Involucre conspicuous; corolla lilac-purple .... 3. *A. hakeaefolia.*
Involucre almost wanting; corolla azure-blue .... 4. *A. multifida.*

1. **Allogyne cuneiformis** (DC.) Lewton.
   Hibiscus capriodorus A. Cunn. MSS. in Herb. Hook.
   Hibiscus cuneiformis DC. Prod. **1:** 454. 1824.
   Lagunaria cuneiformis G. Don. Syst. **1:** 485. 1831.
   Fugosia cuneiformis Benth. Fl. Austr. **1:** 219. 1863.—Curt. Bot. Mag. *pl. 5413.* 1863.
   Fugosia cuneifolia F. von Muell. Fragm. Phyt. Austr. **9:** 127. 1875.
   Cienfuegosia cuneiformis Hochr. Ann. Conserv. Jard. Bot. Genève **6:** 56. 1902.
2. **Allogyne lilacina** (Lindley) Lewton.
   Hibiscus lilacinus Lindley, Edwards' Bot. Reg. *pl. 2009.* 1837.
   Lagunaria lilacina Walpers, Bot. Rep. **1:** 311. 1842.
   Hibiscus coronopifolius Miquel in Lehm. Pl. Preiss. **1:** 239. 1845.
   Fugosia hakeaefolia var. *coronopifolia* Benth. Fl. Austr. **1:** 220. 1863.
   Fugosia lilacina G. Don, ex Loud. Encyc. Pl. Suppl. **2:** 1426. 1866.
   Cienfuegosia hakeaefolia var. *lilacina* Hochr. Ann. Conserv. Jard. Bot. Genève **6:** 56. 1902.
3. **Allogyne hakeaefolia** (Giordano) Alefeld, Oesterr. Bot. Zeitschr. **13:** 12. 1863.
   Hibiscus hakeaefolius Giordano, Att. Real Inst. Sci. Nat. **5:** 252. 1834.
   Fugosia hakeaefolia Hooker, Curt. Bot. Mag. *pl. 4261.* 1846.
   Alogyne hakeifolia Alefeld, Oesterr. Bot. Zeitschr. **13:** 12. 1863.
   Cienfuegosia hakeaefolia var. *genuina* Hochr. Ann. Conserv. Jard. Bot. Genève **6:** 56. 1902.
4. **Allogyne multifida** (Paxton) Lewton.
   Hibiscus multifidus Paxton, Mag. Bot. **7:** 103. *pl.* 1840.

ZOOLOGY.—*The correlation of phylogenetic specialization and bathymetrical distribution among the recent crinoids.*[1] AUSTIN H. CLARK, National Museum.

In the recent crinoids there are thirty-seven pairs of obvious contrasted characters which are commonly employed in distinguishing the various genera and families, and which are similarly used in their fossil representatives.

The two contrasted characters in each pair always differ in that one represents a higher grade of phylogenetic specialization

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of development than the other; and the one representing the greater degree of specialization always differs from the more primitive in the partial or complete suppression of some structural feature, indicating that phylogenetic progress in the crinoids has been along the line of progressive structural degeneration, resulting in a constantly increasing structural simplification.

If in each contrasted pair we place under each of the two contrasted characters the crinoid families in which it is manifested it is evident that, although in nearly every case the families will be differently divided, an examination of the bathymetrical range of all of the entries under the more specialized characters taken together, contrasted with that of all of the entries under the less specialized characters taken together, will enable us to ascertain with a greater or lesser degree of accuracy the relationship between phylogenetic development and depth.

The number of contrasted pairs in each of the divisions of the crinoid body, and the number of separate items or entries in each of the divisions—that is, the number of citations of families under all the subheadings taken together—are as follows:

	Number of headings	*Number of separate items*
Calyx	10	68
Arms	9	63
Column	7	42
Pinnules	5	35
Disk	5	28
General	1	7
Total	37	243

Being composed of the greatest number of structural units—each a group of similar structural elements—all of which vary more or less independently, the calyx is naturally the most changeable division of the crinoid body.

The arms, through their differentiation into phylogenetically very distinct distal and basal portions, and through the close interdependence of the latter upon conditions in the calyx, form the next most changeable division.

The column, in spite of being fundamentally a simple linear series of similar ossicles, shows very great diversity; and it is chiefly as a result of this diversity in the column and the consequent necessity for a compensating mechanical readjustment that the calyx exhibits such a great amount of variation.

The pinnules and the disk, owing to their intimate connection with the gathering of the minute organisms which serve as food, are able to vary but little from a fixed optimum type.

If we take all of the entries under all of the more primitive characters (1) in all of the thirty-seven contrasting pairs, and similarly all of the entries under all of the more specialized characters (2), and determine their frequency at different depths, we get the following table. Under the heading "General" is included only the number of component ossicles in the skeleton, which decreases greatly more or less in correlation with phylogenetic progress along other lines.

TABLE 1

Frequency at different depths of the more primitive (1) and the more specialized (2) characters, arranged according to the divisons of the body

	Calyx		*Column*		*Disk*		*Arms*		*Pinnules*		*General*	
	1	2	1	2	1	2	1	2	1	2	1	2
0–50	12	14	4	8	7	7	11	15	9	6	1	2
50–100	15	20	8	11	8	9	14	21	14	6	1	3
100–150	15	20	8	11	8	9	15	21	14	6	1	3
150–200	13	15	5	8	5	7	12	15	10	5	1	2
200–250	13	15	5	8	5	7	12	15	10	5	1	2
250–300	15	19	11	9	9	8	20	15	15	5	1	3
300–350	15	19	11	9	9	8	20	15	15	5	1	3
350–400	19	20	11	9	9	8	19	16	15	5	1	3
400–450	19	20	11	9	9	8	19	16	15	5	1	3
450–500	19	20	11	9	9	8	19	16	15	5	1	3
500–550	24	25	15	12	9	10	25	18	19	6	1	4
550–600	28	30	20	14	12	10	29	23	23	7	1	5
600–650	28	30	18	14	12	10	29	23	23	7	1	5
650–700	28	30	18	14	12	10	28	22	23	7	1	5
700–750	28	30	18	14	12	10	28	22	23	7	1	5
750–800	23	25	14	11	11	8	22	20	19	6	1	4
800–850	22	25	14	11	11	8	22	19	19	6	1	4
850–900	22	25	14	11	11	8	22	16	19	6	1	4
900–950	22	25	14	13	11	8	22	16	19	6	1	4
950–1000	18	20	11	9	9	8	18	11	15	5	1	3
1000–1100	18	20	11	9	9	8	18	11	15	5	1	3

TABLE 1—Continued

	Calyx		*Column*		*Disk*		*Arms*		*Pinnules*		*General*	
	1	2	1	2	1	2	1	2	1	2	1	2
1100–1200	18	20	11	9	9	7	18	11	14	5	1	3
1200–1300	18	20	11	9	9	7	18	11	14	4	1	3
1300–1400	18	20	11	9	9	7	18	10	14	4	1	3
1400–1500	13	20	11	9	7	7	17	10	13	4	0	3
1500–1600	13	20	11	9	7	7	17	10	13	4	0	3
1600–1700	13	20	11	9	7	7	17	10	11	4	0	3
1700–1800	13	20	11	9	7	7	17	10	11	4	0	3
1800–1900	11	19	11	9	7	7	16	10	11	4	0	3
1900–2000	11	19	11	9	7	7	16	10	11	4	0	3
2000–2500	11	19	10	9	7	7	16	10	11	4	0	3
2500–3000	9	19	9	9	7	6	16	10	11	4	0	3

The same, expressed as percentages of the whole number in each category:

TABLE 2

	Calyx		*Column*		*Disk*		*Arms*		*Pinnules*		*General*	
	1	2	1	2	1	2	1	2	1	2	1	2
0–50	18	21	9	19	25	25	17	24	26	17	14	29
50–100	22	29	19	26	28	32	22	33	40	17	14	43
100–150	22	29	19	26	28	32	24	33	40	17	14	43
150–200	19	22	12	19	18	25	19	24	28	14	14	29
200–250	19	22	12	19	18	25	19	24	28	14	14	29
250–300	22	28	26	21	32	28	32	24	43	14	14	43
300–350	22	28	26	21	32	28	32	24	43	14	14	43
350–400	28	29	26	21	32	28	30	25	43	14	14	43
400–450	28	29	26	21	32	28	30	25	43	14	14	43
450–500	28	29	26	21	32	28	30	25	43	14	14	43
500–550	35	37	36	28	32	36	39	29	54	17	14	57
550–600	41	44	48	33	43	36	46	36	66	20	14	71
600–650	41	44	43	33	43	36	46	36	66	20	14	71
650–700	41	44	43	33	43	36	44	35	66	20	14	71
700–750	41	44	43	33	43	36	44	35	66	20	14	71
750–800	34	37	33	26	39	28	35	32	54	17	14	57
800–850	32	37	33	26	39	28	35	30	54	17	14	57
850–900	32	37	33	26	39	28	35	25	54	17	14	57
900–950	32	37	33	31	39	28	35	25	54	17	14	57
950–1000	26	29	26	21	32	28	29	17	43	14	14	43
1000–1100	26	29	26	21	32	28	29	17	43	14	14	43
1100–1200	26	29	26	21	32	25	29	17	40	14	14	43
1200–1300	26	29	26	21	32	25	29	17	40	11	14	43
1300–1400	26	29	26	21	32	25	29	16	40	11	14	43
1400–1500	19	29	26	21	25	25	27	16	37	11	0	43
1500–1600	19	29	26	21	25	25	27	16	37	11	0	43
1600–1700	19	29	26	21	25	25	27	16	31	11	0	43
1700–1800	19	29	26	21	25	25	27	16	31	11	0	43

TABLE 2—Continued

	Calyx		*Column*		*Disk*		*Arms*		*Pinnules*		*General*	
	1	2	1	2	1	2	1	2	1	2	1	2
1800–1900	16	28	26	21	25	25	25	16	31	11	0	43
1900–2000	16	28	26	21	25	25	25	16	31	11	0	43
2000–2500	16	28	24	21	25	25	25	16	31	11	0	43
2500–3000	13	28	21	21	25	21	25	16	31	11	0	43

Averaging all of the more primitive characters (in the columns numbered 1) and all of the more specialized characters (in the columns numbered 2) we get the following table.

TABLE 3

	Totals of the columns numbered "1"		*Totals of the columns numbered "2"*	
	with "General"	*without "General"*	*with "General"*	*without "General"*
0–50	18	19	22	21
50–100	24	26	30	28
100–150	25	27	30	28
150–200	18	19	22	21
200–250	18	19	22	21
250–300	28	31	26	23
300–350	28	31	26	23
350–400	29	32	27	23
400–450	29	32	27	23
450–500	29	32	27	23
500–550	35	39	34	29
550–600	43	49	40	34
600–650	42	48	40	34
650–700	42	48	39	34
700–750	42	48	39	34
750–800	35	39	33	28
800–850	35	39	32	28
850–900	35	39	31	27
900–950	35	39	32	28
950–1000	29	31	25	22
1000–1100	29	31	25	22
1100–1200	28	31	25	21
1200–1300	28	31	24	21
1300–1400	28	31	24	20
1400–1500	22	27	24	20
1500–1600	22	27	24	20
1600–1700	22	27	24	19
1700–1800	21	27	24	19
1800–1900	20	25	24	20
1900–2000	20	25	24	20
2000–2500	20	24	24	20
2500–3000	19	23	23	20

The averages given in the preceding table are plotted in figure 1.

In this we see that the more specialized characters outnumber the more primitive down to 250 fathoms, but from that point downward the more primitive characters outnumber the more specialized.

Unfortunately the course of the lines in figure 1 is so irregular as to render difficult a true appreciation of the interrelationships

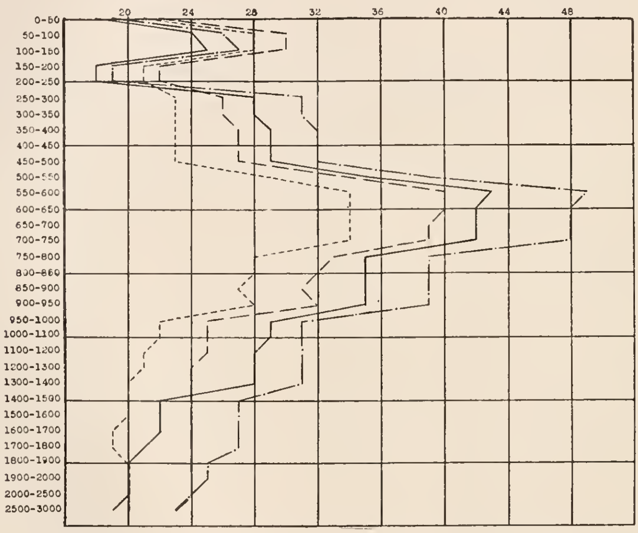

Fig. 1. The bathymetrical distribution of structural characters in the recent crinoids; ———, the more primitive characters, including those under the heading "General;" —.—, the more primitive characters, without those under the heading "General;" — — —, the more specialized characters, including those under the heading "General;" - - - - - -, the more specialized characters, without those under the heading "General."

of the two sets of characters. This difficulty may best be overcome by ascertaining the excess of the primitive or of the specialized characters at the various depths. The figures representing this are given in the following table.

Plotting these (fig. 2), we find that above 250 fathoms the specialized characters predominate; if we include the characters under the heading "General" we find a well marked node at 50–

TABLE 4

Difference between the percentages of the characters "1" and "2" at different depths

	with "General"		*without "General"*	
	excess of "1"	*excess of "2"*	*excess of "1"*	*excess of "2"*
0–50	0	4	0	2
50–100	0	6	0	2
100–150	0	5	0	1
150–200	0	4	0	2
200–250	0	4	0	2
250–300	2	0	8	0
300–350	2	0	8	0
350–400	2	0	9	0
400–450	2	0	9	0
450–500	2	0	9	0
500–550	1	0	10	0
550–600	3	0	15	0
600–650	2	0	14	0
650–700	3	0	14	0
700–750	3	0	14	0
750–800	2	0	11	0
800–850	3	0	11	0
850–900	4	0	12	0
900–950	3	0	11	0
950–100	4	0	9	0
1000–1100	4	0	9	0
1100–1200	3	0	10	0
1200–1300	4	0	10	0
1300–1400	4	0	11	0
1400–1500	0	2	7	0
1500–1600	0	2	7	0
1600–1700	0	2	8	0
1700–1800	0	3	8	0
1800–1900	0	4	5	0
1900–2000	0	4	5	0
2000–2500	0	4	4	0
2500–3000	0	4	3	0

100 fathoms, lying in a zone of higher temperature than the optimum for these animals.

Disregarding the characters under the heading "General," we see that the primitive characters are always in excess below 250 fathoms; this excess reaches a maximum at 550–600 fathoms, slowly rising to only one-third as much at 2500–3000 fathoms.

Including the characters under the heading "General," we note a maximum development of primitive characters between 850 and 1400 fathoms, beyond which point there is a sharp rise so that from 1500 to 3000 fathoms the specialized characters are in excess.

In regard to the characters under the heading "General" we should remember that, while the number of component ossicles in the skeleton is of considerable phylogenetic significance in shallow water, it decreases rapidly in importance with depth, for the conditions in the abysses are typically such that, chiefly on account of the very limited food supply, no crinoid can grow to the phylogenetically normal size, and hence all the species are necessarily dwarfs, unable to develop to the full the skeleton normal to their type. In other words, in the deeps we find a semi-pathological condition inducing degeneration along the same lines taken by normal phylogenetic advance. It is this semi-pathological degeneration simulating phylogenetic advance which causes the rise in the line representing the figures without those under the heading "General" from 550–600 to 2500–3000 fathoms. This occurs in all the differential characters, but its importance in the skeleton as a whole is here exaggerated for the reason that in this feature we have included only one contrasted pair.

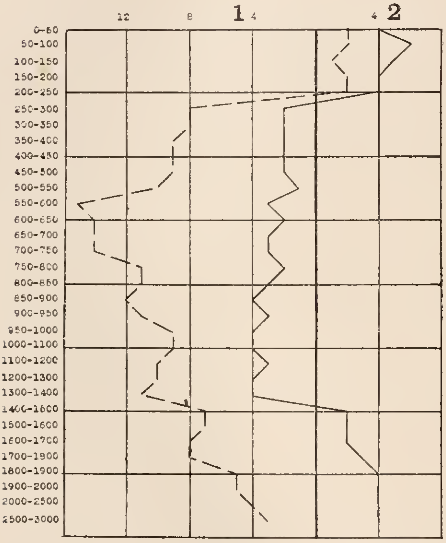

Fig. 2. The excess among the recent crinoids of primitive (1) or specialized (2) characters at different depths, including (———) and without (- - - - - -) those under the heading "General."

Probably in the present study we are most nearly correct if we take above 250 fathoms the line representing the characters including those under the heading "General," and below 250 fathoms the line representing those without.

If we do this, we find the highest degree of specialization in the recent crinoids above 250 fathoms, and especially between 50 and 150 fathoms, which represents a zone above the optimum temperature for the group.

The least degree of specialization is reached between 550 and 750 fathoms, and this is possibly the maximum depth to which a crinoid can ordinarily descend without undergoing semi-pathological degeneration.

Below 750 fathoms the excess of primitive characters becomes slowly less and less pronounced through semi-pathological changes simulating true phylogenetic advance, so that at 2500–3000 fathoms it is only slightly less than the excess of specialized characters at the surface.

If the preceding deductions are justified,

(1) The most marked phylogenetical advance, which is always evidenced by a greater or lesser suppression of some structural feature, occurs not under optimum conditions for the type under consideration, but under the more or less unfavorable conditions of the warm littoral.

(2) Progressively more and more unfavorable conditions induce a correlated phylogenetical conservatism, and finally a phylogenetical stagnation.

(3) Very unfavorable conditions induce a progressively increasing semi-pathological degeneration which, though usually very different in the details of its manifestation, is biologically the equivalent of phylogenetical advance under the optimum conditions.

(4) Many deep sea types, or types living under similarly unfavorable conditions, which exhibit an extraordinary mixture of very primitive and very highly specialized characters, are to be interpreted as primitive types upon which is superposed a pseudo-specialization induced by the pathological effect of their environment.