regularly in size. The first and second rather loosely coiled, marked by faint spiral lirations. On the third the keels characteristic of the adult shell make their appearance: in addition to the keels there are many fine spiral lirations. The adult shell is marked by three spiral keels between the sutures, of which the peripheral one is by far the strongest. The two supra-peripheral keels divide the space between the sutures into three areas, of which the one immediately below the summit is a little wider than the other two, which are equal in width. The space between the summit and the first keel forms a sloping shoulder. In addition to the three keels, the whorls are marked by numerous microscopic, minutely granulose spiral lirations and moderately strong incremental lines between the sutures. Periphery of the last whorl angulated. Base well arched, narrowly umbilicated, marked by lines of growth and many fine, wavy, equally developed, and equally spaced finely wrinkled spiral lirations. In some specimens the area adjoining the umbilicus is moderately excavated, in others it is almost closed. Aperture suboval, bluish white within, edged with a dark-brown border; outer lip thin, rendered slightly sinuous by the keels; columella moderately strong, concave, and slightly reflected; parietal wall covered with a thick callus in adult shells, which is bluish white, with a dark border, and lends the peritreme a complete aspect.

In adult shells the last whorl is usually somewhat deflected below the peripheral keel of the preceding turn, and the keel is thus exposed above the suture. Operculum reddish brown, with scarcely depressed eccentric nucleus and many fine lines of growth.

The specimen figured probably had seven and a half whorls (the early ones being somewhat eroded) and measures: Altitude, 32 mm.; greater diameter, 24.5 mm.; lesser diameter, 21.1 mm.; aperture, altitude (from the posterior angle to the base of the columella), 17.4 mm.; diameter (at right angles to the last from the middle keel of the outer lip), 13 mm. There are eight specimens of this species in the collection of the U. S. National Museum—three, Cat. No. 103669, from Luzon, Philippine Islands, of which one has served for our description and figure; Cat. No. 104056b, one specimen, collected by Rich in Luzon; one, Cat. No. 47996, collected by Hungerford at St. Cruz Bay Lake, Luzon, and three specimens, Cat. No. 19985, obtained by the North Pacific Exploring Expedition at Manila, Luzon, Philippine Islands.

VIVIPARA ANGULARIS BURROUGHIANA Lea.

Plate X, figs. 3, 4.

Paludina burroughiana LEA, Trans. Am. Phil. Soc., V, 1837, p. 113, pl. XIX, fig. 80.

There are three specimens in the Lea collection, Cat. No. 105640, U. S. National Museum, which were collected by Doctor Burroughs at Manila, Philippine Islands. Since the types were collected by Doctor Burroughs at Manila, it is quite likely that these specimens represent the cotypes upon which Doctor Lea based his description. This appears all the more probable, as one of the three shells agrees in every respect with the figure cited above. *V. a. burroughiana* represents a strongly sculptured form of *angularis*. In this, the spaces between the keels on the spire are marked with a number of slender subgranose lirations. In some individuals these lirations attain almost half the size of the middle keel. The sculpture of the base also is much stronger than in *V. angularis* proper. There are five lots in the collection, the one cited above, of which one specimen is figured, Plate X, fig. 4, which measures: Altitude, 39.2 mm.; greater diameter, 28.2 mm. Cat. No. 19984, U.S.N.M., fifteen specimens, collected by Wilsoup at Manila. Of these eight are nepionic shells. Cat. No. 90477, one specimen, from Manila, the strongest sculptured individual, here figured. Plate X, fig. 3. Cat. No. 104056, U.S.N.M., one specimen, collected by Rich, in Luzon, Philippine Islands. Cat. No. 192975, U.S.N.M., four individuals, collected by Maj. Edgar A. Mearns, at Pasay Beach, Manila, Luzon, Philippine Islands.

VIVIPARA ANGULARIS PHILIPPINENSIS Nevill.

Plate X, fig. 2.

Paludina philippinensis NEVILL, Hand List Moll. Ind. Mus., 1884, p. 24. ?*Vivipara hanleyi* FRAUENFELD, Verz. Paludina, 1864, p. 618, for *P. intermedia*, Hanley, Ms., Reeve, fig. 57, 1863, Loc. ? (not of Deshayes).

Long. 23, diam. 19 mm. This is a very closely allied form to *P. javanica*; indeed, probably only a geographical race and perhaps would be better classed as a variety of it. It can nevertheless be readily distinguished by the keel on the last whorls, giving the suture a canaliculate appearance by the less developed spiral structure, by the presence of longitudinal, subobsolete plications, as also by its shorter and more decolated form, more convex whorls, the last one subangulate, darker and duller epidermis and blacker peristome, which is more or less angulate below.

Von Martens would not appear to have met with it, as it can not surely be the form he mentions, Mal. Blatt. 1865, p. 148, as a rounded keelless, extreme variety of *P. burroughiana*. One of my specimens approaches Reeve's fig. 53 (*P. carinata*), in the more rounded peristome and less distinct subangulation of the last whorl. Seven specimens, Majajay, Luzon; coll. R. Hungerford, esq.

The above are Nevill's remarks upon this form. Three specimens, Cat. No. 104056, U.S.N.M., one of which is here figured, agree with Reeve's figure 57 and also with the above remarks. *V. a. philippinensis* represents a form of *V. angularis*, in which the two supra-peripheral keels have become obsolete; the peripheral one alone remains, forming the peripheral angle. Its chief marks of distinction, however, lie in alternating narrow dark and light longitudinal bands, the first, the narrower, probably represent resting stages and are usually a trifle more elevated than the broader light areas, and lend the shell an obsoletely ribbed appearance. The spiral sculpture, consisting of fine granose spiral lines in *V. angularis*, is in the present form reduced to mere indications of microscopic spiral lines, the surface having a polished appearance. The color in the three specimens varies from light yellowish-green to dark olive-green ground, with narrow longitudinal brown bands. The specimens at hand, which also come from Luzon, force me to assign this form a place under *V. angularis*. The one figured measures: Altitude, 21 mm.; greater diameter, 17 mm.

VIVIPARA ZAMBOANGENSIS, new species.

Plate XI, fig. 19.

Shell conic, thin, dark olive green. Nephritic whorls one and one-half, well rounded, smooth. Succeeding turns somewhat inflated, marked between the sutures by three spiral keels, of which the basal one, which is a little stronger than the other two, marks the periphery. The two post-peripheral keels divide the space between the summit and the periphery of the whorls into three equal, almost flattened areas, which are marked by many very fine and somewhat wavy, spiral lines, that lend the surface a silky luster. The summit of the whorls falls immediately below the peripheral keel in all but the last turn; in this it is

deflected toward the base and a narrow band becomes apparent between it and the peripheral keel. Base rather short, well arched, narrowly umbilicated, marked by numerous fine, wavy, spiral striations as on the spire. Aperture small, subcircular; black edged, bluish white within; outer lip thin, faintly angled at the keels, columella thin, strongly concave and somewhat reflected over the slitlike umbilicus; parietal wall covered with a thick callus which renders the peristome practically continuous. Operculum reddish brown with depressed eccentric nucleus, marked by many incremental lines.

The type and fifty-four specimens, Cat. No. 192956, U.S.N.M., were collected by Maj. Edgar A. Mearns, at Zamboanga, Mindanao, Philippine Islands. The type has five whorls (the nucleus being eroded) and measures: Altitude, 25.9 mm.; greater diameter, 20.2 mm.; lesser diameter, 18.8 mm.; aperture, altitude (from the posterior angle to the base of the columella), 13.1 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 11.5 mm.

A single much-worn individual, which is a little more slender than the shells from the type locality, was collected by Major Mearns in Libungan River at Labas, Rio Grande Valley, Mindanao, Philippine Islands.

VIVIPARA ZAMBOANGENSIS TUBAYENSIS, new subspecies.

Plate XI, fig. 16.

Shell similar to *V. zamboangensis*, but subglobose, with the whorl more inflated and with the secondary sculpture much more strongly developed. The six slender keels above the stronger peripheral one are of almost equal strength and the spaces between them are occupied by spiral lirations as in *V. zamboangensis*. The base also is more inflated than in *V. zamboangensis* and the umbilicus is completely closed. In color it is also entirely different, being light brown or yellowish brown. The sculpture of the present form bears the same relation to *V. zamboangensis* that *V. a. burroughiana* bears to *V. angularis*. The type, which has five whorls remaining (part of the nucleus being lost), measures: Altitude, 22.7 mm.; greater diameter, 20.1 mm.; lesser diameter, 18 mm.

The type and two specimens, Cat. No. 192974 U.S.N.M., were collected by Maj. Edgar A. Mearns in Tubay River at Santiago, Mindanao, Philippine Islands.

VIVIPARA ZAMBOANGENSIS DAVAOENSIS, new subspecies.

Plate XI, fig. 17.

This form resembles *V. z. tubayensis* in contour, but is much more delicate. It is flesh colored. The periphery is marked by a weak liration, while the rest of the surface is marked by many ill-defined,

closely spaced, fine, wavy, spiral lirations on the spire and the base. A few of these lirations are a little stronger and visible to the unaided eye. The sutures are strongly impressed and the well-rounded base is openly, narrowly umbilicated.

The type, Cat. No. 192976, was collected by Maj. E. A. Mearns at Davao, Mindanao, Philippine Islands. It has five and seven-eighths whorls and measures: Altitude, 21 mm.; greater diameter, 17.6 mm.; lesser diameter, 14.1 mm.; aperture, altitude (from the posterior angle to the middle of the base), 12 mm.; diameter (at right angles to the last, from the middle of the outer lip), 9.5 mm.

VIVIPARA ZAMBOANGENSIS SURIGENSIS, new subspecies.

Plate XI, fig. 18.

Shell resembling *V. z. daracensis* in outline, but polished, periphery obsolete angulated. The shell is of light olive green color, with a few narrow longitudinal brown bands at irregular intervals. Base well rounded, narrowly umbilicated. Under high magnification the surface of the spire and base show many very fine, quite closely spaced, wavy lirations, which are scarcely perceptible to the naked eye.

The type, Cat. No. 192977, U.S.N.M., was collected by Maj. Edgar A. Mearns in Baganga River, Surigao, Mindanao, Philippine Islands. It has five whorls and measures: Altitude, 16.4 mm.; major diameter, 15.3 mm.; lesser diameter, 13.4 mm.; aperture, altitude (from the posterior angle to the middle of the base), 10.4 mm.; diameter (at right angles to the last, at the middle of the outer lip), 8.5 mm.

VIVIPARA MINDANENSIS, new species.

Plate XI, fig. 11.

Shell subturreted, light olive green. The early whorls of the type are eroded, but it contained nine nepionic shells, one of which will serve for the description of the early turns. The largest nepionic shell has three and one-half volutions, the first two of which are more loosely coiled and more rounded than those that follow. They are all marked by exceedingly fine spiral striations. The periphery of the last whorl of the nepionic shell is strongly angulated, while the base is rounded like the spaces between the sutures and narrowly umbilicated. The adult whorls are inflated, evenly rounded at the side, but abruptly so near the summit, which renders this roundly tabulated. The periphery of the last whorl is marked by a moderately strong keel, while the space between it and the summit is crossed by six slender threads, which are not regularly spaced. In addition to these threads there are many exceedingly fine interrupted wavy spiral lirations between them. The summit of the whorls falls considerably below the peripheral keels and exposes this above the suture in all the

whorls. The summits of the whorls and the rounded shoulders are marked in addition to the above-mentioned sculpture with oblique wrinkles, which give this part of the whorls a quite strongly malleated appearance. Periphery of the last whorl angulated. Base short, somewhat inflated, well arched, excavated about the narrow open umbilicus and marked by ten subequal and irregularly spaced slender spiral lirations, between which there are many exceedingly fine interrupted papillose spiral lines. Aperture oval, bluish white within, bordered by a very narrow black edge on the outside; outer lip thin; columella concave, slender, somewhat expanded at the base and slightly reflected over the umbilicus; parietal wall covered with a thin callus; operculum orange, with depressed eccentric nucleus marked by many lines of growth. The type and seven specimens, Cat. No. 192559, U.S.N.M., were collected by Major Mearns in Lake Lanao, Mindanao. It has lost the first two nuclear whorls. The five which remain measure: Altitude, 31.1 mm.; greater diameter, 24.1 mm.; lesser diameter, 22 mm.; aperture, altitude (from the posterior angle to the middle of the base), 15.3 mm.; diameter (at right angles to the last, from the middle of the outer lip), 12.5 mm.

VIVIPARA MINDANENSIS BAGANGENSIS, new subspecies.

Plate XI, fig. 12.

Shell much more globose than *V. mindanensis*, dark olive green, with a reddish tinge. Interior of aperture reddish brown. Spire and base marked by more or less equally spaced fine spiral lirations and weakly developed obliquely forward slanting folds, which lend the last two turns a malleated appearance. In addition to the spiral lirations visible to the unaided eye there are many closely spaced, more or less interrupted, very fine, wavy lines which can be seen under the microscope. Base well rounded and narrowly umbilicated.

The type, Cat. No. 192979, U.S.N.M., was collected by Maj. E. A. Mearns in Baganga River, Surigao, Mindanao. It has six whorls (the first being decidedly worn) and measures: Altitude, 22.8 mm.; greater diameter, 19.3 mm.; lesser diameter, 17 mm.; aperture (from the posterior angle to the base of the columella), 18.8 mm.; diameter (at right angles to the last, at the middle of the outer lip), 10.3 mm.

VIVIPARA BULUANENSIS, new species.

Plate XI, fig. 15.

Shell thin, subturreted, broadly conic, light brown, shining. All the whorls inflated and well rounded, with a broad rounded shoulder at the summit. Sutures strongly impressed. Periphery of the last whorl with a mere indication of an angulation. Base short, well rounded, rather broadly openly umbilicated. The entire surface, both on the spire and on the base, marked by many moderately strong lines of growth, and many fine equally developed and subequally spaced

wavy spiral lirations. The crossing of these two elements lend the shell a finely reticulated sculpture. Aperture, moderately large, oval, white, with a brownish tinge within; outer lip, thin; columella very slender, somewhat expanded at base and slightly reflected; parietal wall covered with a short, thin, semitransparent callus. Operculum reddish orange, with but slightly depressed eccentric nucleus and many lines of growth.

The type and 136 specimens, Cat. No. 192978, U.S.N.M., were collected at Lake Buluan, Mindanao, Philippine Islands, by Maj. Edgar A. Mearns. The type has six and one-half whorls and measures: Altitude, 30.8 mm.; greater diameter, 23.3 mm.; lesser diameter, 28.8 mm.; aperture (from the posterior angle to the middle of the base), 15.2 mm.; diameter (at right angles to the last from the middle of the outer lip), 12 mm.

This entire lot is remarkably uniform in shape and sculpture, differing only in color, in which there is a variation from light olive green to reddish brown.

VIVIPARA CARINATA Reeve.

Plate XI, fig. 14.

Puludina carinata REEVE, Conch. Icon., XIV, 1863, no. 53, fig. 53.

The name of the present shell is somewhat misleading, since the carination is restricted to the periphery of the early whorls. In the adult turns it is quite obsolete.

The shell is conic and of olive-green color, with an occasional narrow, dark, longitudinal stripe. The early whorls are eroded in all of our specimens. The later ones are evenly rounded between the sutures, marked by lines of growth and exceedingly fine, closely spaced, obsolete, spiral lirations. Sutures strongly impressed. Periphery of the last turn obsoletely angulated. Base well rounded, with a narrow umbilicus, which is almost completely covered by the somewhat reflected columella, marked as the spire. Aperture moderately large, bluish white within, outer lip thin. Columella slender, concave, and somewhat reflected; parietal wall covered by a thin callus. Operculum reddish, with slightly depressed eccentric nucleus and many lines of growth. The specimen described and figured, Cat. No. 103666, U.S.N.M., has the apex badly worn. The six remaining turns measure: Altitude, 31.8 mm.; greater diameter, 25.2 mm.; lesser diameter, 23.4 mm.; aperture, altitude (from the posterior angle to the middle of the base), 18.6 mm.; diameter (at right angles to the last from the middle of the outer lip), 14 mm. Another specimen, belonging to the same lot, with worn nucleus and five whorls remaining, measures: Altitude, 22 mm.; greater diameter, 18 mm.; lesser diameter, 15 mm. These two individuals are marked Philippine Islands, without nearer designation of locality. Three additional specimens, Cat. No. 47995, U.S.N.M., were collected in Luzon, Philippine Islands, by Hungerford.

VIVIPARA CUMINGI (Hanley) Reeve.

Plate X, Fig. 7.

Paludina cumingi (HANLEY) REEVE, Conch. Icon., XIV, 1863, no. 11, figs. 11, 11a.

Shell subglobose, of light olive green color. The early whorls are but little elevated, well rounded, marked by lines of growth and a few exceedingly fine interrupted spiral lirations. From the third whorl on the turns are decidedly inflated and strongly roundly shouldered at the summits, the shoulder being almost tabulated. These whorls are marked by faint lines of growth and exceedingly closely spaced, fine, wavy lirations. In addition to this sculpture a number of moderately strong, low, oblique, raised ridges make their appearance on the last two turns, which, in connection with the above-mentioned sculpture, give these whorls a weakly malleated aspect. Sutures strongly impressed. Periphery of the last whorl rounded. Base well rounded, narrowly umbilicated, marked by the lines of growth and obsolete spiral lirations as on the spire. Aperture moderately large, oval, bluish white, with a narrow dark-colored border; outer lip thin; columella slender, concave, somewhat reflected over the umbilicus; parietal wall covered with a thick, bluish white, dark-edged callus, which gives the peristome a complete aspect.

The specimen described and figured, Cat. no. 105658, was donated by C. M. Wheatley and comes from Luzon, Philippine Islands. It has five and one-half whorls and measures: Altitude, 17.1 mm.; greater diameter, 14.8 mm.; lesser diameter, 12.6 mm., aperture, altitude (from the posterior angle to the middle of the base), 10.2 mm.; diameter (at right angles to the last from the middle of the outer lip), 7.8 mm. Another specimen, Cat. No. 98070, U.S.N.M., was collected at Manila, Luzon, Philippine Islands, by W. W. Walpole.

VIVIPARA MEARNSI, new species.

Plate X, fig. 6.

Shell thin, polished, conic, strongly keeled at periphery, greenish-yellow, with irregularly disposed, narrow, dark, longitudinal bands, which appear to mark resting stages. The entire shell on the spire and base is marked by fine incremental lines and very fine, closely spaced, spiral striations, which lend the surface a finely reticulated aspect when viewed under high magnification. (Nuclear whorls decolated.) Succeeding turns well but not evenly rounded, the posterior half between the summit and the periphery being decidedly more convex than the anterior. Periphery of the whorls bearing a strong narrow compressed keel, which is apparent above the suture in all the volutions. On the earlier ones it is appressed quite closely to the summit of the succeeding turn, while in the last two volutions the

summit falls somewhat below the keel and makes this appear all the more prominent. Base short, evenly and strongly arched, with a narrow perforate umbilicus. Aperture ovate, rather large, the outer lip thin, rendered γ -shaped by the keel in the middle; columella slender, concavely curved; parietal wall covered by a thick callus which joins the columella and the posterior angle of the aperture, rendering the peristome complete. Operculum thin, translucent, reddish-brown, with depressed eccentric nucleus and well-marked incremental lines, the outer edge bearing a slight projection which fits into the angle of the peripheral keel.

The type and 58 specimens Cat. No. 192957, U. S. N. M., were collected by Maj. Edgar A. Mearns, at Lake Lanao, Mindanao, Philippine Islands. The type has five whorls (the nepionic part of the spire being lost) and measures: Altitude, 43.8 mm.; greater diameter, 36.3 mm.; lesser diameter, 32.5 mm. Aperture: Altitude (from the posterior angle to the middle of the base), 21.5 mm.; diameter (taken at right angles to the altitude at the keel of the outer lip), 17.2 mm.

Occasionally there appear one or more very slight spiral lirations on the surface of the spire; these, however, are not constant, even on the same shell, and therefore unimportant in the specific diagnosis.

This species is remarkably distinct from any of the recent *Viviparas*. It resembles *V. yukotinovici* Frauenfeld figured Plate 5, figs. 7, 8, in the Verh. Zool. Bot. Ges. Wien. XIV, 1864, which comes from the Neogentertiary of West Slavonia.

VIVIPARA MEARNSI MISAMISENSIS new subspecies.

Plate X, fig. 5.

Shell large, thin, subturreted, light olive green with many narrow dark brown bands, which coincide with the lines of growth and probably mark resting stages. Entire surface marked by rather strong incremental lines. Nuclear whorls wanting. Succeeding turns inflated, shouldered at the submit and marked by three prominent spiral ridges and two less conspicuous intermediate ones, between the sutures. The most strongly developed of these ridges is at the periphery, the next strongly developed one is located about two-fifths of the distance anterior to the summit, between the summit and the periphery, while the third is about halfway between these two keels. Of the two weaker cords, one stands halfway between the middle and posterior keel, while the other encircles the shoulder, about as far posterior to the first keel as the other intermediate cord is anterior to it. The spaces between these keels appear flattened and lend the outline of the whorls a polygonal appearance. Periphery of the last whorl strongly keeled. Base short, well arched, not umbilicated, marked by many fine rather closely spaced spiral lirations. Aperture suboval, white within, edged with black; outer lip thin, rendered

somewhat polygonal on its posterior half by the spiral cords; columella slender, decidedly concave and slightly reflected; parietal wall covered with a thick white callus which is black-edged like the lip and renders the peristome continuous.

The type, Cat. No. 192960, U.S.N.M., was collected by Maj. Edgar A. Mearns in Lake Lanao, Mindanao, Philippine Islands. It lacks the nucleus and some of the earlier whorls, the last four only remain and these measure: Altitude, 31.7 mm.; greater diameter, 27.4 mm.; lesser diameter, 25.4 mm. Aperture: Altitude (from the posterior angle to the base of the columella), 18.5 mm.; diameter (at right angles to the last from the middle keel), 14.9 mm.

VIVIPARA PAGODULA, new species.

Plate X, fig. 8.

Shell thin, broadly conic, turreted, greenish yellow with irregularly disposed, narrow, dark bands coinciding with the lines of growth. Nepionic whorls decollated. Succeeding turns rather depressed, with a broad sloping shoulder above, which extends from the summit to the strongly keeled periphery. This shoulder is marked by two spiral lirations, which are placed a little to each side of the middle of the upper surface. The periphery is marked by a very strong, hollow keel, which falls about one-third of the distance anterior to the summit, from the summit to the base of the columella in the last turn. The space between the periphery and the summit of the succeeding turn is marked by two equally developed spiral keels, which are placed on the vertical side. The lower one of these is immediately above the suture, while the upper one is at some little distance below the periphery, which projects considerably beyond them. Base of the last whorl rather short, marked by the two strong spiral keels, which are rather closely spaced and enclose a narrow channel between them. The space between the posterior keel and the periphery is quite strongly concave. The space between the basal keel and the narrow, almost covered, umbilicus is well arched and marked by eight slender lirations, which are less strongly developed and more closely spaced about the umbilical area than at the keel. These lirations as well as the two basal keels are rendered faintly crenulate by the incremental lines. The spaces between the spiral keels and the lirations are marked by many exceedingly fine incised spiral striations, both on the spire and the base. Aperture slightly effuse basally, irregular in outline, the peripheral keel marking a deep acute angle and the two basal ones shallow rounded channels in the thin outer lip; columella slender, concave, and somewhat reflected over the umbilical opening; parietal wall covered with a thin callus.

The type, Cat. no. 192858, U.S.N.M., was collected in Lake Lanao, Mindanao, Philippine Islands, by Maj. Edgar A. Mearns, and has five and

one-fourth turns (the nucleus being lost), which measure: Altitude, 30 mm.; greater diameter, 26.5 mm.; lesser diameter, 22.4 mm.; Aperture, altitude (from the posterior angle to the base of the columella), 15.9 mm.; diameter (at right angles to the last measurement at the basal keel of the outer lip), 13.3 mm.

VIVIPARA GILLIANA, new species.

Plate X, fig. 12.

Shell large, broadly conic, reddish brown. (First one and one-half whorls worn.) The second part of the second whorl shows the beginning of the sculpture of the adult turns, which consists of three poorly developed keels, of which one appears at the periphery and the other two between it and the summit. The space between the peripheral keel and the next one is a little narrower than the space between the median and posterior keel, while the space between the summit and the posterior keel is considerably wider still. The space between the summit and the posterior keel is moderately rounded and forms the shoulder of the whorl. The spaces between the other keels are flattened. The greatest convexity of the whorls is marked by the median keel. Periphery of the last whorl angulated. Base moderately long, strongly arched. The entire surface of the spire and base is marked by rather strongly expressed, incremental lines and many closely placed, microscopic spiral lirations. Aperture large, subcircular, reddish brown within; outer lip thin, rendered slightly angular by the keels; columella slender, concave, somewhat reflected over the umbilical area; parietal wall covered with a moderately thick dark colored callus. Operculum thin, yellowish, with decidedly depressed eccentric nucleus, marked by many lines of growth.

The type and five additional specimens (three of which are nepionic shells having the same sculpture as the adult turns). Cat. No. 192972, U.S.N.M., were collected by Maj. Edgar A. Mearns, in Lake Lanao, Mindanao, Philippine Islands. The type has five and one-half whorls and measures: Altitude, 37.4 mm.; greater diameter, 27.7 mm.; lesser diameter, 23.5 mm. Aperture, altitude (from the posterior angle to the middle of the base), 21.1 mm.; diameter (at right angles to the last, at the middle keel), 17.3 mm.

VIVIPARA LANAONIS, new species.

Plate XI, fig. 7.

Shell of medium size, decidedly turreted, olive-green with many narrow dark-brown bands which coincide with the rather strongly developed lines of growth. The largest young shell, taken from a specimen before birth, has four whorls, the first two of which are helicoid, well rounded, and marked by a few faint spiral striations,

while the two which follow bear the same sculpture as the adult shell, though less strongly developed. The whorls of the adult shell are very strongly tabulately shouldered, the shoulder terminating in a prominent compressed keel, which is located at about one-third of the distance between the summit and the base of the columella, anterior to the summit. This keel, which may be known as the peripheral keel, marks the widest part of the turn and overarches the rest. Between this keel and the summit of the succeeding whorl there are two additional keels which are a little less strongly developed. The basal one of these (the suprasutural keel) is immediately above the suture, while the other (the median keel) lies half-way between it and the peripheral keel. A fourth keel, which is considerably less developed than any of the three others, is situated on the shoulder, about as far posterior to the peripheral keel as the first one below the peripheral keel is anterior to it. Base of the last whorl rather short, well arched, marked by about eight subequal spiral lirations, which are a little more closely spaced and less strongly developed near the umbilical chink than away from it. Aperture irregular, bluish white within, with dark border; outer lip thin, rendered sinuous by the keels; columella slender, concavely curved; parietal wall covered with a moderately thick, bluish white callus, which is dark edged and gives the peritreme a complete aspect. Operculum thin, orange colored, with depressed eccentric nucleus and many lines of growth.

The type, which has lost the first two nepionic turns, has five whorls left, which measure: Altitude, 24.5 mm.; greater diameter, 17.4 mm.; lesser diameter, 15.4 mm.; aperture, altitude (from the posterior angle to the base of the columella), 11.6 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 9 mm.

The present species, while fairly constant as far as general outline is concerned, nevertheless presents considerable variations in sculpture. These variations appear to follow certain definite lines, which will be noted below. It is an interesting fact that in all the gravid specimens examined, the nepionic shells taken from the parent, always had the sculpture of the parent. There are 104 shells which belong to this species, all collected by Major Mearns, in Lake Lanao, Mindanao, Philippine Islands. Eleven of these belong to the typical form, which is entered as Cat. No. 192363, U.S.N.M.

Form alpha (Plate XI, fig. 8).—Differs from typical *lanaonis* in having the base smooth. There are six specimens of this form. Cat. No. 192364, U.S.N.M.

Form beta (Plate XI, fig. 2).—Has two slender cords between the peripheral and suprasutural keel, instead of a single median one. There are only two specimens of this type. Cat. No. 192365, U.S.N.M.

Form gamma (Plate XI, fig. 4).—This lacks the keel on the shoul-

der. There are eleven specimens of this form. Cat. No. 192366, U.S.N.M.

Form delta (Plate XI, fig. 10).—This lacks the median keel. There are four specimens of this form. Cat. No. 192367, U.S.N.M.

Form eta (Plate XI, fig. 9).—This lacks the median and shoulder keel. There are thirty-two specimens in the lot. Cat. No. 192368, U.S.N.M.

Form theta (Plate XI, fig. 1).—Has same number and arrangement of the keels as in the typical form, but they are only weakly developed; the peripheral one is not stronger than the rest and does not overhang them. There are twelve specimens of this form. Cat. No. 192369, U.S.N.M.

Form iota (Plate XI, fig. 5).—Like theta, but lacking the cord on the shoulder. There are seven specimens in the lot. Cat. No. 192370, U.S.N.M.

Form kappa (Plate XI, fig. 3).—All the cords lost, except faint angles marking the peripheral and suprasutural keels. Nineteen specimens. Cat. No. 192371, U.S.N.M.

Form lambda (Plate XI, fig. 6).—In this form the periphery is angulated and the two suprapерipheral keels are merely indicated; base smooth. One specimen. Cat. No. 192973, U.S.N.M.

VIVIPARA POLYZONATA Frauenfeld.

Plate XI, fig. 13.

Vivipara polyzonata FRAUENFELD, K. K. Zool. Bot. Ges. Wien, 1862, p. 2.

Shell conic, thin, with the apex flesh colored, the ground color of the rest olive green, while the spiral keels are dark brown. The first three whorls are helicoid and smooth excepting a few spiral striations. With the beginning of the fourth, the characteristic sculpture of the adult whorls makes its appearance, though at first this is merely indicated. The adult whorls are encircled between the sutures by three equally strong, well-rounded dark-brown cords of which the third is at the periphery and is just covered by the summit of the succeeding turns, though in the last half of the last turn it is left exposed. The other two keels divide the space between the peripheral keel and the summit into three equal spaces. The first of these spaces forms a moderate shoulder. An additional slender brown spiral cord, which is only about one-fifth as strong as the others is located a little nearer the first keel than the suture. Base of the last whorl rather short, well arched, without umbilicus, marked by a number of spiral keels which gradually diminish in size and become closer spaced from the periphery toward the umbilicus chink. One of the specimens has seven quite regularly spaced basal cords. Another has five less regularly dis-

tributed, while a third has only four cords. The entire surface of the shell, in addition to the keels is marked with fine lines of growth and many exceedingly fine spiral striations, the latter occurring between the keels. Aperture suboval, bluish white within, edged with dark brown; outer lip thin, rendered sinuous by the spiral keels; columella moderately thick, glazing the umbilical area; parietal wall covered with a moderately thick bluish white callus, which is edged with dark brown and lends the peritreme a complete appearance. Operculum light orange, thin, with depressed, eccentric nucleus, marked by many lines of growth.

The three specimens before me agree in size and sculpture, two, Cat. No. 105636, U.S.N.M., come from Manila, Luzon. One of these has seven whorls and measures, altitude, 19.9 mm.; greater diameter, 9 mm.; lesser diameter, 12.7 mm. Aperture, altitude (from the posterior angle to the base of the columella), 11 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 6.4 mm. The third specimen, Cat. No. 41125, U.S.N.M., was collected by Benson and donated by McAndrew. It bears the locality label, Philippines, and probably comes from Luzon, the type locality of the species.

VIVIPARA MAINITENSIS, new species.

Plate X, figs. 9, 10, 11.

While the collection contains no less than forty-three specimens of this species, there is not one of the adult shells which is perfect. It has been deemed advisable therefore to base the specific diagnosis upon several cotypes rather than a single imperfect individual.

Shell subglobose, with multisulcate spire and of light brown color. (The description of the first four whorls is based upon the juvenile specimen.) The first two and a half whorls helicoid, well rounded, rather loosely coiled. The first one marked by a few transverse wrinkles only. On the second one a few faint spiral lirations are apparent as well as weak lines of growth. On the first half of the third turn these lirations become stronger and are granulose, while on the second half of the same turn three conspicuous spiral keels make their appearance. These keels and the spaces between them are marked by many closely-spaced, fine, finely papillose lirations. The fourth whorl bears five very strong rounded keels above the periphery which are equally well developed and equally spaced. Periphery marked by a depressed sulcus, which bears a low, well-rounded keel in the middle, which is about one-half as wide as the first supra and infra peripheral keel. The peripheral sulcus in reality is not a sulcus but a keel less raised than the two which bound it. The base of the fourth whorl is well rounded and marked by low, almost flattened, closely spaced cords, of which there are two kinds, narrow and broad, the latter about three times as wide as the former and alternating with

them. There are about twenty-four cords on the base; they gradually become narrower from the periphery to the umbilical chink. These cords are marked by spiral lines of very minute papillae.

Second cotype.—Fifth and sixth whorls inflated, marked by six strong, moderately rounded cords between the summits and the peripheral sulcus. The first of these, at the suture, is considerably broader than the rest, and somewhat flattened, forming a narrow shoulder. The sutural keel is very low and ill-defined, in places bifid. Base not perforated; inflated and well rounded, marked by irregularly developed keels, which become quite obsolete from the middle of the base to the umbilical region. Aperture rather small, suboval, bluish white within; outer lip thin, faintly wavy, columella moderately thick, concave; parietal wall covered with a thin callus. Opereulum reddish yellow, with slightly depressed eccentric nucleus, marked by numerous lines of growth.

Third cotype.—This is a badly eroded and fragmentary shell. It has at least one whorl more than the second cotype, i. e., about seven. This last turn has a decidedly tabulated shoulder and six rather rugose spiral keels between the shoulder and the obsolete peripheral sulcus. The base is likewise marked by rugose spiral keels. The keels are rendered rugose by the strong almost riblike incremental lines, which grow stronger as the shell increases with age.

The three cotypes have the following number of whorls and measure: First, young, has a little more than four turns, nucleus complete; altitude, 9.2 mm.; greater diameter, 8.4 mm.; lesser diameter, 7.8 mm.

The second cotype has five whorls (it has lost probably one and one-half), and measures: Altitude, 29.6 mm.; greater diameter, 24.5 mm.; lesser diameter, 21.3 mm. Aperture, altitude (from the posterior angle to the base of the columella), 16.8 mm.; diameter (at right angles to the last, from the insertion of the columella), 13.3 mm. The third cotype must have had about seven and a half whorls, six of which are still visible; it measures: Altitude, 37.1 mm.; greater diameter, 31.5 mm.; lesser diameter, 28.4 mm.

All of the specimens, 42, Cat. No. 192962, U.S.N.M., were collected by Maj. E. A. Mearns in Lake Mainit, northeastern Mindanao, Philippine Islands. - One, Cat. No. 192961, U.S.N.M., comes from Baganga River, southeastern Mindanao, Philippine Islands.

There are two young individuals in the collection, Cat. No. 192980 U.S.N.M., collected by Maj. E. A. Mearns at Lake Mainit, Mindanao, Philippine Islands, which do not belong to any of the species of which we have adults from that locality. They are broadly conic, with the first one and one-half turns cylindrical, forming a mucronate apex. The periphery is strongly keeled and the shining surface marked by exceedingly fine closely spaced spiral lirations.

EXPLANATION OF PLATES.

[All figures are natural size.]

PLATE X.

- FIG. 1. *Vivipara angularis* Müller, p. 135.
2. *Vivipara angularis philippinensis* Nevill, p. 137.
3. *Vivipara angularis burroughiana* Lea, p. 136.
4. *Vivipara angularis burroughiana* Lea, p. 136.
5. *Vivipara mearnsi misamisensis* Bartsch, p. 143.
6. *Vivipara mearnsi* Bartsch, p. 142.
7. *Vivipara cuningi* (Hanley) Reeve, p. 142.
8. *Vivipara pagodula* Bartsch, p. 144.
9. *Vivipara mainitensis* Bartsch, p. 148.
10. *Vivipara mainitensis* Bartsch, p. 148.
11. *Vivipara mainitensis* Bartsch, p. 148.
12. *Vivipara gilliana* Bartsch, p. 145.

PLATE XI.

- FIG. 1. *Vivipara lanaonis* form *theta* Bartsch, p. 147.
2. *Vivipara lanaonis* form *beta* Bartsch, p. 146.
3. *Vivipara lanaonis* form *kappa* Bartsch, p. 147.
4. *Vivipara lanaonis* form *gamma* Bartsch, p. 146.
5. *Vivipara lanaonis* form *iota* Bartsch, p. 147.
6. *Vivipara lanaonis* form *lambda* Bartsch, p. 147.
7. *Vivipara lanaonis* Bartsch, p. 145.
8. *Vivipara lanaonis* form *alpha* Bartsch, p. 146.
9. *Vivipara lanaonis* form *eta* Bartsch, p. 147.
10. *Vivipara lanaonis* form *delta* Bartsch, p. 147.
11. *Vivipara mindanensis* Bartsch, p. 139.
12. *Vivipara mindanensis bagangensis* Bartsch, p. 140.
13. *Vivipara polyzonata* Frauenfeld, p. 147.
14. *Vivipara carinata* Reeve, p. 141.
15. *Vivipara luluanensis* Bartsch, p. 140.
16. *Vivipara zamboangensis tubayensis* Bartsch, p. 138.
17. *Vivipara zamboangensis davaoensis* Bartsch, p. 138.
18. *Vivipara zamboangensis surigauensis* Bartsch, p. 139.
19. *Vivipara zamboangensis* Bartsch, p. 137.



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PHILIPPINE ISLAND VIVIPARIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 150.



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PHILIPPINE ISLAND VIVIPARIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 150.

