American Anthropologist

NEW SERIES

VOL. 28 October-December, 1926 No. 4

A NEW OBJECTIVE METHOD FOR SHOWING SPECIAL RELATIONSHIPS

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AS LONG ago as 1889, the British anthropologist, E. B. Tylor, called attention to the growing need of more exact methods for treating cultural data. In the *Journal of the Royal Anthropological Institute*, Vol. 18, page 245, he writes,

> For years past it has become evident that the great need of anthropology is that its method should become strengthened and systematized.

Revolutionary changes have come about in ethnological thinking, since Tylor's day. New theories, new concepts, and painstaking field studies have radically modified our ideas of culture processes in the last decade, and ethnology has consistently tended to become more and more objective. Yet, it is a truism that in every science there is always room for further refinement of method. Accordingly, the writers believe that the method which forms the subject of this paper is a further step toward that purely objective treatment of data which is so desirable.

Before proceeding with the detailed explanation of the method, it may be well to say a few words regarding our preliminary work. The process was developed in our seminar under the direction of Professor A. L. Kroeber of the University of California. Early in the work of the seminar, we took up for discussion a recent monograph by Ralph Linton on "The Material Culture of the Marquesas Islands," *Memoirs of the Bishop Museum*, Vol. 8, No. 5 (1923). In this monograph (pp. 449-457) Linton gives a comparative table of the material culture of six Polynesian groups: the Marquesas, New Zealand, Hawaii, the Society Islands, Samoa, and

Tonga. From the first, this table engaged our attention and we endeavored to adduce independent ethnological conclusions from it. It was soon apparent, however, that ordinary methods in the hands of persons not specialists in the Polynesian field were quite inadequate to cope with the material contained in the table. Accordingly, we turned to statistics for aid in the hope that some satisfactory means could be discovered of correlating the mass of tabulated data. In this hope we were not disappointed, and the method outlined below is the result of our work. During this phase of our task we were ably advised by Dr. Raymond Franzen of the Education Department at the University of California, and wish to take this opportunity of expressing our appreciation for his generous co-operation.

The process which we finally adopted and applied to the data is an extension of the well known "mean square contingency" method of correlation and gives its results in terms of probabilities. The detailed explanation of the process which follows will show exactly how it is to be applied.

In its original form, Linton's table was unsuited for our treatment and we were obliged to modify it accordingly as will be explained.

The following is our modification of Linton's table (pp. 449-457 in his book.)

TABLE I

		M.	N.Z.	H.	Soc.	I S.	T.
1.	Platform present	1	0	1	1	1	1
2.	Platform constant	1	0	1	0	0	0
3.	Platform rare	0	0	0	1	1	1
4.	Platform rectangular	1	0	1	1	0	x
5.	Platform oval	0	0	0	0	1	x
6.	Shape rectangular, house	1	1	1	1	0	0
7.	Shape oval, house	0	0	0	1	1	1
8.	Shape round, house	0	1	0	0	1	0
9.	Ridge pole	1	1	1	0	1	0
10.	End posts	1	1	1	1	0	0
11.	Indirect ridge pole	0	0	0	1	0	1
12.	Rigid triangular support	0	0	1	0	0	0
13.	Three posts in center and apse	0	0	0	0	1	0
14.	Entrance, end	0	1	1	0	0	0
15.	Entrance, side	1	0	1	1	1	1
16.	Door, wooden slide	1	1	0	0	0	0

		M.	N.Z.	H.	Soc.I.	S.	T.
17.	Door, mat	1	0	0	0	0	1
18.	Interior permanent division	1	1	1	1	0	0
19.	Ornamental lashings	1	0	1	1	1	1
20.	Carved posts	1	1	0	0	0	0
21.	Carved panels	0	1	0	0	0	0
22.	Woven panels	0	1	0	0	0	0
23.	Painted rafters	0	1	0	0	0	0
24.	Stools	0	0	1	1	0	0
25.	Soft Pillows	1	1	1	0	0	0
26.	Wooden pillows	1	1	0	0	0	0
27.	Legged pillows	0	0	0	1	1	1
28.	Store house on posts	1	1	0	1	0	x
29.	Men's house on posts	1	0	1	0	0	0
30.	House decoration	1	1	0	0	0	0
31.	Sacred house, high roofed	1	0	0	0	0	0
32.	Sacred house, like dwelling	0	1	1	1	1	1
33.	Sacred house, tapa, pyramid	0	0	1	0	0	0
34.	Canoes, five pieces	1	1	1	0	0	0
35.	Canoes, dugout	1	1	1	0	0	0
36.	Plank canoe	1	0	1	1	1	1
37.	Bow, long projection	1	1	0	1	0	0
38.	Bow, no projection	0	0	1	0	1	1
39.	Bow, horizontal	1	1	0	1	0	0
40.	Bow, decorated	1	1	0	1	1	0
41.	Bow, upturned knob	0	0	1	0	0	0
42.	Stern, upward curving	1	1	0	1	0	0
43.	Stern, upturned knob	0	0	1	0	0	0
44.	Stern, no projection	0	0	0	0	1	1
45.	Seams covered	1	1	0	0	0	0
46.	Seams decorated	1	1	0	0	0	0
47.	Outside rubbed down	0	0	0	1	1	1
48.	Lashings invisible outside	0	0	0	1	1	1
49.	Lashings visible inside and out	1	1	1	0	0	0
50.	Decoration elaborate	1	1	0	0	0	0
51.	Decoration slight	0	0	0	1	1	0
52.	Canoes painted	0	1	0	0	0	0
53.	Double canoe rare	0	1	0	0	0	0
54.	Double canoe equal size	1	1	1	1	0	0
55.	Double canoe unequal size	0	0	0	0	1	1
56.	Double canoe permanent	0	x	x	0	1	1
57.	Double canoe temporary	1	x	x	1	0	0
58.	Sail, inverted triangle	1	1	1	1	1	0
59.	Sail, lateen	0	0	0	0	1	1
60.	Tanged adz present	1	1	1	1	1	0
61.	Tanged adz common	1	1	1	1	0	0
62.	Tanged adz rare	0	0	0	0	1	0
63.	Triangular cross-sections	1	1	0	1	1	0

		M.	N.Z.	H.	Soc.I.	S.	T.
64.	Rectangular cross-sections	1	1	1	0	0	0
65.	Rough finish	1	1	1	1	1	0
66.	Rough finish rare	0	1	0	1	0	0
67.	Complete grinding	1	1	1	1	0	1
68.	Complete grinding rare	1	0	1	0	0	0
69.	Tangless adz secondary	1	1	0	0	0	0
70.	Tangless adz rare	0	0	1	1	0	0
71.	Tangless adz normal	0	0	0	0	1	1
72.	Axes	0	1	0	0	0	0
73.	Melanesian forms	0	1	0	0	0	1
74.	Pounders	1	1	1	1	0	0
75.	Pounders, flat tops	1	0	1	0	0	0
76.	Pounders, phallic tops	1	0	0	0	0	0
77.	Pounders, round tops	0	1	1	0	0	0
78.	Pounders, cross-grip	0	0	0	1	0	0
79.	Pounders, flaring base	1	0	1	1	0	0
80.	Pounders, carved	1	1	0	0	0	0
81.	Pestles	0	1	1	1	0	0
82.	Sinkers	1	1	0	0	0	0
83.	Small figures present	1	1	1	1	0	0
84.	Small figures fish, common	1	0	0	0	0	0
85.	Small figures fish, rare	0	0	1	1	0	0
86.	Small figures human, common	1	1	0	0	0	0
87.	Small figures, human, rare	0	0	1	1	0	0
88.	Large figures common	1	0	0	0	0	0
89.	Large figures rare	0	1	1	0	0	0
90.	Large figures present	1	1	1	0	0	0
91.	Box oval	1	1	0	x	0	x
92.	Box bird form	1	0	0	x	0	x
93.	Box round	0	0	1	x	1	x
94.	Legged bowls rare	0	0	1	0	0	0
95.	Legged bowls common	0	0	0	1	1	1
96.	Legged bowls present	0	0	1	1	1	1
97.	Paddle club	1	x	0	1	0	0
98.	Uu	1	x	0	0	0	0
99.	Stone club	0	x	1	0	0	0
100.	Sickle club	0	x	0	1	0	0
101.	Throwing club	0	x	1	0	1	1
102.	Bludgeon	0	x	1	1	0	0
103.	Fijian types blubs	0	x	0	0	1	1
104.	Shark tooth knives	1	1	1	0	0	0
105.	Shark tooth weapons	0	0	0	1	0	0
106.	Shark tooth sickle	0	0	0	1	0	0
107.	Bow, toy	1	0	1	1	1	0
108.	Bow, fishing or rat hunting	1	0	1	0	1	0
109.	Bow, weapon, important	0	0	0	0	0	1
110.	Bow, weapon traditional	0	1	0	0	0	0

	M.	N.Z.	H.	Soc.I.	S.	T.
111. Sling important	1	0	1	1	1	0
112. Sling rare	0	1	0	0	0	1
113. Sling as toy	0	1	0	0	0	0
114. Sling-stone, double conical	1	0	1	0	x	x
115. Sling-stone, not shaped	0	1	0	1	x	x
116. Throwing cord	1	1	0	0	0	0
117. Throwing cord with stick	0	1	0	0	0	0
118. Spear with detachable head	1	1	0	0	0	0
119. Chiefs stave	1	1	0	0	0	0
120. Chiefs stave with hair	1	0	0	0	0	0
121. Chiefs stave top carved	0	1	0	0	0	0
122. Armor, mats	0	1	1	0	0	0
123. Armor, wicker helmets	0	0	1	0	0	1
124. Armor, breast plates of fiber	0	0	0	1	0	0
125. Armor, like Gilbert Is.	0	0	0	0	1	0
126. Trumpet, cassis shell	1	0	1	0	0	0
127. Trumpet, Triton shell	1	1	0	1	1	1
128. Trumpet, separate mouthpiece	1	1	0	1	0	0
129. Wooden trumpet	1	1	0	0	0	0
120. Drum, cylindrical	1	0	1	1	0	0
131. Drum, canoe-shaped and gongs	0	1	0	0	0	0
132. Drum, horizontal	0	0	0	0	1	1
133. Flute important	1	1	0	0	0	0
134. Flute rare	0	0	0	0	1	1
135. Flute tunable	1	0	0	0	0	0
136. Presence of mouth flute	1	1	0	0	1	1
137. Nose flute important	1	0	1	1	0	0
138. Nose flute present	1	1	1	1	0	1
139. Musical bow present	1	0	1	x	0	0
140. Musical bow with strings	0	0	1	x	0	0
141. Jew's harp	1	0	1	x	0	0
142. Slotted bamboo	0	0	0	1	x	0
143. Bamboo lengths important	0	0	0	0	1	0
144. Bamboo lengths present	0	0	1	0	1	1
145. Stilts important	1	0	0	0	0	0
146. Stilts present	1	1	1	1	0	0
147. Surf boards present	1	1	1	1	1	0
148. Surf boards important	0	0	1	0	0	0
149. Darts important	1	1	0	0	0	0
150. Bowling	0	0	1	0	0	0
151. Coasting, children	0	1	0	0	0	0
152. Coasting, important	0	0	1	0	0	0
153. Coasting, present	0	1	1	0	0	0
154. Kites, important	0	1	0	0	0	0
155. Kites, present	1	1	1	1	0	0
156. Draft game	0	1	1	0	0	0
157. Men, tattooed, waiste to knee only	0	0	0	0	1	1

	M.	N.Z.	H.	Soc.I.	S.	T.
158. Men, tattooed, general	1	0	1	1	0	0
159. Men, tattooed, face	0	1	0	0	0	0
160. Women, tatooed, mouth	1	1	0	0	0	0
161. Women, tatooed, limbs	1	0	0	1	1	1
162. Women, tattooed, girdle	0	0	0	1	0	0
163. Tapa making stone anvil	1	x	0	0	0	0
164. Tapa making hollow wooden anvil	1	x	1	1	0	0
165. Tapa making solid wooden anvil	1	x	0	0	1	1
166. Tapa making square beater	1	x	1	1	1	1
167. Tapa making round beater	1	x	1	0	0	0
168. Tapa making grooved beater	1	x	1	1	1	1
169. Tapa making beater with water marks	0	x	1	1	0	0
170. Tapa decoration, dyed yellow	1	x	0	0	0	0
171. Tapa decoration, free-hand painting	0	x	0	1	1	1
172. Tapa decoration, block painting	0	x	0	0	1	1
173. Tapa decoration stamped design	0	x	1	1	0	0
174. Feather cloaks	0	1	1	0	0	x
175. Feathers pasted in base	1	0	0	0	0	x
176. Feathers in woven fabric	0	1	0	0	0	x
177. Feathers in netted fabric	0	0	1	1	0	x
178. Feathers woven in edges of fine mats	0	0	0	0	1	x
179. Necklaces of braided hair	1	0	1	0	0	0
180. Turban of braided hair	0	0	0	1	0	0
181. Fans, restricted use	1	x	1	0	0	0
182. Fans decorated and elaborate	1	x	1	1	1	1
183. Fly flap, restricted use	0	0	1	0	1	0
184. Fly flap, present	0	0	1	0	1	1
185. Fly flap, elaborately decorated	0	0	1	1	0	0
186. Carving highly developed	1	1	0	0	0	0
187. Carving poorly developed	0	0	1	0	1	1
188. Carving moderatley developed	0	0	0	1	0	0
189. Carving on utensils	1	1	1	1	0	0
190. Carving on tools	1	1	0	0	0	0
191. Carving on houses	1	1	0	0	0	0
192. Carving on canoes	1	1	0	1	1	0
193. Inlay	0	1	1	1	0	1
194. Designs lime filled	0	0	0	0	1	0
195. Painting of rafters, canoes and images	0	1	0	0	0	0
196. Painting of tapa only	0	0	1	1	1	1
197. Painting present	0	1	1	1	1	1
198. Designs curvilinear	1	1	0	0	0	0
199. Designs spiral	1	1	0	0	1	0
200. Designs conventional	1	1	0	0	0	0
201. Designs human forms	0	0	0	1	1	0
202. Designs animal forms	1	1	0	1	1	0
203. Treatment of design, surface zoned	1	1	0	1	1	1
204. Treatment of design, surface striped	0	0	1	0	0	0

	M.	N.Z.	H.	Soc.I.	S.	T.
205. Treatment of design, surface treated as whole	0	1	1	0	0	0
206. Treatment of design, superposition	1	1	0	0	0	0
207. Human figures conventionalized	1	1	1	1	0	x
208. Human figures naturalistic	0	1	1	0	0	x
209. Human figures present	1	1	1	1	0	1
210. Leg half flexed	1	1	1	1	0	x
211. Arms at sides	1	1	1	1	0	x
212. Hands on abdomen	1	1	0	1	0	x
213. Hands on hips	0	0	1	0	0	x
214. Five fingers equal length	1	0	1	1	1	x
215. Three fingers equal length	0	1	0	0	0	x
216. Outer fingers connected by groove	1	0	0	0	0	x
217. Body formed by series of planes	1	0	1	1	0	x
218. Body formed by rounded contours	0	1	1	1	0	x
219. Exaggerated mouth	1	1	1	1	0	x
220. Oval mouth	1	0	1	1	0	x
221. Naturalistic mouth	0	0	0	1	0	x
222. Beaked mouth	0	1	1	0	0	x
223. Prominent tongue	1	1	1	1	0	x
224. Nostril exaggerated	1	1	1	1	0	x
225. Flat nose	1	0	0	0	0	x
226. Bridge of nose not shown	0	1	1	0	0	x
227. Naturalistic nose	0	0	0	1	0	x
228. Oval eye	1	1	1	1	0	x
229. Eye with upward slant	1	1	1	0	0	x
230. Straight eyes	1	0	1	0	0	x
231. Eye with raised rim	1	0	0	1	0	x
232. Exaggerated brows	1	1	1	1	0	x
233. High brows	1	1	1	1	0	x
234. Arched brows	1	1	1	1	0	x
235. Straight brows	0	0	0	1	0	x
236. Straight brows slightly developed	1	0	1	1	0	0
237. Wall terrace and platform	1	0	1	1	1	1
238. Cut stone present	1	0	1	1	1	1
239. Cut stone highly developed	1	0	0	1	0	1
240. Cut stone rare	0	0	1	0	1	0
241. Rectangular slabs of cut stone	1	0	1	1	0	1
242. Mummification present	1	1	0	1	1	0
243. Mummification normal	1	0	0	1	0	0
244. Mummification rare	0	1	0	0	1	0
245. Evisceration	1	1	0	1	1	0
246. Temporary mummification by salt	0	0	1	0	0	0
247. Mummification in special house	1	1	0	1	1	0
248. Earth burial normal	0	0	0	0	1	1
249. Earth burial rare	1	1	1	1	0	0
250. Buried in flexed position	x	1	1	1	0	0
251. Buried in extended position	0	0	0	0	1	1

	M.	N.Z.	H.	Soc.I.	S.	T.
252. Body kept until disintegration	1	1	1	1	1	0
253. Body kept until disintegration rare	0	0	1	0	1	0
254. Body kept until disintegration normal	1	1	0	1	0	0
255. Bones put in sacred places	1	1	1	1	x	0
256. Skulls preserved	1	1	0	1	1	0
257. Vaults present	1	0	1	0	0	1
258. Cannibalism present	1	1	0	0	1	1
259. Cannibalism highly developed	1	1	0	0	0	0
260. Head-hunting present	1	1	0	1	1	1
261. Skulls decorated	1	0	0	0	0	0
262. Skulls preserved	1	1	0	0	0	0
263. Overlords	0	0	1	1	0	0
264. Loose tribal confederacies	1	1	0	0	0	0
265. Large political units	0	0	1	1	1	1
266. Chiefs of little power	1	0	0	0	0	0
267. Chiefs of little power rare	1	0	0	0	0	0
268. Ancestor worship	1	1	1	1	0	0
269. Worship of great gods	0	1	1	1	0	0
270. Worship of village animal gods	0	0	0	0	1	0
271. Priesthood organized	1	0	1	1	0	0
272. Ceremonial priests	1	0	1	1	0	0
273. Inspirational priests	1	0	0	0	0	1
274. Priest-chiefs	0	1	0	0	1	0
275. Human sacrifice present	1	1	1	1	0	0
276. Human sacrifice highly developed	1	0	1	0	0	0
277. Sacred houses with platforms	1	0	0	1	1	1
278. Sacred houses with enclosures	0	1	1	1	0	0
279. Sacred houses temporary	0	1	0	0	0	0
280. Sacred houses taboo	0	0	1	1	0	0
281. Organized instruction	1	1	0	0	0	0
282. Organized instruction for men and women	1	0	0	0	0	0

This table is compiled from Linton's table *without reference to any other data*—even such as might be gathered from the text of his book—and with minor exceptions (cited below) all of the data contained in his tabulation appear in Table I in the same order and classification. In order to treat the data statistically, we have made a separate item of each single trait, descriptive detail, or special characteristic. By this process of reduction to *simple* units, the ninety-three traits enumerated by Linton were expanded into two hundred eighty-two unit traits. Every island group was then scored for each unit trait in one of three ways, thus: presence of trait (score 1); absence of trait (score 0); no data on trait (score x).

An apparent objection to this process of splitting is that it will result in an unequal weighting of the material since certain of the original traits have not been subdivided, whereas certain other traits have been broken up into numerous separate units. Actually, whatever of weighting there may be is inherent within Linton's table and is not altered by our treatment, each of the thirteen main divisions breaking up, by our method, into roughly three times as many units as he makes of them. To wit:

Houses	10 traits, (Linton)	33 (ours).
Canoes	2 traits, (Linton)	26 (ours).
Stone artifacts	11 traits, (Linton)	31 (ours).
Containers	2 traits, (Linton)	6 (ours).
Weapons	9 traits, (Linton)	29 (ours).
Musical instruments	9 traits, (Linton)	19 (ours).
Toys	7 traits, (Linton)	12 (ours).
Dress and ornament	7 traits, (Linton)	28 (ours).
Art	6 traits, (Linton)	24 (ours).
Human figure	8 traits, (Linton)	26 (ours).
Stone construction	2 traits, (Linton)	6 (ours).
Mortuary practices	5 traits, (Linton)	16 (ours).
Miscellaneous	9 traits, (Linton)	25 (ours).

At this point it may be advisable to point out again that our method is primarily an objective process for showing *special* relationships. No one doubts that the island groups considered here belong to that general type of culture called Polynesian. What our method does is to show the little mountain peaks of agreement and disagreement rising above the level plain of general Polynesian culture; in other words, it shows the special relationships within the area.

This being true, it was, therefore, necessary to *eliminate all common elements*, that is, all traits either present or absent in all six of the island groups were disregarded. Throughout Table I we have made the presence of a trait a first unit; then, whenever the data contained the requisite information, we have made further units on the basis, first, of varying degrees of development, importance, (as given by Linton) and frequency; second, of special characteristics of style, type of construction, etc.

It is apparent that data such as these, the intention of which is descriptive, do not lend themselves to numerical treatment without certain judgments being passed in the course of their reduction to statistically comparable units. In order that the reader may know just what these judgments are, we append below a summary of our interpretations.

Such entries in Linton's table as "not reported," "not found," "found archeologically," were scored as 0 (absent) in Table I.

Under Houses. 1) Platform—Samoa "limited to temples and chief's houses" we interpreted as rare. 2) Houses on posts—Tonga, "occurrence of storehouses on posts uncertain" we scored as x (no data) in Table I.

Under Canoes. 1) Decoration—Society Islands, "small figures and other carving on bow and stern" we interpreted as "slight decoration."

Under Stone Artifacts. 1) Finish—Samoa, "very crude" was interpreted as "rough."

Under Containers. 1) Boxes—Society, "form unknown" was scored an x (no data).

Under Weapons. 1) Clubs—New Zealand, "characteristic local forms" was scored an x since the information is not sufficient for either a positive or a negative comparison. 2) Bow—Society, "used in chief's game" was interpreted as "toy" in Table I.

Under Musical Instruments. 1) Mouth-flute—Tonga, "rare or absent" was scored 1 (present).

Under Dress and Ornament. 1) Fans—Marquesas and Hawaii, "used by chiefs" was interpreted as "restricted use" in Table I. 2) Fly-trap—Hawaii, "part of chief's insignia" and Samoa, "carried by speaker chiefs," were both interpreted as "restricted use."

Under Art. 1) Human Figures—Samoa, "not used (one doubtful example) was scored 0 (absent). Hence, all the items for Samoa under "Conventions of the Human Figure" were scored 0 for absence.

Under Stone Construction. 1) Rough Stone—New Zealand, "little or no construction in recent times" was scored 0 for absence.

The foregoing explanation shows briefly just how Linton's table was transposed into the form of our Table I. It is now necessary to show in considerable detail the various mathematical steps involved in the statistical interpretation of Table I.

In the first place, it is necessary to list all the possible pairs of combinations of the six groups. There are fifteen of these pairs, thus, "Marquesas-New Zealand," "Marquesas-Hawaii," "New Zealand-Hawaii," etc. A square compartment divided into four cells is then drawn for each of the fifteen pairs of island groups. The following example will illustrate this clearly. Let us take for our purpose the first pair of islands, "Marquesas-New Zealand."

		New Zealand	
		Present	Absent
Marquesas	Present	Present in both.	Present in Marquesas; Absent in New Zealand
	Absent	Present in New Zealand; Absent in Marquesas.	Absent in both.

Now, by consulting Table I, we simply count up the number of traits present or absent in the Marquesas and in New Zealand and enter these totals in the appropriate small cells of the large square as indicated above. Upon doing this, we find the following distribution of traits in our square:

New Zealand

		Present	Absent	Sums
Marquesas	Present	90 *74* (A)	55 *71* (B)	145 (A+B)
	Absent	41 *57* (C)	70 *54* (D)	111 (C+D)
Sums		131 (A+C)	125 (B+D)	256 Total

The arabic figures indicate the actual totals for each cell.
The italic figures are explained in the second paragraph below.

It is now necessary to get the sum of these figures both vertically and horizontally. Thus, the sum of 90 and 41 is 131; of 55 and 70 the sum is 125. Now, adding horizontally, the sum of 90 and 55 is 145; that of 41 and 70 is 111. These sums added together either vertically or horizontally will give the same answer which is the total number of traits involved. Thus, the sum of 145 and 111 is 256 and the sum of 131 and 125 is also 256. There are 256 traits involved, then, in regard to the two groups constituting the Marquesas-New Zealand pair.

The next step is the calculation of the "chance" frequencies which are indicated in italics in the above square. This is done as follows: for convenience the cells are lettered A,B,C,D, and will be referred to hereafter by these letters. To get the "chance" frequency for cell A the following formula is used:

$\frac{(A+B)\times(A+C)}{T}$ = *the theoretical number of traits in cell* A *if chance were the only factor operative.*

T = total number of traits.

Substituting in this formula, we get:

$\frac{145\times131}{256}$ = *74, the theoretical number of traits in cell* A *if chance were the only factor involved.*

Similarly, for the other cells the formulae are as follows:

For cell B. $\frac{(A+B)\times(C+D)}{T}$ = the chance frequency.

For cell C. $\frac{(C+D)\times(A+C)}{T}$ = the chance frequency.

For cell D. $\frac{(C+D)\times(B+D)}{T}$ = the chance frequency.

Substituting in the above formulae, we get the number of traits which would occur in the respective cells if pure chance were the only force operating in the distribution of the data. These chance figures are indicated in italics in the large square above: Marquesas-New Zealand.

Suppose, now, that we let *nss* equal the actual frequency of a cell and let *mss* equal the theoretical or chance frequency. Thus, for cell A in the above distribution *nss* will equal 90 and *mss* will equal *74*.

If, now, we let the difference between *nss* and *mss* equal *dss*, we will get the difference between the actual frequency of a cell and its theoretical chance frequency. Thus, in cell A this difference, *dss*, equals the difference between 90 and *74* or +16, i.e., there are 16 more traits in cell A than there would be if chance were the only force operative in the data. Looking at cell B, we see that the actual frequency, *nss*, is 55, while the chance frequency, *mss*, is *71*. The difference, *dss*, in this case is minus 16, i.e., the actual number of traits in cell B is 16 less than it would be if chance were the only thing involved in the distribution. Thus, *dss* will be either plus or minus, depending on whether the actual frequency is greater or less than the theoretical chance frequency.

The following check is useful at this point as a means of testing the accuracy of the foregoing arithmetical operations. If the positive values for *dss* are added together, their sum should exactly equal the sum of the negative values for *dss*, and the total sum of all four *dss* values for any square will equal zero. If this sum of the positive and negative values is not zero, then a mistake has been made in the previous arithmetical calculations. Any such mistake must be rectified before continuing.

After getting *dss* for each cell, the next step is to calculate the "cell square contingency." This is done by substituting in the following formula:

$$\frac{(\text{dss})^2}{\text{mss}} = \text{the cell square contingency.}$$

In the case of cell A, substituting in the formula we get

$$\frac{(16)^2}{74} = \frac{256}{74} = 3.46, \text{ the contingency square for cell A.}$$

As the *dss* values are all squared in this process, the minus signs drop out and the values for the cell square contingencies are all positive.

The cell square contingencies are calculated in this way for all four cells and then added together. This sum is X^2. In the case used for illustration the sum of the cell square contingencies for all four cells is 16.29. In other words, the X^2 for Marquesas-New Zealand is 16.29

The values for X^2 were calculated in the way which has been described for each of the fifteen pairs of islands. These values for X^2 are given in Table II.

It now becomes necessary to convert the values found for X^2 into terms of probability expressed by P. This is best done by using Table XII in Karl Pearson's *Tables for Statisticians and Biometricians*, Biometric Laboratory, University College, London. Cambridge University Press, 1914.

Here various values for X^2 are given opposite the corresponding value for P. As we have used four cells in each of our fifteen squares, we use the P given in the column "n equal 4" in Pearson's Table

XII. A moment's glance at Pearson's table will make this clear. The corresponding value of P is thus found for each X^2 interpolating in the usual way if the exact value for X^2 is not given in the table.

For example, in the case used for illustration above, we find by consulting Pearson's Table XII and interpolating, that the P for a X^2 of 16.29 equals .001001. This is an expression of the probability of a similar distribution occurring by chance—in other words, there are only 1011 chances in a million, or one chance in one thousand, that the distribution of traits in the Marquesas and New Zealand is due to chance.

The values for P in each of our fifteen cases are given in Table II opposite their respective X^2 values.

Now P is also an indirect expression of correlation, but possesses the disadvantage of not showing whether the correlation is positive or negative. To overcome this difficulty, Dr. Kroeber suggested the following addition to the contingency method.

Referring back to the large square containing the distribution of traits in Marquesas-New Zealand, we see that cell A contains traits present in both islands while cell D contains traits absent in both. The traits in these cells evidently represent agreements between the two islands. On the other hand, cell B contains traits present in the Marquesas but absent in New Zealand, and cell C contains traits present in New Zealand but absent in the Marquesas. These latter two cells obviously represent disagreements between the two islands. Now, if we find the sum of the agreements and the sum of the disagreements, the difference between the two sums will represent the *excess* number of agreements or disagreements as the case may be. Thus, for any case

(1) $(A+D)-(B+C)=$ the excess of agreements over disagreements *where* $A+D$ *is larger than* $B+C$.

(2) $(B+C)-(A+D)=$ the excess of disagreements *where* $B+C$ *is larger than* $A+D$.

Substituting in No. 1 for our example "Marquesas-New Zealand," we get

$(90+70)-(55+41)=64$ excess agreements over disagreements.

Such a large excess of agreements superficially indicates a high degree of special relationship between the two islands. For confirmation of the figure, however, it is very important to consult the P for this pair of islands. Looking at Table II, we see that the P for Marquesas-New Zealand is .001011. In other words, pure chance has had very little to do with the distribution of traits found in these two islands and the degree of special relationship indicated by the high excess figure of 64 is valid.

The excess agreements or disagreements were calculated as explained above for each of the fifteen pairs of islands, and are listed in Table II. Excess agreements are indicated by positive signs while excess disagreements are marked with negative signs.

Explanation of Table II

The first column in the table shows the various values for the cells A,B,C, and D for each of the fifteen cases. These figures are derived from Table I as has been explained above. The second column in Table II contains the values for excess agreements or disagreements. Column three contains the values for X^2 from which the corresponding values for P in the fourth column are derived. The table is arranged to read from the greatest number of excess agreements down to the greatest excess of disagreements.

Concluding the explanation of the method, we may say that the P gives the reliability of the figure expressing the excess of agreements or disagreements. The lower the P, the less potent is the factor of chance and the greater the reliability of the *excess* figure. Just where the line shall be drawn to show this validity is a matter dependent on the set of data being used. For example, if, in a certain set of data, most of the values for P are high, say around .60 or .70, but one P has a value of .30, then this low P is very significant. On the other hand, another set of data may show values for P running around .002 or .06. In this latter case of P of .30 would show a relatively great factor of chance.

For example, in the set of data dealt with here, inspection reveals that a P of about .30 is the point of division. Then, a P below .30 indicates that the excess figure is valid, this validity

TABLE II

Islands	A	B	C	D	Excess agreements or disagreements	X^2	P
Samoa-Tonga	46	32	13	147	+148	75.00	.000000
Hawaii-Society	78	54	48	93	+69	17.04	.000697
Marquesas-New Zealand	90	55	41	70	+64	16.29	.001011
Society-Tonga	32	56	26	108	+58	7.88	.049119
Marquesas-Society	81	73	44	76	+40	7.23	.065944
Society-Samoa	43	81	35	110	+37	3.54	.321339
Marquesas-Hawaii	79	88	55	67	+ 3	0.22	.956276
Hawaii-Tonga	25	86	33	95	+ 1	0.35	.930439
New Zealand-Society	60	73	56	64	− 5	0.04	.992051
New Zealand-Hawaii	59	75	64	60	−20	1.54	.677677
Hawaii-Samoa	32	102	48	94	−24	3.43	.335656
Marquesas-Tonga	25	108	33	73	−43	4.50	.216631
New Zealand-Samoa	24	98	47	75	−46	9.60	.022856
Marquesas-Samoa	35	121	45	80	−51	5.72	.128463
New Zealand-Tonga	14	100	37	68	−55	17.31	.000625

increasing as the P decreases toward zero. Likewise, a P higher than .30 shows that the corresponding excess figure is not so reliable, this unreliability increasing as the P increases toward unity. However, we can draw the line at .30 only after inspection of the other values for P. In another set of data, a P of .30 might be relatively low or high, and the line of division would then be drawn elsewhere. We cannot arbitrarily say that all P's below .30 show reliability and all P's above .30 show unreliability. The matter is purely relative, and the selection of any given value of P below which all figures are reliable and above which all figures are untrustworthy depends wholly on the relative standing of the P's to each other in any set of data.

Two examples may clarify the matter. Referring to Table II, we see that Society-Samoa have an excess agreement of 37 traits. In itself, this excess would seem to indicate a considerable degree of special relationship between the two islands. The P for this group is .321339. That is, there are 32 chances out of 100 that this excess figure is due to chance. This means that the odds here are 2 to 1 against chance. Such odds, of course, are considerable; but when we look over the list of all the P's in Table II we see that there are many cases with much greater odds against chance. *Relatively*, then, a P of .32 is pretty close to the border line of validity for this particular set of data. We may conclude, then, that although Society and Samoa have an excess of 37 agreements, this excess is not nearly so reliable as it might be although it is still sufficiently reliable to be quite significant.

Again, we see that New Zealand and Hawaii have an excess of 20 disagreements which would seem to indicate a rather large degree of dissimilarity between the two islands. However, the P for these two groups is .677677, which means that the odds against chance being the sole factor involved are only 2 to 3. In other words, in the set of data dealt with here, a P of .67 indicates a considerable preponderance of chance and shows that the dissimilarity indicated by the 20 disagreements is largely superficial and really due to nothing but chance. On the other hand, Tonga-New Zealand show an excess of 55 disagreements with a P of .00625, which indicates that chance has been practically inoperative here and that the observed degree of dissimilarity is both high and valid. A few moments' study of Table II will serve to clear up any points remaining obscure.

From an examination of the figures in the preceding tables, various conclusions regarding the relations of the islands within the group to each other may be adduced. It is well to reiterate here, perhaps, that our interest is in the presentation of a method, and the ethnological conclusions which we give must be regarded in the light of a demonstration of the workability of our method. In no case do our conclusions go beyond the tabulated data and their numerical demonstration. It is our belief that our figures will prove highly suggestive to specialists in Polynesian ethnology, both as to the positive tendencies they seem to indicate for further investigation along the lines here started, and as to inadequacies and other weaknesses of the present data.

A study of Table II reveals the outstanding fact that the three highest positive excess figures with very low P's are for three pairs of islands none of which appears more than once. That is to say, the six islands fall into three groups which are primary. These are the three culture areas which are alluded to by Linton—Samoa-Tonga, Hawaii-Society, and Marquesas-New Zealand. A glance at a map of Polynesia will show the striking fact that these affiliations run counter to geography.

Again referring to Table II, we see that the last four groups have the greatest excess of disagreements with low P's which indicate that the excess figures are valid. All four of these are comparisons of the group Samoa-Tonga with Marquesas-New Zealand and exhaust all the possible relations between them. Thus, Samoa-Tonga and Marquesas-New Zealand have markedly greater divergence from each other than either has from the third culture area, Society-Hawaii.

Next to the three primary groups, we see that highest excess agreements (lines 4, 5, and 6 in Table II) all include Society. These figures all have reasonably low values for P which insures their reliability. This means that Society not only belongs to the primary culture area of Society-Hawaii but also has definite secondary affiliations with the two other groups, i.e., with Samoa-Tonga and with Marquesas. This makes Society the most generally connected of any of the six islands considered. But whether Society was an active source of culture which was carried out into Polynesia or simply acted as a passive focus which received a certain amount of culture from everywhere else, the figures do not show.

The remaining cases (lines 7, 8, 9, 10, and 11 in Table II) have the lowest excess figures with very high values for P. Thus, any apparent agreements or disagreements here are largely due to chance and there is no relationship except a generic Polynesian one. In these cases, there are four comparisons of Hawaii with members of the other areas. As the P's show a high chance factor here we must conclude that Hawaii has no specific relations with any other member of the group except Society with which it forms one of the three primary areas referred to above. Hawaiian culture, then, consists of two things, generic Polynesian elements and elements from Society.

On the other hand, Society has secondary affiliations with every member of the group except New Zealand. Therefore, New Zealand was not reached by specific Society influences while apparently Hawaii was reached *only* by them.

Regarding Samoa-Tonga, the relations of each to Marquesas and New Zealand are about equal both as the excess figures and the reliability of these figures. But in relation to Society and Hawaii, Tonga is much nearer than Samoa. We may then conclude that Tonga probably had somewhat more of a connection with Society, and through this with Hawaii, than did Samoa.

The high degree of special relationship between Samoa and Tonga is due to absences. That is, of the 282 traits considered here, so many were absent in both Samoa and Tonga that the relationship between them is overemphasized by the figures. Their relationship consists in a common *lack* of many traits found in the other groups. However, this does not affect our interpretation of the results because it shows even more clearly than in the other cases that Samoa-Tonga is a separate entity and makes it stand out more definitely than before as a primary area.

Summing up, we may say that the simplest interpretation of all these relationships is that there were two varieties of Polynesian culture which differed considerably. One of these is represented in Samoa and Tonga while the other is shown by Marquesas, New Zealand, and perhaps elsewhere. This latter type must be old; the Samoa-Tongan culture may be old or new. A third culture form, which is apparently new, overlaid the ancient Marquesan form but failed to reach New Zealand. It flooded Hawaii and either centered or culminated in Society. This culture also had some degree of relationship with the eastern type, primarily through Tonga.

Whether this Society form of culture was carried to Samoa and Tonga, there to be accepted as an overlay on the old native culture, or whether specific Samoa-Tongan elements were accepted in Society is not clearly indicated by our figures. This, however, is due to the fact that the data used were collected primarily from the standpoint of Marquesan culture.

The main outlines of our interpretation are shown graphically in the diagram.

The above results show, we believe, the practicability of our method and also its objectivity. It will be interesting to see just how it works out when applied generally in the field of ethnology.

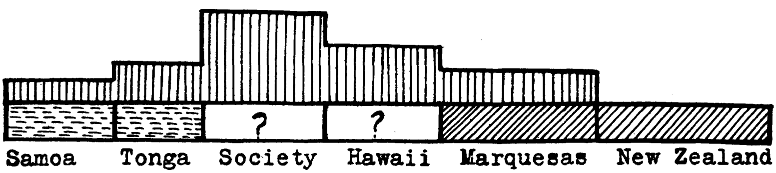
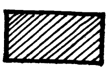
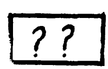


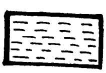
FIG. I.

KEY TO FIG. I.

 Old New Zealand-Marquesan culture.



Old Society-Hawaii culture?

 Samoan-Tongan culture.

 Overlaid culture, origin uncertain, but most strongly marked in Society.

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