A Statistical Study in Cowries: The Size of *Mauritia arabica* (Linnaeus)

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(2 Textfigures)

Mauritia arabica (Linnaeus) ranges from the Red Sea and Natal to Japan and the Samoan Islands, if we include the well separable East African race immanis Schilder & Schilder, as well as the distinct species M. grayana Schilder which replaces M. arabica in the Red Sea and in the Persian Gulf. The other allied species, however, as M. eglantina (Duclos), histrio, (Gmelin), maculifera Schilder, depressa (Gray), etc., will not be discussed in the present paper as they belong to other superspecies (Schilder, 1947).

For forty years we have accumulated accurate notes on more than one hundred thousand cowry shells examined by us personally; they include almost 3,000 Mauritia arabica coming from about 350 localities.

We have stated the exact length of each shell in tenths of a millimeter (using a vernier); in this paper, however, the mean length of the shells coming from each locality or geographical area has been expressed in millimeters. As the standard deviation in these series of shells generally is about 4 to 7 mm., the mean error of their average length mostly is about ±1 mm., never exceeding ±2 mm.

The following list contains 55 habitats from which we have examined a significant number of Mauritia arabica personally; there are a few specific localities from which we received plenty of shells, and numerous extended areas containing several adjacent localities from which the number of specimens was too small to be treated separately. The geographical names are preceded by the average length of shells in millimeters, and they are followed by three figures: the first figure indicates the number of examined specimens divided by ten, so that, e.g., 3 is equal to about 25 to 35 shells; while the second figure indicates the number of different localities included in the area (independent collectors said to have collected at the same "locality" have been treated as different localities also). The average length of specimens living in each area can be estimated more accurately by a few shells coming from several localities than by numerous shells coming from one locality only in which the size of the shells may be influenced by an unusual environment. The third figure (in parentheses) indicates the average temperature (in degrees Centigrade) of the surface of the sea in the coldest month (February or August).

Mauritia grayana:

52 Aqaba — Ras Benas 2/10 (21°)
44 Jidda — Assab 2/6 (25°)
42 "Red Sea" (no locality) 5/8 (25°)
40 Perim — Berbera — Obbia 3/11 (25°)
49 Aden 2/9 (23°)
59 Muscat — Persia 2/4 (21°)
63 Karachi 3/5 (21°)
43 Seychelles — Mauritius (The occurrence needs confirmation, see Schilder & Schilder, 1939; Allan, 1956.) 2/5 (23°)

Mauritia arabica immanis:

74 Mogadishu — Delagoa Bay 3/11 (24°)
78 Natal 1/5 (21°)
68 Madagascar 2/12 (23°)
66 Réunion -- Rodriguez 2/9 (22°)
72 Seychelles 1/3 (25°)

Mauritia arabica arabica:

59 Bombay — Malpé 1/2 (25°)
47 C. Comorin — Pamban — Galle 2/6 (26°)
58 "Ceylon" (no locality) 5/5 (27°)
56 Trincomali 5/4 (27°)
58 Madras -- Waltair 1/5 (26°)
55 Mergui Archipelago 1/2 (27°)
47 Penang (Griffiths, 1956) 5/9 (28°)
52 Andaman Islands 6/8 (27°)
45 Atjeh — Nias — Oosthaven 7/16 (28°)
44 Labuan — Wijnkoopsbay 1/4 (27°)

42 Tjilaut Eureun (Schilder and Schilder, 1934) 54/1 (27°)
40 Tjilatjap — Sumbawa 2/7 (27°)
46 Tiger Islands — Macassar — Kutei 2/6 (27°)
47 Northcoast of Java 6/9 (27°)
50 Belitong — Singapore 1/6 (27°)
50 Siam Gulf — Pakhoi 1/7 (23°)
54 Hong Kong — Amoy 2/6 (14°)
58 Tokyo — Shikoku 1/3 (13°)
53 Ryukyu Islands — Taiwan 2/8 (20°)
45 Philippine Islands 4/12 (27°)
44 Sangi Islands — Mapia Island 1/2 (27°)
36 Ternate 7/1 (27°)
39 Menado 1/2 (27°)
44 Busak (N. W. Minahassa) 2/1 (27°)
43 Obi — Buru — Banda 9/12 (27°)
45 Kaimana — Kei — Aru 3/4 (26°)
61 Port Essington — Broome 1/2 (25°)
55 Sydney — Torres Straits 1/7 (20°)
42 Geelvink Bay — Huon Gulf 2/7 (28°)
41 Purdy Islands, Admiralty Islands 2/2 (28°)
45 New Britain (Schilder and Schilder, 1937): Bitokara 3/2 (28°)
44 id.: Ulamona 4/2 (28°)
38 id.: Mope — Iltishuk 46/6 (28°)
40 id.: Karlei 1/1 (28°)
43 Solomon Islands — Santa Cruz Islands 4/8 (28°)
53 New Caledonia 4/16 (23°)
56 Fiji Islands -- Tonga Islands 2/5 (24°)
55 Samoan Islands? ? (Schilder, 1958) 3/1 (27°)
49 Samoan Islands 2/7 (27°)
48 Wallis Island — Marshall Islands 2/7 (28°)
49 Palau Islands — Yap Island 2/6 (27°)
49 Guam, Marianas Islands 1/4 (26°)

According to this list, the average length of Mauritia arabica varies in various areas from 36 mm. (Ternate) to 78 mm. (Natal). We can afford a general view of these figures, if we reduce them into classes differing from each other by 5 mm. (e. g., class 40 embraces 38 to 42 mm., class 45 embraces 43 to 47 mm., etc.). Then we express these classes by visually impressible signs so that darker signs and triangles indicate larger shells than plain and round signs; we enter them on a map (fig. 1) from which we can learn the following interesting facts:

1. The smallest Mauritia arabica (classes 40 and 45 mm.) inhabit all areas between the Solomon Islands, the Philippine Islands, and Western Sumatra; this central zone can be indistinctly traced as far as to the Southern Red Sea.

2. On the Northern and Southern border of this equatorial zone the average size becomes larger (Bergmann's rule, Schilder, 1956); the gradual increasing of size in Mauritia arabica towards the polar confines of its distribution can be followed most distinctly from Singapore to Japan and from Berbera in both directions towards Aqaba and Karachi.

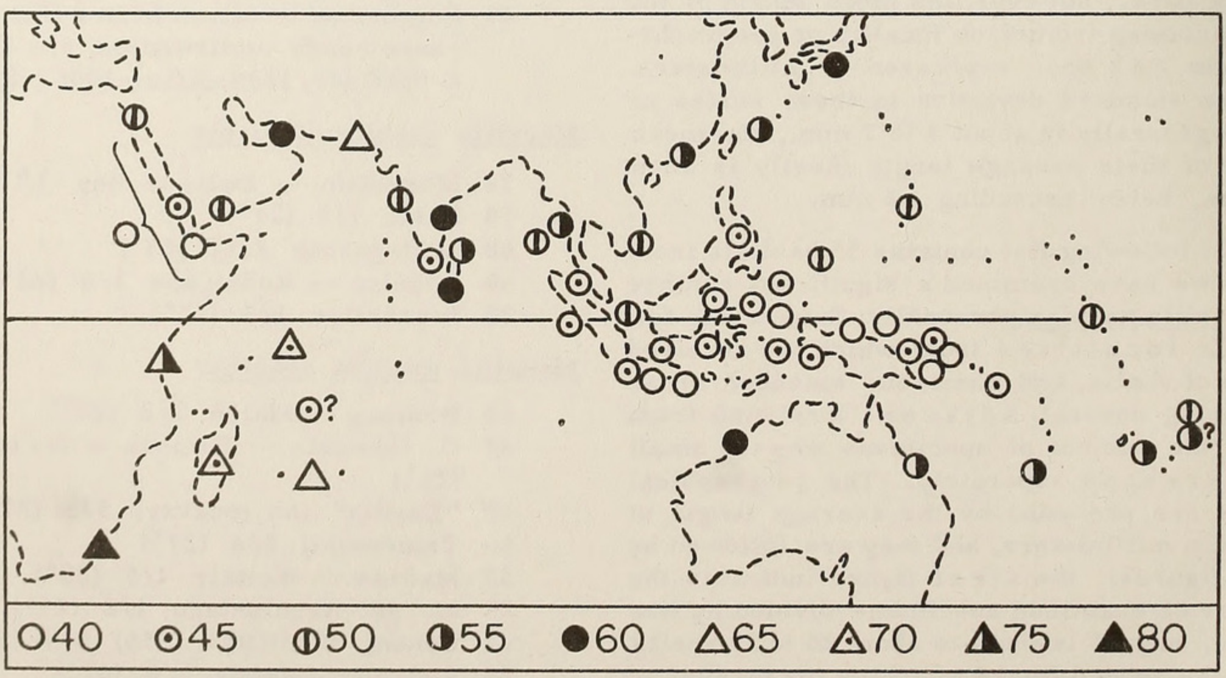

Figure 1

3. In addition, there is also a distinct increasing of size from the Malayan and Melanesian region towards the Eastern and Western borders of the habitat of Mauritia arabica arabica, i. e., towards Polynesia and India, so that the central zone around the Moluccas with small M. arabica becomes totally encircled by a zone with larger ones.

4. The North Western Mauritia grayana generally agrees in size with the Eastern M. arabica arabica, but the South Eastern race of the latter, M. arabica immanis, is extremely large; its size gradually increases from the Mascarene Islands to the African coast, and attains its maximum on the South Western border (Natal).

5. The North West Australian Mauritia arabica also seem to be much larger than one would expect, but the material available is too scanty for a definite statement; most Mauritia coming from this region belong to M. eglantina (perconfusa) and M. histrio (westralis).

These facts can also be shown by plotting the size against the winter temperature of the areas (fig. 2). The general ecological influence increasing the size in colder waters is modified by the probably genetical enlargement of shells in the central Pacific (nameless) and in the Indian race (dilacerata Schilder and Schilder) which becomes far surpassed in the East African Mauritia arabica immanis. Even in M. grayana there seems to be a racial difference between the Western and the Eastern populations {see Schilder and Schilder, 1939; the mean size of M. grayana from the Red Sea (Aqaba to Berbera) and from the Persian Gulf (to Karachi) is 43.8 ± 0.74 mm. and 61.8 ± 1.32 mm., respectively; the difference is significant ($P < 0.001$)}.

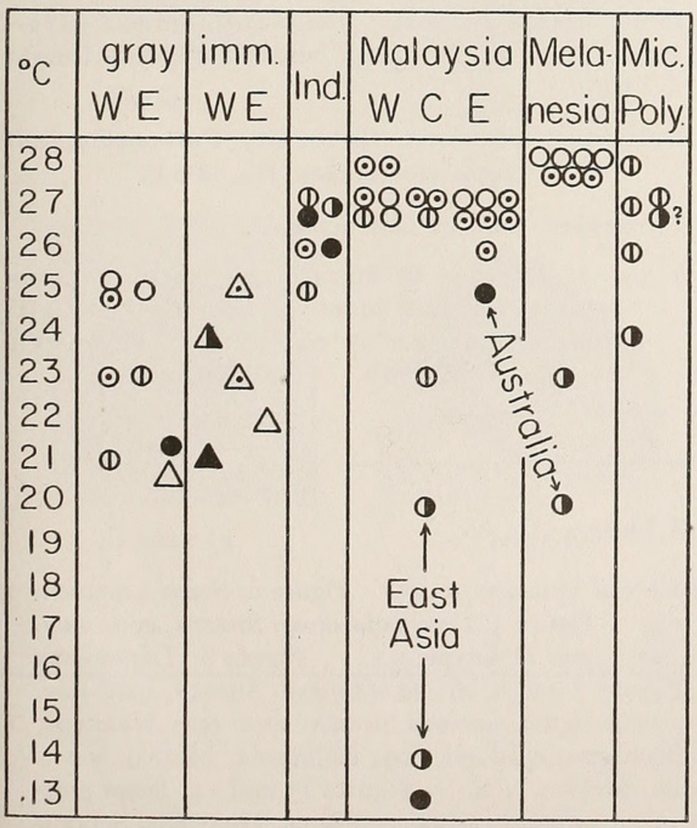

Figure 2

Annex. The correlation between the length of the shells and their relative breadth (i. e., the maximum breadth expressed in percent of the length) may be shown by the following table concerning 154 adult Mauritia arabica from Tjilaut Eureun:

Relative Breadth	Length 30	35	40	45	50	55	60	65
73	—	1	5	—	—	1	—	—
70	1	9	8	5	12	3	—	—
67	1	8	16	11	6	4	1	—
64	2	7	9	6	3	2	2	1
61	2	4	5	3	4	1	—	1
58	—	5	2	1	—	—	—	—
55	—	1	—	1	—	—	—	—

The correlation coefficient between these classes has been computed at $r = +0.104 \pm 0.080$ so that no correlation can be proved: broad shells generally occur among small specimens about as frequently as among large ones.

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