

Article III.— ORTHOGENESIS IN THE EGG CAPSULES OF CHIMÆRA.

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The egg capsules of Chimæroids, even of the common species, are rare objects in collections. The museum is accordingly greatly indebted to Professor H. F. E. Jungersen of the Zoölogical Department of the University of Copenhagen, for the gift of one of these capsules, of a kind, moreover, which has not been recorded. It was "dredged in the North Atlantic from great depths," but unfortunately the station is not known.

Up to the present the egg-capsules of four species of Chimæra have been described, *C. collieri*, *monstrosa*, *phantasma*, and *mitsukurii*. Of these the present specimen resembles most closely the egg-case of the last mentioned species. It is a fair inference, therefore, in view of the ultra specialization of these capsules, that the parental fishes were similar, and in this event we may provisionally assign the present capsule to *C. (Bathyalopez) mirabilis* (Collett),¹ a Chimæra recently described from the same general region in which this capsule was dredged. (Fig. 1.)

Comparison of the present capsule with those of other Chimæras may be given in tabular form on p. 37.

Interpreting the foregoing results one observes that in certain regards, as in *C. mitsukurii*, the present capsule is highly specialized: it is remarkable in the slenderness of its trunk-sheath in terms of the entire length: in the great length of its tail-sheath and of its opening valve: and in its very numerous respiratory openings along the tail-sheath. In addition to these features we note that the marginal web, so conspicuous in *collieri* and *monstrosa*, has undergone great reduction, about indeed as in *mitsukurii*, and is represented at the best by small flaring barbs at the extreme anterior end: also that the dorsal keel of the capsule is very low, and that the "teeth" on the anterior rim of the valve are specialized anteriorly into long and delicate processes, more exaggerated in regional differentiation than in the capsules of other species.

In certain regards, therefore, the present specimen is the most specialized capsule known in chimæroids, and possibly,³ judging from the number and

¹ Collett, Forh. Vid. Selsk. Christiania, 1904, No. 9, p. 5, and 1905, Report on Norwegian Fishery and Marine Investigation, Vol. II, No. 3, p. 35, pl. i.

² Dean, Chimæroid Fishes and their Development. 1906, Carnegie Institution, p. 30.

³ Dean, 1904, Biol. Bull., Vol. VII, pp. 105-112; Amer. Naturalist, Vol. XXXVIII, pp. 486-487.

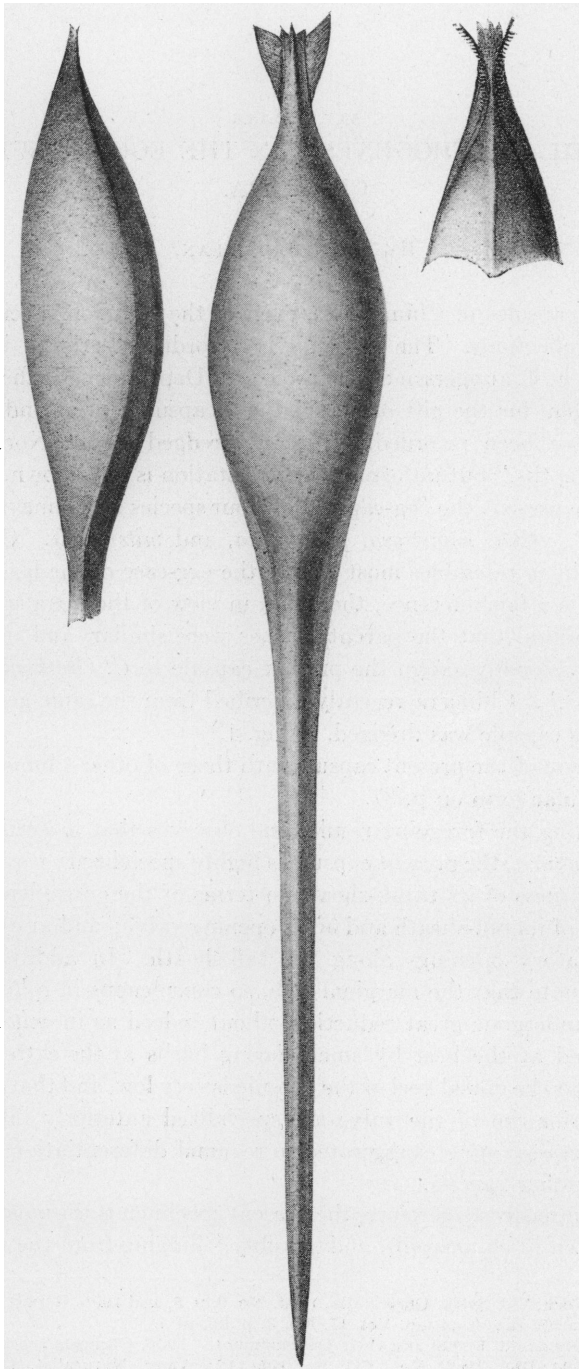


Fig. 1. Egg-capsule of a North Atlantic Chimæroid, probably *Chimera* (*Bathyalopez*) *mirabilis* (Collett). Natural size, shown in lateral, ventral and dorsal aspects.

Length of Capsule. (cm.)	Genus Chimæra, Species.	Percentage of breadth to length.		Percentage of tail-sheath to entire length.	Proportional length of opening valve from hinge to anterior end of capsule (i. e. in percentage of total length of capsule.)	Number of respiratory openings along each side of opercular valve.	Number of respiratory (couples of) openings in caudal-sheath.	Proportional length of rim of operculum bearing serrations (actual), i. e. in percentage of total length of capsule.	Rugæ, number of.
		Breadth of trunk-sheath only.	Breadth, measured between basis of lateral web.						
15-17	collicii	14-17	18	43	33 37	86(+ many (30) rudimentary pores).	89	10(beginning in front).	35
17	monstrosa	17	15 ¹	54	16	50 (very small).	75	6 " "	—
27	phantasma	26	22 ^{1 2}	63	18	54(+20 rudimentary pores).	62	5.5 " "	—
22	mitsukurii	22	12 ¹	56	?70 ³	24	200+	5+" "	—
17	?(Bathyalopex) mirabilis (Jungersen's capsule.)	14	10	64		38	110	6+" "	—

range of its structures, the most specialized hitherto described among all animals.

In a final note we suggest the lines of the evolution of the capsules of Chimæras:

If we compare the known egg capsule of various species of chimæroids, we find that with slight simplifications, they arrange themselves in a series somewhat as shown in Fig. 2, in the order B, C, D, E, forms which typify recent species. In this series, on account of the reduction of the

¹ There is an apparent contradiction between these figures and the proportional breadth of the trunk sheath,—that is the entire breadth of the capsule is apparently less than the breadth of the trunk sheath. This is due to the fact that the "breadth" is intended to mean the widest distance from lateral web-tip to lateral web-tip. This is in certain cases less than the entire breadth of the trunk sheath, since the ventral region of the capsule often enlarges in an extraordinary way.

² Proof error in earlier paper,—12 instead of 22.

³ This great percentage is doubtful; In the single specimen available the hinge was not clearly shown, and it may have been torn through.

marginal web of the capsule, the extraordinary development of its caudal sheath and the huge size of the opening valve, we are led to conclude that the form E is more specialized than the form B. Interpreting this result evolutionally, we are warranted in assuming that the species of *Chimæra* which had oviducal structures of such a nature as to produce the capsule E, was descended from species of *Chimæra* whose structures in turn produced capsules not unlike those of D, C, and B. All of this follows clearly from the evidence of the capsules themselves, *i. e.*, without collateral evidence as to chimæroid descent. We may go so far, I believe, as to assume on this evidence that the capsule B was represented in a still older (ancestral) form by the hypothetical capsule A, and that the form E predicates oviducal structures of a form which may be expected to give rise to the hypothetical capsule F. In fact, encouraged by the findings of recent years, we suggest the probability that these two types of capsules will eventually be discovered.

It is an interesting fact that the capsule suggested in A is similar to the type of capsule which occurs in the neighboring chimæroid family *Callorhynchidæ*. And it is also pertinent to observe that there are many reasons, anatomical, embryological and palæontological, for regarding *Callorhynchus*¹ as similar to the ancestor of the *Chimæridæ*. Accordingly it is by no means illogical to consider such a capsule as A as representing the earliest "*Chimæra*."

If now we review the capsular structures of the various species of *Chimæra*, we are impressed with the fact that the series falls into a "direct line" (orthogenetic). In this series of capsules we note that:

I. The lateral web becomes reduced and obsolescent: its most conspicuous rudiment appearing at the capsule's anterior end.

II. The dorsal web undergoes a similar reduction.

III. The body-sheath becomes shorter, and the tail-sheath of the capsule proportionately longer and narrower.

IV. The exit-valve of the capsule increases in length. At first (C) it becomes actually shorter, but not relatively, *i. e.*, in terms of the length of the body-sheath.

V. The serrated portion of the edge of the valve becomes constantly reduced in length (and the individual serrations in general more conspicuous).

VI. The line of respiratory apertures on the sides of the caudal sheath becomes lengthened.

¹ The capsule of *Callorhynchus*, it may be recalled, corresponds more closely with that of sharks, which in general, on grounds anatomical, embryological and palæontological, are shown to be more primitive than chimæroids. Cf. Dean, Carnegie Memoir already cited.

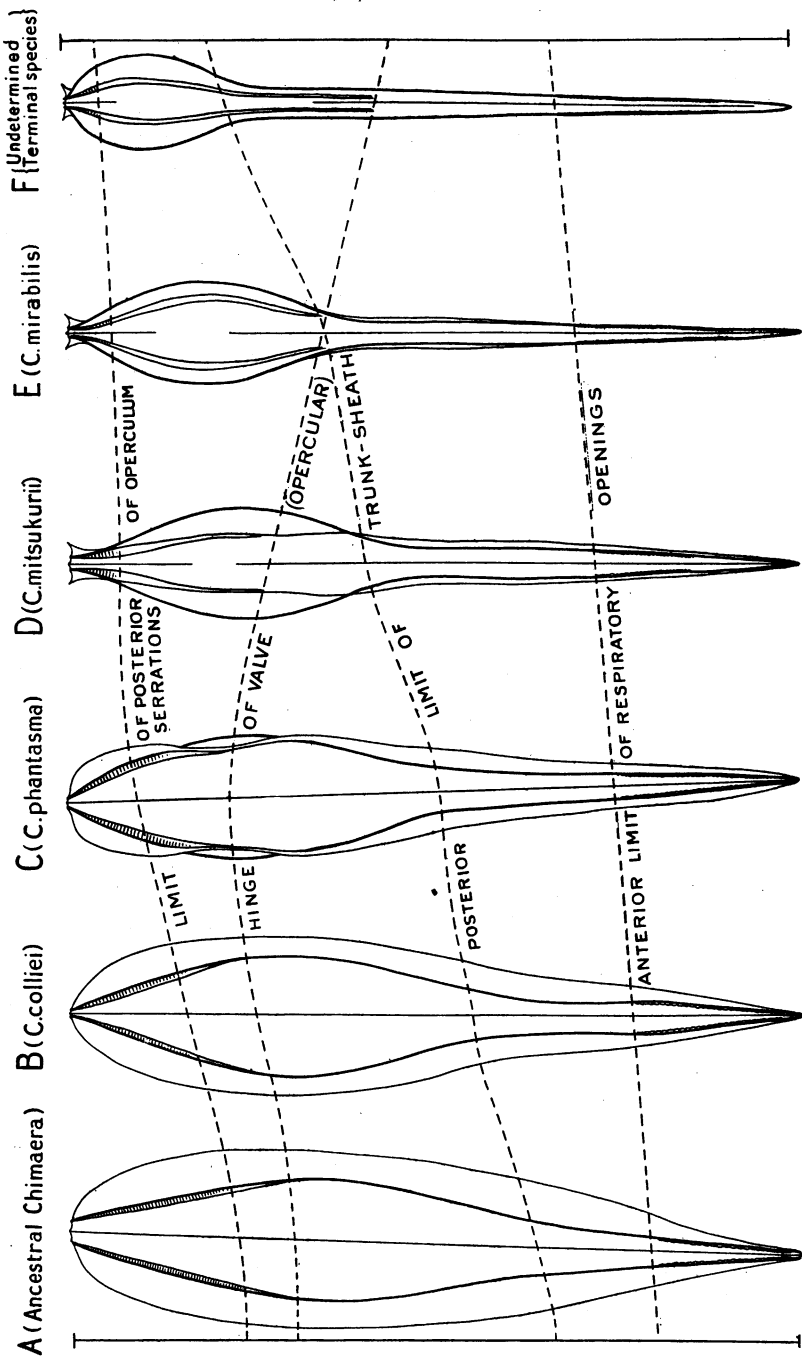


Fig. 2. Egg-capsules of Chimæroids (B-E), arranged in orthogenetic series. At each end of this series an hypothetical form is indicated (A and F).

The character of the changes which here are indicated, are certainly definite in their direction; and it is significant that this serial arrangement in the capsules accompanies a similar serial arrangement in at least the external characters of the adult Chimæras. It is thus an orthogenetic series narrowly defined. It cannot be explained on grounds of natural selection, for the reasons which we have already enumerated,¹ unless indeed, one can, following the recent admissions of Weismann, regard selection as an impersonal process conditioned by "alterations in the equilibrium of the determinant system," and having a "quite definite direction persisted in for internal reasons." However the variations occurred (*e. g.*, mutational) which produced the foregoing result we must nevertheless admit that they have expressed themselves orthogenetically.

¹ Biol. Bull., Vol. VII, 1904, pp. 105-112.