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Endemic Hawaiian Cowries

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Five of the 29 species of *Cypraea* reported from the Hawaiian islands are endemic forms[1]. These are *Cypraea sulcidentata* Gray, *C. semiplota* Mighels, *C. tesellata* Swainson, *C. madagascariensis* Gmelin, and *C. ostergaardi* Dall. The present literature is largely confined to a systematic discussion of these species. Little information is available concerning the individual variations in size and relative abundance[1,2]. Therefore, I present such information here. Data concerning the possible evolution of the endemic species are also discussed, and detailed systematic descriptions based on large series of individuals are given.

The endemic cowries are distributed throughout the whole of the Hawaiian archipelago, extending from the northernmost and westernmost islands, Kure (Ocean), Midway, and Pearl and Hermes Reef respectively, to the southern and easternmost island, Hawaii.

No endemic species, except *Cypraea semiplota* Mighels, are collected abundantly in the living state. There are restricted localities on the Waikiki Reef, Maile Point, Kaneohe Bay and Kupikipikio Point, Oahu; Seal and Grass Islets, Pearl and Hermes Reef; Lahaina Reef, Maui; and Midway Island where *C. semiplota* is known to occur in quantity. The next most prevalent species, although not common, is *Cypraea sulcidentata* Gray. A number of large and perfect specimens have been obtained from Pearl and Hermes Reef by Captain and Mrs. William G. Anderson and Mr. Alex Anderson of Honolulu.

[1] Ingram, W. M., The family Cypraeidae in the Hawaiian islands: Nautilus, 50:77-82, 1937.

[2] Ostergaard, J. M., Fossil marine mollusks of Oahu: B. P. Bishop Mus., Bull. 51:1-32, 1928.

Mr. David Thaanum and Mr. Ted Dranga of Honolulu have collected series of individuals from Kaneohe Bay, Oahu, and from the reef at Lahaina, Maui. Individuals of these two species occur in moderate abundance as beach shells on the islands of Oahu and Kauai; in this state, however, most of them are fragmentary or very badly worn by the grinding action of the surf upon the reefs before they are washed on the beach.

Although *Cypraea madagascariensis* Gmelin is commonly found as a beach shell on a number of islands, the only live collection that I know of was taken from the Lahaina Reef, Maui, by Thaanum and Dranga. *C. tesellata* Swainson is likewise very rarely taken alive, the only authentic living collections, so far as I know, being those of W. G. and Alex Anderson from Pearl and Hermes Reef, and Thaanum from Hilo, Hawaii. *C. tesellata* is collected occasionally as a beach shell and I have specimens gathered from the beach at Paumalu, Oahu, that are almost perfectly preserved.

Cypraea ostergaardi Dall is the rarest of the endemic cowries; individuals have never been collected alive. Mr. Jens M. Ostergaard of the University of Hawaii was the discoverer of this cowry; he gathered the type specimen with four others from the Honolulu harbor dredgings of 1905 and 1915. Thirteen specimens have been found since Mr. Ostergaard's first collection; four individuals from Pearl and Hermes Reef, three of which belong to Dranga and one to Thaanum; and nine individuals from Honolulu Harbor in the possession of Mr. H. C. Alexander. This latter collector obtained his shells from the sand dredged from Honolulu Harbor and used to construct Sand Island situated in the harbor.

There is a great range in size between the largest and the smallest individuals of the endemic species measured here. In computing the shell size only fully mature specimens were employed; measurements were made along the dorsal-ventral, anterior-posterior, and basal axes at the points of greatest development.

The 18 individuals of *Cypraea sulcidentata* Gray that were measured exhibit the greatest range in size of the endemic species; generally any one mature individual of this species is larger than a mature individual of the other species. The largest shell measured approaches gigantism. This shell, now housed in Bernice P. Bishop Museum, Honolulu, was dredged from Honolulu Harbor, and is in excellent condition except that the dorsal coloration has bleached from the nor-

mal brown to a rich orange, much resembling that of *Cypraea aurantium* Martyn. The specimens measured of *C. madagascariensis* are of much more uniform size. The specimens taken from Honolulu harbor dredgings are as a group slightly larger than those taken in other parts of the archipelago.

Measurements in millimeters of five endemic species of Hawaiian cowries

Species	posterior anterior-	ventral dorsal-	basal
Cypraea sulcidentata			
average (18 specimens)	37.4	21.1	25.3
largest	69.0	39.0	39.0
smallest	29.4	16.0	19.0
Cypraea madagascariensis			
average (25 specimens)	27.6	11.7	17.8
largest	42.0	18.0	25.0
smallest	18.0	7.0	12.0
Cypraea tesellata			
average (11 specimens)	29.6	16.4	20.6
largest	34.0	18.0	23.0
smallest	17.0	12.0	9.0
Cypraea semiplota			
average (25 specimens)	15.9	6.7	9.0
largest	26.0	12.0	16.0
smallest	9.5	4.1	5.8
Cypraea ostergaardi			
average (5 specimens)	——	——	——
largest	20.0	——	——
smallest	14.0	——	——

The evolutionary descent of endemic forms is often an interesting problem. Mr. Jens M. Ostergaard has aptly discussed and has formed a hypothesis as to the immediate ancestors of the five endemic Hawaiian cowries.[3] I agree with his theories and cite them here, supplemented by additional observations.

There is but little doubt that *Cypraea tesellata* Swainson and *C. sulcidentata* Gray represent an evolutionary relationship to *C. arenosa* Gray. Ostergaard states, "The species *Cypraea arenosa* ap-

[3] Ostergaard, J. M., Fossil marine mollusks of Oahu: B. P. Bishop Mus., Bull. 51:1-32, 1928.

proaches *C. tesellata* in having shallow interstices between the teeth. In color pattern *C. arenosa* closely resembles *C. sulcidentata*. The relationship to *C. sulcidentata* is represented by a specimen of uncertain locality; the resemblance to *C. tesellata* by an abberant form recently dredged from Honolulu Harbor." I examined three specimens of *C. arenosa* from the Honolulu harbor dredgings that are very closely allied in general shell form as well as in coloring to specimens of *C. sulcidentata*; I also examined immature stages of both species and in some instances found it almost impossible to separate one from the other. Immature stages of *C. tesellata* that have been deposited by waves on the beaches about Oahu show close relationship to *C. arenosa* in the banding over the dorsal surface of the shell and in the dentition of the teeth lining the aperture. Ostergaard's conclusions are in accord with mine: "Owing to the very general distribution of *C. arenosa* and the local distribution of the other two species, it seems safe to infer that *C. tesellata* and *C. sulcidentata* are its modified offshoots."

Cypraea semiplota Mighels seems to have had a somewhat modified descent from *C. staphylea* Linnaeus. Although the latter species has never been collected alive or in the fossil state in the Hawaiian group, *C. semiplota* so closely resembles this species and its varieties, particularly var. *limacina* Mighels, that it seems likely that *C. semiplota* is the Hawaiian representative of *C. staphylea.*

Ostergaard writes: "*Cypraea madagascariensis* Gmelin (by some authors placed in the sub-genus *Pustularia,* comprising three recent species) is the endemic form of the genus that can be traced with certainty to the modified descent of *Cypraea nucleus* Linnaeus. Several fossils of this species from the limestone of Oahu show a marked approach to *C. nucleus*; although some recent specimens may also show its strong characters." I gathered two beach shells of *C. madagascariensis* from Sand Island in Honolulu Harbor which closely resemble specimens of *C. nucleus* Linnaeus that have been collected from the dredgings of Honolulu Harbor.

The closest relative of *Cypraea ostergaardi* Dall seems to be *C. helvola* Linnaeus, which is well established in the Hawaiian group and has been taken from various localities about Oahu in the fossil state. It seems safe to infer that *C. ostergaardi* Dall is a recent development from *C. helvola* Linnaeus that has not yet become established.

TAXONOMY OF THE ENDEMIC COWRIES

Cypraea semiplota Mighel, Boston Soc. Proc., **2**:24, 1848.
Cypraea polita Roberts, Am. Jour. Conch., **4**:70, pl. 15, figs. 1-3, 1868.
Cypraea annae Roberts, Am. Jour. Conch., **4**:250, pl. 15, figs. 4-6, 1868.

Shell obovate, sometimes nearly cylindrical; creamy orange to blackish brown; dorsal surface sprinkled with minute white spots; columellar side of aperture angled, sometimes heavy; teeth on columellar side at the anterior and posterior canal extremities extend toward the lateral margins of the shell across the base, teeth in columellar center sometimes extend a short distance over the base but are sometimes confined to the aperture; teeth and aperture tinged with orange yellow or brown, interstices between the teeth wide; aperture narrow, curved posteriorly; base ivory white or tumid; margin of shell at base fluted; anterior and posterior canal extremities brown or yellow brown.

The shells of this species from the Honolulu harbor dredgings are often bleached to an orange or yellow-orange color. Sometimes the minute white spots on the dorsal surface of a specimen that has been collected alive are destroyed by bleaching. The color of the canal, base, and extremities of shells dredged in the dead state from Honolulu Harbor is often obscured.

Cypraea ostergaardi Dall, Nautilus, 35:50, 1921 (fig. 1).
Cypraea pacifica Ostergaard, Nautilus, **33**:92, 1920.

Shell whitish to cream colored to light brown, abundantly ornamented with chestnut brown spots, evenly sprinkled over the dorsal surface; base, aperture, and teeth white; lateral margins of shell elevated and pitted; teeth small and delicately cut, not confined to the aperture, and extending evenly over a narrow zone of the base. (Type specimen in the private collection of J. M. Ostergaard, Honolulu.)

When the late Dr. W. H. Dall reduced Mr. Ostergaard's species to synonomy he stated,[4] "I have had the opportunity of comparing a specimen [*Cypraea pacifica* Ostergaard] with the varieties of *C. Helvola* from the dump at Honolulu, to which it bears a suspicious resemblance, though apparently very distinct . . . I would suggest that this interesting form, whether variety or good species be named *ostergaardi* after its discoverer." Apparently Dr. Dall was not certain of the distinctness of this species from that of *Cypraea helvola* Linnaeus, and thought that it might prove to be only a variety. I have examined

[4] Dall, W. H., Nomenclature notes: Nautilus, **35**:49-50, 1921.

15 of the 18 specimens known to exist, and although *C. helvola* is the nearest relative of *C. ostergaardi,* this species is certainly distinct enough in shell characters so that it could not be considered the same or even a variety.

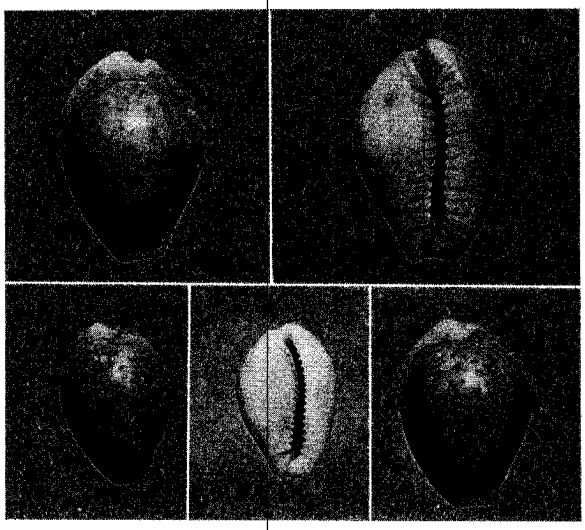

FIGURE 1.—*Cypraea ostergaardi* Dall: type specimen (lower right corner) and paratypes, about natural size (from photograph by C. H. Edmondson).

Cypraea tesellata Swainson, Zool. Jour., **1:** 150, 1824.

Shell squarely ovate; sides thickened; base angled upward toward lateral margins of shell; shell produced into distinct margins dorsally at anterior and posterior canal regions; extremities blunt; dorsal surface distinctly 3 banded with brown zones, color between zones light ash white to light brown; sides tesselated with light or dark brown square blotches, tesellations not always confined to the sides but sometimes found on dorsal-lateral portions of the shell, tesellations may be separated from base by irregular band of white or may be continuous with the color zonation of the base; base usually irregularly 3-banded with brown separated by white zones, the central brown band generally the broadest; teeth colored brown or orange brown; teeth usually extend for a short distance over the columellar and outer lip surfaces; teeth at the extreme anterior and posterior canal regions may or may not be confined to the aperture; teeth narrow.

The shells that have been gathered from the Honolulu harbor dredgings are usually bleached; sometimes the color zonation on the dorsal surface is obscured and the tesellations are much faded.

Cypraea sulcidentata Gray, Zool. Jour., **1**: 148, 1824.

Shell ovate, sides and base thick; canal extremities blunt; sides are generally but slightly produced to form a narrow margin at the dorsal anterior and posterior canal extremities, though such a margin may be lacking in some specimens; dorsal surface ornamented with four distinct pale brown bands, these bands may be nearly equal but generally the most anterior one is the widest; sides brown, granulously arenaceous; base light brown; canal slightly curved anteriorly and posteriorly; teeth prominent, interstices quite deep, teeth generally extend over the outer lip surface of the base to nearly half its width, columella teeth are more extensive on this surface at the anterior and posterior canal extremities than at the columella center.

Dredged specimens from Honolulu Harbor are often bleached to a rich orange color; the dorsal banding is generally much faded and is sometimes entirely lacking, and the brownish color of the base is usually reduced to a smoky white.

Cypraea madagascariensis Gmelin, Syst. Nat., 3419, 1790.

Shell ovate, compressed dorso-ventrally; dorsal surface noduled, nodules prominent and connected with one another by irregular ridges; a dorsal groove is depressed upon the back of the shell running from posterior to anterior extremities; lateral margins usually produced; extremities obtuse; aperture narrow or mediumly so; teeth extend over the entire base and are prominent, teeth may or may not be continuous with the ridges connecting the nodules on the dorsal surface; interstices between the teeth broad; teeth may be alternately large and small, or equal; shell color creamy white, dorsal surface tinged with light brown or pinkish brown; lateral edges of teeth edged with orange brown.

Beach shells of this species often lack coloring due to bleaching by the sun.