

ZOOLOGY.—*The bathymetrical and thermal distribution of the unstalked crinoids, or comatulids, occurring on the coasts of China and Japan.* AUSTIN H. CLARK, National Museum.<sup>1</sup>

The fauna of the coasts of China and Japan includes 92 recognized species and subspecies of comatulids, of which 2 are probably best considered as local aberrant forms, so that the actual number may be placed at 90.

Of these 90, 61 belong to the Indo-Pacific fauna, characterizing the Southern Japanese division of that fauna, which ranges from Hong Kong and Formosa to the Korean Straits and thence eastward to Tokyo Bay; 22 are Malayan, wide ranging types, each with a distribution different from that of the others; 4 are Antarctic, reaching Japan from the northeastward by way of Alaska and the Aleu-

tian Islands; and 3 (plus varieties of one of them—5 in all) are Arctic. One of these last, *Heliometra glacialis maxima* (with *Heliometra glacialis biarticulata* and *Heliometra glacialis brachymera*) is very closely related to *Heliometra glacialis glacialis*, which occurs in the Arctic Ocean from west of Greenland to the Kara Sea, and southward to Nova

Scotia and northern Norway, but the other two are of quite different origin; *Psathyrometra erythrizon* was originally Antarctic, like *Psathyrometra fragilis*, to which it is closely related, and entered the Seas of Okhotsk and Japan from the northeastward; *Thaumatometra tenuis* is most closely related to species in the

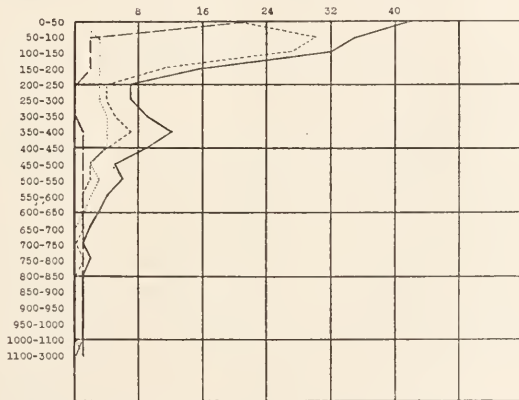


Fig. 1. The frequency at different depths of the comatulids of the coasts of China and Japan. ----- The Species of the Indo-Pacific Fauna; ——— The Species of the Malayan Fauna; ..... The Species of the Arctic and Antarctic Faunas; — · — · The Total for all Species.

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*Bathymetric and thermal ranges of the comatulids occurring along the coasts of China and Japan*

	Depth in fathoms	Temperature
M	<i>Comatella stelligera</i> .....	0-36 (24+)
	<i>Comatella decora</i> .....	95-106 13.28
M	<i>Capillaster macrobrachius</i> .....	0 (24+)
	<i>Capillaster mariae</i> .....	0-59 16.72
M	<i>Capillaster multiradiata</i> .....	0-160 (24+)
M	<i>Comatula solaris</i> .....	0-14 (24+)
M	<i>Comatulides decameros</i> .....	170 ?
M	<i>Comaster gracilis</i> .....	0-30 (24+)
M	<i>Comaster fruticosus</i> .....	19-58 24.28
	<i>Comaster serrata</i> .....	30-106 13.28
	<i>Comantheria intermedia</i> .....	83 ?
	<i>Comantheria grandicalyx</i> .....	0 (24+)
	<i>Comantheria imbricata</i> .....	36-50 ?
	<i>Comanthus (Bennettia) solaster</i> ..	0-108 13.28-18.00
	<i>Comanthus (Bennettia) pinguis</i> ..	21-125 14.33-15.89
	<i>Comanthus (Bennettia) japonica</i> ..	0-140 11.28-16.72
M	<i>Comanthus (Vania) parvicirra</i> ...	0-44 (24+)
M	<i>Zygometra comata</i> .....	0-49 (24+)
	<i>Eudiocrinus variegatus</i> .....	60 ?
	<i>Catoptometra rubroflava</i> .....	14-100 16.72
	<i>Catoptometra hartlaubii</i> .....	63-152 13.33
M	<i>Amphimetra schlegelii</i> .....	0 (24+)
M	<i>Amphimetra varipinna</i> .....	0 (24+)
M	<i>Amphimetra sinensis</i> .....	0 (24+)
M	<i>Amphimetra laevipinna</i> .....	0 (24+)
M	<i>Himerometra magnipinna</i> .....	0-21 (24+)
M	<i>Craspedometra acuticirra</i> .....	0 (24+)
M	<i>Dichrometra flagellata</i> .....	0-14 (24+)
	<i>Dichrometra dosleini</i> .....	83 (24+)
	<i>Dichrometra döderleini</i> .....	0-84 23.78
	<i>Mariametra subcarinata</i> .....	22-59 16.72
	<i>Mariametra delicatissima</i> .....	84 23.78
	<i>Liparometra grandis</i> .....	40 ?
M	<i>Lamprometra protectus</i> .....	0-12 (24+)
M	<i>Cenometra bella</i> .....	0-20 (24+)
	<i>Cyllometra albopurpurea</i> .....	12-139 11.61-23.78
	<i>Decametra tigrina</i> .....	8-34 (24+)
	<i>Prometra owstoni</i> .....	55 ?
	<i>Oligometra japonica</i> .....	5-8 ?
M	<i>Oligometra serripinna</i> .....	0-50 (24+)
	<i>Tropiometra macrodiscus</i> .....	0-50 ?
M	<i>Tropiometra encrinus</i> .....	0 (24+)
	<i>Neometra multicolor</i> .....	11-333 13.28-15.89
	<i>Gephyrometra versicolor</i> .....	53 16.50
	<i>Gephyrometra propinqua</i> .....	95 13.28

	Depth in fathoms	Temperature
<i>Pectinometra flavopurpurea</i> .....	63-200	8.67-17.22
<i>Calometra callista</i> .....	107-139	11.61
<i>Calometra separata</i> .....	55-150	13.28-15.89
<i>Asterometra macropoda</i> .....	103	15.89
<i>Asterometra anthus</i> .....	103	15.89
<i>Asterometra lepida</i> .....	35	?
<i>Cosmiometra aster</i> .....	369-405	4.44- 5.44
<i>Cosmiometra conifera</i> .....	?	?
<i>Stenometra dorsata</i> .....	52-170	11.28-15.89
<i>Daidalometra hana</i> .....	107-139	11.61
<i>Parametra alboflava</i> .....	103	15.89
<i>Parametra orion</i> .....	71-170	10.78-15.89
<i>Thalassometra latipinna</i> .....	345	5.05
<i>Thalassometra pubescens</i> .....	440	5.44
<i>Pachylometra septentrionalis</i> .....	?	?
<i>Glyptometra lata</i> .....	361	5.95
<i>Chlorometra garrettiana</i> .....	95	13.28
<i>Strotometra hepburniana</i> .....	100-135	11.28
<i>Pæcilometra scalaris</i> .....	361	5.95
<i>Euantedon sinensis</i> .....	?	(24+)
<i>Compsometra serrata</i> .....	8-35	?
<i>Iridometra adrestine</i> .....	13-107	11.61
<i>Iridometra psyche</i> .....	30-107	11.61
<i>Iridometra briseis</i> .....	59	16.72
<i>Thysanometra tenelloides</i> .....	70-197	8.67-13.50
Arc. <i>Psathyrometra erythrizon</i> .....	390-406	0.39
Ant. <i>Psathyrometra fragilis</i> .....	300-533	1.61- 2.17
<i>Perometra diomedea</i> .....	39-139	11.61-20.39
<i>Erythrometra ruber</i> .....	55-150	11.11-15.89
Arc. <i>Heliometra glacialis maxima</i> ....	32-428	-1.22- +1.72
Arc. <i>Heliometra glacialis biarticulata</i> .	?	?
Arc. <i>Heliometra glacialis brachymera</i> .	[172]	[1.05]
Ant. <i>Florometra mariæ</i> .....	70-337	4.83-13.50
Ant. <i>Florometra rathbuni</i> .....	533-587	2.17-383
<i>Cyclometra clio</i> .....	107	?
<i>Nanometra bowersi</i> .....	139-191	9.67-13.33
Arc. <i>Thaumatometra tenuis</i> .....	80-620	0.39-1.72
<i>Thaumatometra isis</i> .....	361	5.95
<i>Thaumatometra comaster</i> .....	300-533	1.61- 2.17
<i>Thaumatometra cypris</i> .....	775	3.11
<i>Thaumatometra parva</i> .....	120-265	?
Ant. <i>Bathymetra abyssicola</i> .....	2900	1.83
<i>Thaumatocrinus borealis</i> .....	361	5.95
<i>Pentametrocrinus tuberculatus</i> ....	169-333	8.89
M <i>Pentametrocrinus diomedea</i> .....	103-186	13.33-15.89
<i>Pentametrocrinus japonicus</i> ....	139-662	3.17-13.33
M <i>Pentametrocrinus varians</i> .....	361-1050	3.17- 5.95

The frequency at different depths of the comatulids occurring on the coasts of China and Japan

Fathoms	All species	Indo-Pacific species	Malayan species	Arctic and Antarctic species.
0-50.....	42	20	21	1
50-100.....	35	30	2	3
100-150.....	32	27	2	3
150-200.....	16	11	2	3
200-250.....	7	4	0	3
250-300.....	7	4	0	3
300-350.....	9	5	0	4
350-400.....	12	7	1	4
400-450.....	9	4	1	4
450-500.....	5	2	1	2
500-550.....	6	2	1	3
550-600.....	4	1	1	2
600-650.....	3	1	1	1
650-700.....	2	1	1	0
700-750.....	1	0	1	0
750-800.....	2	1	1	0
800-850.....	1	0	1	0
850-900.....	1	0	1	0
900-950.....	1	0	1	0
950-1000.....	1	0	1	0
1000-1100.....	1	0	1	0
1100-3000.....	1	0	0	1

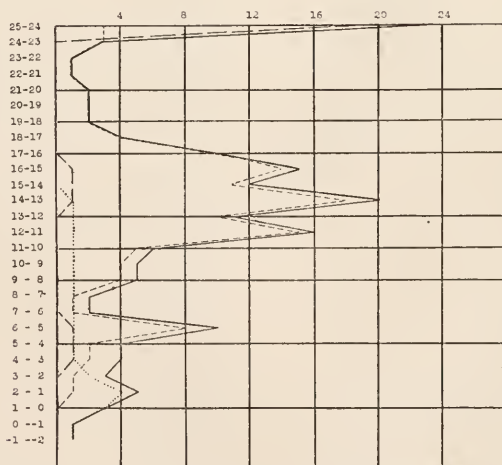


Fig. 2. The frequency at different temperatures of the comatulids of the coasts of China and Japan. ----- The Species of the Indo-Pacific Fauna; ——— The Species of the Malayan Fauna; ..... The Species of the Arctic and Antarctic Faunas; ——— The Total for all Species.

The frequency at different temperatures of the comatulids occurring on the coasts of China and Japan

Degrees * Centigrade	All species	Indo-Pacific species	Malayan species	Arctic and Antarctic species
25-24.....	23	3	20	0
24-23.....	3	3	0	0
23-22.....	1	1	0	0
22-21.....	1	1	0	0
21-20.....	2	2	0	0
20-19.....	2	2	0	0
19-18.....	2	2	0	0
18-17.....	4	4	0	0
17-16.....	10	10	0	0
16-15.....	15	14	1	0
15-14.....	12	11	1	0
14-13.....	20	18	1	1
13-12.....	11	10	0	1
12-11.....	16	15	0	1
11-10.....	6	5	0	1
10- 9.....	5	4	0	1
9- 8.....	5	4	0	1
8- 7.....	2	1	0	1
7- 6.....	2	1	0	1
6- 5.....	10	8	1	1
5- 4.....	4	2	1	1
4- 3.....	4	2	1	1
3- 2.....	3	1	0	2
2- 1.....	5	1	0	4
1- 0.....	3	0	0	3
0- -1.....	1	0	0	1
-1- -2.....	1	0	0	1

Southern Japanese division of the Indo-Pacific fauna, and probably reached the Sea of Japan through the Korean Straits.

In the foregoing lists are included all the comatulids known from Chinese and Japanese waters, with their bathymetric and thermal ranges. The fauna to which each belongs is indicated as follows: *M.*, Malayan; *Arc.*, Arctic; *Ant.*, Antarctic; those not especially marked belong to the Southern Japanese division of the Indo-Pacific fauna.

In the diagram (fig. 1) on which are shown the bathymetric ranges of the species of the different faunal units which collectively constitute the comatulid population of the Chinese and

Japanese coasts it is interesting to note that the species of each of these units show the same line that the corresponding species of the same units show in other parts of the world. The mingling of the faunas here, as elsewhere, has resulted in a distinctive collection of individuals which, however, is easily resolved into the original component units, and these component units are found to retain all the distinctive features of the parent faunal groups from which they were originally derived. In their relation to temperature the three faunal groups are very different. The Malayan species, which are mostly confined to the littoral, almost all occur in water with a temperature above  $23^{\circ}$ , but they are also represented between  $12^{\circ}$ , and  $16^{\circ}$ , and  $2^{\circ}$  and  $7^{\circ}$ . The Indo-Pacific species have their maximum between  $10^{\circ}$  and  $18^{\circ}$ , and especially between  $13^{\circ}$  and  $14^{\circ}$ ; they are also numerous between  $5^{\circ}$  and  $6^{\circ}$ . The Arctic and Antarctic types, which do not occur in water warmer than  $15^{\circ}$ , are most numerous between  $0^{\circ}$  and  $2^{\circ}$ .

We get, therefore, the following optimum temperatures for these three components of the Japanese and Chinese fauna:

Malayan.....	$23^{\circ}+$	$12^{\circ}-16^{\circ}$	$2^{\circ}-7^{\circ}$
Indo-Pacific.....	$23^{\circ}+$	$13^{\circ}-14^{\circ}$	$5^{\circ}-6^{\circ}$
Arctic and Antarctic...			$0^{\circ}-2^{\circ}$

The point  $2^{\circ}$  to  $7^{\circ}$  (including  $5^{\circ}$  to  $6^{\circ}$ ) is characterized especially by the genera of Oligophreata with highly developed side- and covering-plates along the ambulacra of the pinnules and arms (included in the families Thalassometridæ and Charitometridæ) which, occurring from 0 to 1600 fathoms, are most noticeable between 350 and 400 fathoms; most of these belong to the Indo-Pacific fauna, but a few are Malayan.

Although on the Japanese coast it is possible to take species of the Indo-Pacific and the Antarctic, and of the Indo-Pacific and Malayan, faunal units in one and the same dredge haul, it is evident that this overlapping, which in some places is quite extensive, does not mean that these faunal units here have lost or are losing their identity.