400 Å in diameter, are irregular in their outlines, and show various degrees of clumping into groups of two, three, four, or five individuals. The particles are extractable at the ultrastructural level with alpha amylase after long periods of time (12 to 18 hours), or in a short period of time (1 hour) following a pretreatment for 1 hour with pullulanase (*10*). Pullulanase is known to be selective for α-D(1→6) bonds (*11*), and although these data indicate a high degree of branching in the polysaccharide, they do not allow for an in vivo distinction between amylopectin and glycogen (*10*). The particles stain intensely with the periodic acid–thiocarbohydrazide–silver protein method of carbohydrate localization developed by Seligman *et al.* (*12*) and modified for ultrastructural use by Thiéry (*13*).

A complete biochemical analysis of this material is difficult because of the small size of each Müllerian body. However, 200 to 300 individual Müllerian bodies were collected in a microhomogenizer and ground in cold water. After centrifugation the supernatant had a very opalescent appearance. The material was initially precipitated with ethyl alcohol, and reprecipitated three times with ethyl alcohol, after which the final alcohol precipitate was evaporated at 40°C over silica gel. A small amount of the resulting white fluffy material was resuspended to 0.5 percent in water and tested with the Sumner and Somers (*14*) procedure for phytoglycogen and glycogen. As a control, glycogen from oyster was used. Both with and without the addition of a saturated ammonium sulfate solution, the oyster glycogen and the material from the Müllerian body remained colorless or turned slightly yellow to yellow-brown depending on the amount of I_2KI added. A pink color, indicative of phytoglycogen, was never detected in either the glycogen or Müllerian body material solutions.

Therefore, it seems reasonable to conclude that the material in the glycogen plastids of the Müllerian body is similar in every respect to oyster glycogen if not all animal glycogens. The location in a plastid is particularly significant if one considers the cytological machinery available for carbohydrate metabolism in a plant cell. Further, there are many interesting evolutionary ramifications to this system in that a survey of the ultrastructure of cells from trichilium tissue, leaf tissue, and green photosynthetic stem tissue of *Cecropia* reveals the presence of typical higher plant chloroplasts complete with a grana-lamella system and starch grains. Further study, on the ultrastructure of the young, maturing, mature, and germinating endosperm tissue of Golden Bantam sweet corn, is needed: the location of the glycogen in those cells should shed light on the question of glycogen metabolism in relation to ultrastructure, in higher green plants.

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Cerumen Genetics and Human Breast Cancer

Abstract. *International mortality and frequency rates for breast cancer seem to be associated with the frequency of the allele for wet-type cerumen. A preliminary retrospective case-control study in California indicates that phenotypically wet-type cerumen is found in Japanese women with breast cancer more often than in healthy Japanese women. Findings support the hypothesis that the apocrine system's genetically determined variation may influence susceptibility to breast cancer.*

Mortality rates from breast cancer are exceptionally low in Oriental populations and intermediate in those of Eastern Europe and the Middle East, as compared with women in Western Europe and the United States (*1*)—an epidemiological finding that so far is unexplained. The recently established genetic dimorphism in human cerumen (earwax) may be a significant trait for the studies of these international variations in rates of breast cancer.

Matsunaga (*2*) showed that cerumen occurs in two phenotypic forms, wet (sticky) and dry, and that the quality of cerumen is controlled by a single pair of genes in which the allele for the sticky trait is dominant to the allele for the dry. The homozygous wet type is phenotypically indistinguishable from the heterozygous form. Races vary widely in their frequencies of alleles for wet and dry cerumen: in Mongoloid populations of Asia and the Americas (Japanese, Koreans, Mongols, Chinese, and American Indians) frequencies of the dry allele are high; in Caucasians and U.S. Negroes they are low; and in populations in some countries of the Middle East and Southeast Asia (Turkey, Iran, Afghanistan, India, and Malaysia) they are intermediate (*2–5*).

This report presents data supporting an association between wet cerumen and rates of breast cancer in diverse population groups. Such an association is plausible since the ceruminous, mammary, and certain axillary sweat glands are histologically of the apocrine type, and their secretions are biochemically similar (*6–8*).

These histological and functional relations suggested the hypothesis that the disparate rates for breast cancer between Mongoloid and Caucasian populations might in part reflect genetic differences between persons with alleles for dry and wet cerumen expressed through the apocrine gland system. Such differences might differentially influence the susceptibility

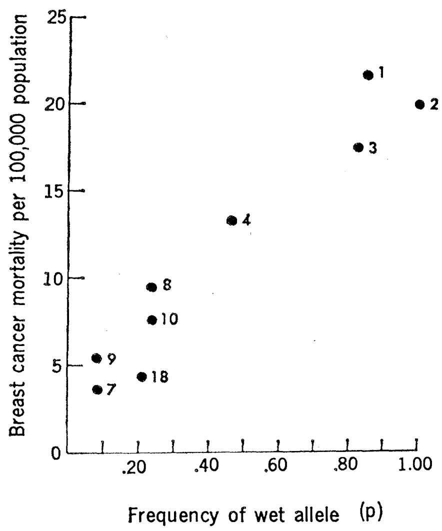

Fig. 1. Breast cancer mortality and the frequency of the allele (p) for wet cerumen. See Table 1 for key to numbers.

to breast cancer of persons with these alleles.

To test this hypothesis, I compared morbidity and mortality rates for breast cancer and the frequency of wet- and dry-type cerumen in selected countries or regions from which corresponding data were available. I also made a limited retrospective case-control study of the type of earwax in Japanese women in California with proven breast cancer. Caucasian and Negro women were unsuitable for such study because 99 percent of persons of these racial groups characteristically have wet cerumen, whereas only about 17 percent of Japanese have that type.

Age-adjusted data on rates for cancer mortality and case frequency were obtained from Dunham and Bailar (*9*) and from Segi *et al.* (*10*). Frequencies for cerumen type were obtained from published and unpublished data of Petrakis and co-workers (*3–5*) and from Matsunaga (*2*) (Table 1). Data on mortality and case-frequency rates were correlated, by population, with earwax frequencies; the mortality data were age-adjusted to the World Health Organization population standard (*10*). I did not believe it appropriate to use incidence rates in this analysis because corresponding cerumen data were available for only six populations.

Thirty-one California Japanese women with surgically proved breast cancer were examined for earwax type; an additional 54 Japanese women without breast cancer constituted a control group. The latter were healthy adults from community, church, and social groups in the San Francisco Bay area. Standard statistical techniques were used for evaluation.

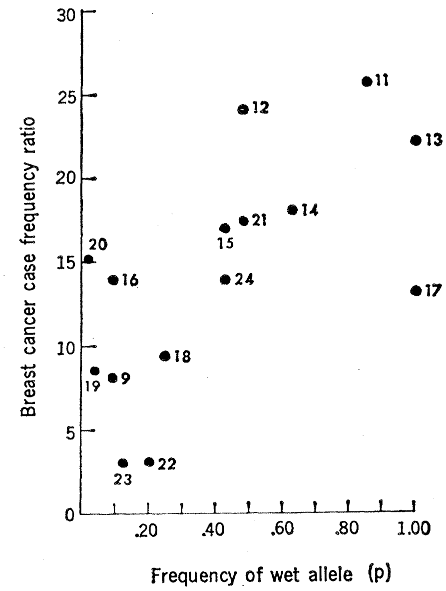

Fig. 2. Frequency rates of breast cancer and of the allele (p) for wet cerumen. See Table 1 for key to numbers.

Breast cancer mortality and case-frequency rates correlated positively with the frequency of wet cerumen (Figs. 1 and 2). Correlation coefficients were 0.956 ± 0.027 (standard error) and 0.642 ± 0.151, respectively. These population-based correlations appear to be supported by the pilot retrospective study of individual Japanese cancer patients, in which more Japanese women with breast cancer (9 out of 31 or 29 percent) had wet cerumen than did women of the control group (9 out of 52 or 17 percent). This suggests that in Japanese women with wet cerumen there is an approximately twofold increased relative risk of developing cancer. To statistically confirm these case-control findings will require sampling of more Japanese women with breast cancer than are available in California.

The findings reported here suggest that the association of wet cerumen and cancer rates may be due to the action of a pleiotropic allele, affecting the apocrine system (ceruminous, mammary, and axillary apocrine sweat glands), the fat depots, and possibly other systems, which in turn may affect susceptibility to breast cancer. In this regard, Wynder (*11*) reported that in Japanese women with breast cancer breast size was greater than it was in control subjects. Prior studies have indicated a significant degree of heritability in breast cancer (*12*) and stable

Table 1. Data used for frequency correlations of breast cancer and wet-type cerumen.

Country, group, or place	Cancer mortality (age-adjusted) per 100,000 (*10*)	Cancer frequency ratio (*9*)	Frequency of wet gene* (p)
1. U.S. whites	21.76		0.85
2. U.S. Negroes	20.02		1.00
3. West Germany	17.5		0.83
4. Finland	13.5		0.46
5. Armenian S.S.R.†			0.50
6. Turkmen S.S.R.†			0.42
7. Japan	3.80		0.09
8. Hong Kong	9.56		0.24
9. Japanese in California	5.3	8.1	0.09
10. Chinese in California	6.8		0.24
11. Caucasians in Hawaii		25.6	0.85
12. Turkey		24.0	0.49
13. Ghana‡		21.9	1.00
14. Bombay		17.1	0.62
15. Iran		16.0	0.42
16. Japanese in Hawaii		14.0	0.09
17. Nigeria‡		13.1	1.00
18. Taiwan	4.04	9.7	0.24
19. Korea		8.8	0.04
20. Shanghai, China		15.1	0.02
21. Malays in Malaysia		17.5	0.48
22. U.S. Indians		3.3	0.20
23. Oroya, Peru		3.2	0.12
24. Indians in Canada		14.0	0.42

* Gene frequencies obtained from studies of Petrakis and co-workers (*3–5*) and Matsunaga (*2*).
† Gene frequencies from Erzurum, Turkey, and Gonabad, Iran, were used as representative of Armenian S.S.R. and Turkmen S.S.R. in view of their geographic proximity and ethnic similarities.
‡ The frequency of wet genes in the U.S. Negro was used for Ghana and Nigeria since the African contribution to the U.S. Negro gene pool was preponderantly from West Africa (*19*), and H. Kalmus (personal communication) found only wet cerumen in Nigerians.

secular incidence and mortality rates (*13*) from this tumor. Unfortunately, it is not possible to distinguish between persons homozygous and heterozygous for the wet allele. Possibly a differential susceptibility to cancer may exist between these genotypes.

This hypothesis does not conflict with hormonal, dietary fat, and carcinogenic factors, whose importance has been suggested in the pathogenesis of breast cancer (*14, 15*) and which were recently summarized by MacMahon and Cole (*14*). Also, evidence suggests that the allele for wet cerumen may have an influence on fat metabolism. Kataura and Kataura (*16*) found that the relative proportion of polyunsaturated to saturated fatty acids was increased in dry cerumen, and Miyahara and Matsunaga (*17*) reported that wet cerumen was significantly more frequent in patients diagnosed with arteriosclerosis than in patients with other diseases. More recently, lysozyme and immunoglobulin G have been found in cerumen and were highly associated with the dry-type cerumen (*7*). Since these immunological factors are also found in the secretions of the breast and axillary apocrine glands, one might speculate that additional, possibly antiviral, immunological substances that could affect susceptibility to oncogenic viruses may be present in secretions of the apocrine system.

As one moves geographically westward from Asia to Western Europe, the increasing mortality rate for breast cancer is inversely related to the genetic gradient (or cline) of dry cerumen (*5*). The intermediate rates of breast cancer mortality and incidence that are reported in Eastern Europe and Asia Minor may reasonably be the current biomedical reflection of the historical and prehistorical admixture of Asian and European populations with differing genetic susceptibilities to breast cancer (*18*).

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18. For example, modern Finland and Hungary are believed to have been originally populated by peoples from the Ural Mountains region of Siberia. These peoples, in turn, represented a chain of intermediate Mongoloid-Europoid populations dating back to the time of first settlement of the Western Siberian forest belt [C. S. Coon, *The Living Races of Man* (Knopf, New York, 1965), pp. 60–67]. Soviet anthropologists suggest that considerable intermixing of populations of Asiatic and European peoples occurred in this area in the past [M. G. Levin, in *The Peoples of Siberia*, M. G. Levin and L. P. Potapov, Eds., S. P. Dunn, Transl. (Univ. of Chicago Press, Chicago, 1964), pp. 99–104]. Further gene flow from Asia to Europe also took place during historical times. The admixture of the Turks with the Mongols in the 13th to 15th centuries is also well documented.
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Rowing: A Similarity Analysis

Abstract. *The theory of models is employed for calculating the speed of geometrically similar racing shells. The theoretical prediction, that shells should have a speed proportional to the number of oarsmen raised to the 1/9 power, is in excellent agreement with observations. A significant implication for the proportions of lightweight and heavyweight eight-oared shells, indicating how both might attain the same speed, is developed.*

Why should larger boats containing many oarsmen go faster than smaller ones containing fewer oarsmen? The task of predicting the performance of a single man as he engages in athletic tasks such as running, jumping, flying, or, as in this case, rowing is in general difficult, since a specific knowledge is required of how chemical energy is converted to work and of how that work is utilized against external forces to produce motion. The theory of geometrically similar models makes possible enormous simplifications, provided the objective is changed from a prediction of absolute performance of a particular boat and crew to a comparison of the speeds of geometrically similar boats containing different numbers of oarsmen.

Consider the schematic representation of a shell in Fig. 1. The fundamental postulate of the following analysis will be that competitive shells are geometrically similar. The validity of this assumption is revealed in Table 1, where the length l and beam b are compared for shells accommodating one, two, four, and eight oarsmen. Despite the variety of sizes among the boats, the slenderness ratio l/b is reasonably invariant of the length of the boat. Also reasonably invariant is the boat weight per oarsman, which will have important consequences.

Each oarsman in either the lightweight or heavyweight class is assumed indistinguishable from other members of his class in weight and capability for sustained power output. The principal force that hinders the motion of the boat through the water is assumed to be skin friction drag. The great l/b ratio and relatively low velocity of the boats suggest that wave drag is small, and, in fact, full-scale towing tank tests have shown that the resistance due to leeway and wave-making together constitute only 8 percent of the total drag at 20 km per hour, the Olympic target speed, for an eight-oared shell (*1*).

The assumptions may be summarized as follows.

1) There is geometric similarity between boats, and the draft, or, equiv-