IV.—REMARKABLE CASES OF VARIATION.

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I.—SQUILLA INVESTIGATORIS.

Anyone who examines large numbers of animal organisms and attempts to fit them into the established specific groups, must be sometimes in doubt as to the propriety of placing certain of them into any particular group. This doubt is by no means always felt. As a rule organisms can be readily placed in established groups, or new ones or species defined for their reception. Occasionally, however, a number of individuals are found living together in the same environment, and resembling one another so closely in most respects that we hesitate to place them in more than one species, although in certain particular features they differ widely, one from the other. To establish several species for such a collection seems most inappropriate, for by so doing the offspring of even the same parents might be described as different species. If certain of the crustacea here described had been taken from widely separate localities there is no doubt that they would have been regarded as separate species. Animals which show such a wide range of variation are rare in comparison with ones showing a limited range, but they undoubtedly occur. They are perhaps less uncommon among the marine fauna of tropical seas than in other environments.

During the early part of 1906, the R.I.M. Survey ship "Investigator" trawled at ten stations along the south-west coast of Arabia. At one of these (Lat. 15° 8′ 30″ N. Long. 51° 52′ 15″ E.), from a depth of 110 fathoms, a very large number of a species of *Squilla* was obtained. It is much to be regretted that the interesting features of the species were not recognised at the time of their capture, and that only some twenty complete specimens were retained. Seventeen of these are now available for examination in the Indian Museum; this number, however, is quite sufficient to illustrate the remarkable variability of the species.

The seventeen specimens resemble one another very closely in all parts of their outer structure with one exception. The number of spinous teeth on the dactyle of the raptatorial claw varies from ten to eighteen among this small collection of seventeen individuals. Furthermore, as regards this appendage, they show no less than eleven different types displayed in the following table :—

Type.	TEETH PRESENT IN TYPE.		Number of individuals of the type.
	Left claw.	Right claw.	
1	10	16	1 (figured, pl. iii).
2	13	13	3
3	14	13	1
4	14	14	2
5	15	15	2
6	16	15	1
7	16	16	3
8	16	17	1
9	17	16	1
10	17	17	1
11	17	18	1
			TOTAL 17

Besides this great variation in the number of teeth, their curvature and proximity one to the other are very variable. It was thought well to illustrate them fully (plate ii). The dactylus, in each case, was drawn under a low power of the microscope by the aid of the camera lucida. The resulting outline drawings, which were each twelve times the size of the object they represented, were reduced in the process of reproduction to more convenient dimensions. By these means accurate figures were obtained.

Owing to the great similarity of all their other features and to the fact of their community, they were regarded as one species and described as such under the name *Squilla investigatoris* (*Rec. Ind. Mus.*, i, p. 10), though it is impossible to say whether the species has 13, 14, 15 or 16 teeth on its claw. Perhaps if larger numbers were available, a clear majority might be found to possess claws bearing teeth to the value of only one of these numbers. A remarkable feature of this variation is that it occurs in an organ which is very stable in other species of the genus.

The genus *Squilla* has been defined as having no more than six teeth on the raptatorial claw, but in spite of this there can be little doubt that this variable species has been correctly assigned to the genus *Squilla*.

In his report on the "Challenger" *Stomatopoda* Brooks defines the genus as follows:—

> 2. Dactyle of raptatorial claw not dilated at the base, but usually armed with marginal spines.
>
> (1) Primary marginal spines of the telson small, with no more than four secondary spines between the submedian and the intermediate; outer

spine of the basal prolongation of the uropod usually longer than the inner; dactyle of raptatorial claw with not less than six marginal spines — Genus *Lysiosquilla.*

(2) Primary marginal spines of telson large, with more than four secondary spines between the intermediate and the submedian; inner spine of the basal prolongation of the uropod longer than the outer; dactyle of the raptatorial claw usually with no more than six marginal spines — Genus *Squilla.*

Bigelow, in a report on the Stomatopods collected by the "Albatross," follows Brooks in his definition of the genus (*Proc. U. S. Nat. Museum*, vol. 17, 1894).

Of the three features chosen to define *Squilla* from *Lysiosquilla*, the "Investigator" species exhibits only two, for *Lysiosquilla* is the genus which possesses, according to the above definition, not less than six raptatorial spines (some species of this genus have ten). In the form of the telson and uropods, however, the new species is obviously a true *Squilla*; the figure (plate iii) shows this better than any verbal description.

At least two other species of *Squilla* possess a larger number of raptatorial teeth than six. *Squilla raphidea*, a very widely distributed species, has eight: *S. armata* is referred to by Bigelow (*ant. cit.*) as having, "7 to 9 teeth on the raptatorial claw, rarely 6"; this species evidently resembles *S. investigatoris* in the nature of its variability, though this occurs to a less degree in the former species.

Except for these two species the genus *Squilla* seems to be remarkably constant as regards the raptatorial claw. In order to test and illustrate the stability of this appendage, the number of teeth on the claws of all the Squillas in the Indian Museum was counted. The collection is a large one and in excellent order; as can be seen from the following list, it has been gathered from eastern tropical seas in a wide sense, though chiefly from the Bay of Bengal and the Arabian Sea. It should be mentioned that all of one species from one named locality have been included in one group, although they may have been received from different donors at different times. For example, the 71 specimens of *S. interrupta* from Hongkong were received on four separate occasions, the 39 specimens of *S. hemischista* were obtained from three separate stations on the Orissa coast; the same may be said of the 55 specimens of *S. hemischista* from Madras. Although included in one group the specimens were

probably collected from widely separate places. Only species of the true genus *Squilla* have been included. *Lysiosquilla*, *Pseudosquilla* and *Protosquilla* were not counted.

Species.	Locality	Number of normal specimens.	Number of abnormal specimens.
S. interrupta	Sandheads (mouth of Hooghly).	15 ($\frac{6}{6}$)	0
,,	Hongkong	71 ($\frac{6}{6}$)	2 ($\frac{6}{5}$. $\frac{6}{7}$)
,,	Karachi	14 ($\frac{6}{6}$)	0
,,	Bombay ..	18 ($\frac{6}{6}$)	0
,,	Orissa coast (B. of Bengal)	3 ($\frac{6}{6}$)	0
,,	Mutlah light (mouth of Hooghly).	1 ($\frac{6}{6}$)	0
,,	Singapore	3 ($\frac{6}{6}$)	0
,,	Akyab (Burma)	1 ($\frac{6}{6}$)	0
,,	Camorta I. (Nicobars)	1 ($\frac{6}{6}$)	0
,,	Vizagapatam coast	1 ($\frac{6}{6}$)	0
S. affinis	Hongkong	19 ($\frac{6}{6}$)	0
,,	Yokohama	1 ($\frac{6}{6}$)	0
,,	Nagasaki	1 ($\frac{6}{6}$)	0
S. holoschista	Madras	28 ($\frac{6}{6}$)	3 ($\frac{5}{6}$. $\frac{6}{7}$. $\frac{6}{9}$)
,,	Sandheads	1 ($\frac{6}{6}$)	0
,,	Colombo	2 ($\frac{6}{6}$)	0
,,	Vizagapatam	1 ($\frac{6}{6}$)	1 ($\frac{7}{6}$)
S. hemischista	Madras	55 ($\frac{6}{6}$)	0
,,	Orissa coast	39 ($\frac{6}{6}$)	1 ($\frac{5}{6}$)
,,	Sandheads	4 ($\frac{6}{6}$)	0
,,	Cochin	8 ($\frac{6}{6}$)	0
,,	Penang	4 ($\frac{6}{6}$)	0
,,	Singapore	1 ($\frac{6}{6}$)	0
,,	Ganjam coast	1 ($\frac{6}{6}$)	0
,,	Bombay	2 ($\frac{6}{6}$)	0
,,	Ganjam port	8 ($\frac{6}{6}$)	0
,,	Vizagapatam coast	4 ($\frac{6}{6}$)	0
,,	Hongkong	2 ($\frac{6}{6}$)	0
S. stridulans	Orissa coast (68 fathoms)	17 ($\frac{6}{6}$)	0
,,	"B. of Bengal" (240 fathoms).	2 specimens, only one claw present, bearing 6 spines.	
,,	Godavery coast (95 fathoms).	4 ($\frac{6}{6}$)	0
S. multicarinata	Hongkong	8 ($\frac{5}{5}$)	0
S. tenuispina	Arakan coast	1 ($\frac{4}{4}$)	0
,,	Off L. Andaman I. (188 fathoms).	3 ($\frac{4}{4}$)	0
,,	Ganjam coast	1 ($\frac{4}{4}$)	0
,,	Godavery coast (95 fathoms).	2 ($\frac{4}{4}$)	0

Species.	Locality.	Number of normal specimens.	Number of abnormal specimens.
S. leptosquilla (closely resembling *S. tenuispina*).	"B. of Bengal" (270—419 fathoms).	3 ($\frac{4}{4}$)	0
S. polita	Madras	13 ($\frac{6}{6}$)	1 ($\frac{7}{6}$)
,,	Pondicherry	3 ($\frac{6}{6}$)	0
,,	Bombay	1 ($\frac{6}{6}$)	1 ($\frac{5}{5}$)
,,	Hongkong	2 ($\frac{6}{6}$)	0
,, ..	Orissa coast	1 ($\frac{6}{6}$)	0
S. fasciata .	Andamans	1 ($\frac{6}{6}$)	0
S. gorypetes	Cheduba straits (Burma)	1 ($\frac{6}{6}$)	0
S. gilesii .	"B. of Bengal" (65 fathoms).	4 ($\frac{8}{8}$)	0
S. scorpio (immaculata).	Hooghly estuary	7 ($\frac{8}{8}$)	0
S. scorpio (genuina)	Karachi ..	1 ($\frac{8}{8}$)	0
,, .	Bombay	1 ($\frac{8}{8}$)	0
S. raphidea	Mergui	3 ($\frac{8}{8}$)	1 ($\frac{9}{9}$)
,, .	Bombay	14 ($\frac{8}{8}$)	0
,,	Sandheads	10 ($\frac{8}{8}$)	0
,,	Rangoon	1 ($\frac{8}{8}$)	0
,,	Andamans	1 ($\frac{8}{8}$)	0
,,	Singapore	1 ($\frac{8}{8}$)	0
,,	Persian Gulf	1 ($\frac{8}{8}$)	0
,,	Karachi	1 ($\frac{8}{8}$)	0
,, .	Hongkong ..	23 ($\frac{8}{8}$)	0
,,	Gulf of Martaban (61 fathoms).	1 ($\frac{8}{8}$)	0
,, ..	Off Cape Negrais (Burma)	1 ($\frac{8}{8}$)	0
S. ovatoria	Bombay	1 ($\frac{6}{6}$)	0
S. supplex	,,	1 ($\frac{5}{5}$)	0
S. chlorida	Hongkong	6 ($\frac{6}{6}$)	0
S. foveata	Ye (Burma)	1 ($\frac{6}{6}$)	0
TOTAL 19	63	451	10

The 451 specimens are, therefore, remarkably stable as regards number of raptatorial teeth. Variations from the normal type of the species only occurring to the extent of about 2 per cent. In their other features the members of this collection seem also very stable, and in these other features *S. investigatoris* is itself very stable: for example, on the outer border of the tail of a *Squilla* (exopod of uropodite) are eight movable spines; this number is very constant throughout the genus, and all of the seventeen specimens of *S. investigatoris* possess eight spines in this situation. The stability of this feature is in striking contrast to the variability of the claw in the same species.

The following facts seem, therefore, to be well established:—

(1) The great variability of one feature (the raptatorial claw) in a particular race of the genus *Squilla.*

(2) The comparative stability of the same feature in other races of the genus from neighbouring seas.

In reference to the same subject the following statements may also be made, though the supporting evidence is much less sure:—

(3) This variable race of the genus is very common in one locality; but is rare (or does not occur) outside that locality.

No exception can be taken to the first part of this statement. The number of specimens actually taken at one hawl of the net was recorded as over 500. It is not usual to obtain a new species in such large numbers, though the records of deep-sea dredging show similar results from time to time.

The second part of the statement, that this variable race is rare outside the particular locality where it was found, is, of course, open to the objection that the fauna of Indian seas is very imperfectly known. How far this is true of the genus *Squilla* is fully shown in the above table, which shows the wide distribution of some of the species on both sides of the Indian Peninsula.

(4) This variable race occupies an environment (beneath 110 fathoms of water, far from terrestrial influences) which must be comparatively constant in any one place, through considerable periods of time: furthermore, the circumstances of this environment cannot differ widely from those met with close to the 100-fathom line in neighbouring seas.

This statement does not rest on any definite evidence, though it appears generally true that the conditions of life beneath 100 fathoms of water must be less liable to change than in very shallow water or on land.

The genus *Squilla* is usually found in shallow water. It is comparatively rare in depths of over 50 fathoms. In the above list, the depth has been noted in the case of specimens taken from other than shallow water. It is not likely that increased depth of water could in itself produce variation in the direction of an increase of raptatorial spines. That it has no such influence is shown by the species *S. stridulans*, which has been taken from 68, 240 and 95 fathoms but shows only six raptatorial teeth, still more so by the species *S. tenuispina* and *S. leptosquilla* which have been taken from 188, 95, 270 and 419 fathoms, for these species have only four teeth.

Theoretical considerations.

Taking into consideration the number of teeth on the raptatorial claw of all the known species of *Squilla*, it is difficult to believe

otherwise than that this variable and many-toothed species has been derived from a form which had a smaller number of teeth. This number was probably six, for this is most common throughout the genus.

One who holds strictly to the idea that such changes are brought about by the perpetuation and accumulation of minute variations which occur in any direction, must suppose that the widely distributed members of the genus are kept constant as regards number of teeth, because that number suits some peculiarity of their environment. Any individuals showing variations from that number are usually unable to reach maturity, for abnormal specimens appear among a collection of adults to the extent of only 2 per cent.

In order to explain how a form having fifteen teeth was derived from one having but six, one must believe, if the theory of gradual change is true, that a series of ancestors having 7, 8, 9. 15 teeth must have existed. Starting from the point when the six-toothed form gave rise to one having seven teeth, one must imagine a change in the environment which favoured the few seven-toothed variations, so that few as they were among the myriads of young, a comparatively large percentage of them began to reach maturity and to transmit the new character to their offspring, until seven-toothed adults formed a majority and a new species was formed.

By a like process this gave rise to a species having eight teeth. The change of environment which caused the production of the seven-toothed form out of the six-toothed, could not produce the eight-toothed form from the seven-toothed. To produce this a further change in the environment appears to be necessary. This change must have been similar in nature to the first change, for it produced a like effect, but it must have been of increased intensity. If it were not so, the race would remain seven-toothed. In other words there must have been a continuous and increasing change of some particular feature of the environment to have caused the change in number of teeth from six to fifteen. What this change could have been is not easy to imagine. The supposition might be made of a gradual diminution in the size of the favourite prey, favouring an increase in number of the raptatorial teeth. However, if one examines, side by side, the claw of a *Squilla* with six teeth, and that of one with fifteen teeth, it seems impossible to imagine a small animal which could escape from either when the dactyle is closed down into its opposing groove; still less can this supposition account for an increase of one tooth at a time.

The facts of the case, which do not seem to be in favour of the "Theory of gradual change," are recorded here as a contribution to the study of animal variation available for comparison with similar cases which may be recorded.