

CHRYSODOMUS HEROS. (Mollusca, Pl. VII.)

Shell elongate; spire conical, longer than the mouth; whorls convex, two or three upper with a strong central keel, rest with irregularly placed distant rounder tubercles, the last rounded, not keeled; throat white.

Var. 1. Whorls as with a strong, central, continuous keel; the last slightly nodulose.

Egg-cases ovate-oblong, erect, on an expanded base, contracted beneath; surface deeply punctated, granular.

Inhab. Arctic Ocean.

This shell is very like *Chrysodomus despectus*, but differs from that species in the form and surface of the egg-cases, as well as by the greater convexity of the whorls, and the strength and angularity of the keel on the upper whorls.

Like the other species of the genus, the white, opake, outer coat of the shell is very much inclined to separate from the inner or central coat, which presents, where the outer coat is removed, a smooth surface of yellowish or brown colour.

Dr. Richardson observed several specimens of this shell in the sand-hills which edge the coast, some distance from the sea.

I have named this species *Heros*, as being finest of the genus, and in commemoration of the enterprise and heroic conduct under great hardship of its discoverer.

2. REMARKS ON THE MORPHOLOGY OF THE VERTEBRATE SKELETON. BY EDWARD FRY.

The objects of the present paper are,—1st, the brief statement of the probability that there are laws which govern animal form, in addition to the law of final causes; and 2nd, the *à priori* discussion of certain propositions about the vertebrate skeleton; being an attempt to illustrate the vertebrate by some invertebrate forms, and thus to show their unity of plan.

SECTION I.

The existence of laws governing animal form is rendered probable by the discovery of such laws as regards the forms of plants, all whose parts may be referred to a leaf as the fundamental archetype, as is shown not only by the correspondency in many normal conditions, but also by the transmutations of parts, and the monstrosities to which the petals, sepals, stamens, &c. are liable. Though the greater simplicity of plants, and the more numerous monstrosities to which they are liable by nature or art, render the existence of laws of the kind spoken of more readily apparent in them than in animals, the nature of the proofs and of the conclusions are alike in both cases.

It may, secondly, be remarked, by way of showing a general probability for such a scheme, that there exist unities of structure both in different animals and in different stages of development of the same animal, which are independent, so far as we know, of unity of

end; or, in other words, that final causes do not explain all the affinities and resemblances which we are able to trace*.

And again, it must be observed, that those remarkable likenesses, which are observable in many or all animals, between their various forms and conditions up to maturity, on the one side, and the various members of the animal kingdom up to their own position in the scale, on the other hand (so that, for instance, man passes through forms resembling, but not identical with, those of many animals from the lowest monad up to his own position in the scale), are inexplicable on the theory that the forms of animals are regulated by final causes only; but are in perfect accordance with that other which holds that there is expressed in the structure of animals some abstract idea, which running through all the frame, and modified to all purposes of need, and manifested in all variety of conditions, is yet one and the same.

It must be admitted that the force of these arguments may, to some extent, be barred by an assertion which it is difficult fully to answer, viz. that our ignorance of final causes is so great as to allow us no room to argue on the existence of other causes from their apparent inadequacy; nevertheless as the other supposition seems to have in it no improbability, but as I think the contrary, it may be admitted as at least what best suits our present knowledge.

The belief in the existence of other laws of organization besides that of final causes does in no wise lessen or obscure the argument of natural religion derived from it, which was advanced with great pertinency by the ancient Stoical philosophers, and has been amplified by Derham, Paley and others in our own country.

I now proceed to the second portion of my paper.

SECTION II.

There are reasons derived from the structure of animals below the Vertebrata which might induce us to expect that the vertebrate skeleton should be composed of elements of a common character.

1. So soon as the nervous system assumes the form of a line or chain down the body of the animal, the whole structure puts on a segmental or annular arrangement. Thus in the Annelida the body consists of numerous segments, similar one to the other, with the exception of the anterior one or head, which is sometimes slightly different in form, but in other instances only distinguishable by the presence of a mouth. Each segment has its proper nervous ganglion, connected by two fibrous commissures with those of the neighbouring division.

2. But these segments are subject to change. Thus the *Polydesmida*, a family of the Myriapoda, exhibit the posterior part of the body composed of segments similar to those above described, whilst in the anterior part each segment is the result of the coalescence of two original ones. In the Chilipoda, the same process has

* This part of the subject has been fully illustrated by Prof. Owen in his various writings.

gone on further ; so that all the apparent segments are thus composed by the anchylosis of two original ones at an early period of growth, as proved by the two pair of legs which each one bears, and the double nervous ganglia which they contain, the nervous centres of the original elements having approximated to one another without coalescence (Newport on Myriapoda, Phil. Trans. 1843).

3. But not only does the progression from lower to higher forms in the scale of the animal kingdom teach us how segments of the body originally similar may be changed—the progression of individuals does the same thing. The larval condition of insects undoubtedly corresponds very nearly with the Annelida ; the arrangement of the body and the relation of each segment to the nervous system are similar. But the perfect state shows a very great modification in the form ; many segments have disappeared by coalescence, whilst the equality of size originally existing between them has been lost by reason of the centralization of functions ; the nervous centres have often been removed from their respective segments, yet the number remains the same ; for although only nine centres appear in the abdomen (Blanchard sur les Coleoptères, Annales des Sciences Naturelles, 1846, part i.), yet the last has been shown in the Lepidoptera (Newport on *Sphinx*, Phil. Trans. 1832) to consist of two which have united.

4. The same segmental arrangement of the body, and the same ganglionic condition of the nervous centres in accordance with the rings of the body, obtain throughout many members of the class of the Articulata.

We now descend to two more particular propositions, resulting from and embraced in the foregoing, but which we nevertheless prefer to illustrate separately.

There are reasons to expect that the head of the Vertebrata should be composed of segments similar to those of the body.

1. We have already noticed the close resemblance between the anterior segment or head and the following ones in the *Polydesmidæ*.

2. In the larval insects the similarity is great ; but in the perfect one a number of the other segments become anchylosed, and enter into the composition of the head, in accordance with the law, that the more perfect an animal is, the more complex and individualized are its parts, and consequently the more is its abstract nature hidden under its teleological manifestation. The divisions between the segments entering into the composition of the head sometimes remain permanently recognizable in the external skeleton. The number of these segments has been a much-vexed question among entomologists, the numbers advocated by different naturalists having been two, three, four, five and seven. I am inclined to believe the real number of these segments to be four :—1st, because of the very slight evidence for the presence of any other, the fifth segment being considered as entirely atrophied, and no corresponding manducatory organ appearing ; 2nd, from four being the only number at all discoverable in some insects, as in the *Hydroüs piceus* (see Newport on Insecta in Todd's Cyclopædia) ; 3rd, because the brain (*i. e.* the coalesced

ganglia of the cranial segments) of the *Necrophlagæophus longicornis* has been discovered by Newport, at the period of its bursting its shell, to consist of four double ganglia (Newport in Phil. Trans. 1843).

We next consider the reasons for supposing *that the organs composing the mouth of the Vertebrata should be the homologues of those of locomotion.* It must be remarked, that everything now to be said assists most strictly in support of the preceding proposition, and would have been introduced under that head but for the sake of conveniency in illustrating the vertebrate skeleton.

1. In the Crustaceans the jaws differ in scarcely any other character than size from the true legs used in locomotion.

2. In the Myriapoda the members of the basilar segments of the head are jointed and retain the form of true legs, but are used for prehension (Newport in Todd's Cyclopædia).

3. In Insects the tarsal joints of the cranial legs are undeveloped; the femur and coxa are small or confluent with the under side of the segment, whilst the tibiæ are alone enormously enlarged, and thus become elements in the complex mouth of Insects; their muscles, however, being attached to the basilar and posterior lateral parts of the head, just as if they still subserved the purposes of locomotion (*idem*).

4. All the parts of the complex mouth of Insects are thus referable to the segments of the head. In the Great Water Beetle this is clearly shown; the manducatory organs visibly resemble the proper organs of locomotion, and are articulated to the distinct segments (*idem*).

5. We must remark intermediate normal conditions between the true locomotive and manducatory form of leg; as in the genus *Onitis*, where the prothoracic legs are without tarsi, and the tibiæ are terminated by sharp hooks; and in the *Bubos bison*, a species of a neighbouring genus, where the tibiæ strongly approach in form the proper mandibles of the head: also,

6. A monstrous condition in a specimen of *Geotrupes stercorarius*, where the prothoracic legs were arrested in development and the tarsi were absent, so that they very closely resembled the form of the mandibles (*idem*).

SECTION III.

The spinal cord of the Vertebrata is homologous with the ganglionic cord of the Articulata.

1. The elements of the systems are alike, being in both cases cellular nervous matter and commissural fibres.

2. The experiments and investigations of recent physiologists have proved the real independence of the segments of the cord contained in each vertebra, insomuch as each performs separately from the others its own reflex actions, just as is the case in the ganglionic cord of the Articulata; so that, as far as its reflex actions are concerned, the cellular or dynamic element of the spinal cord is not one organ or centre, but a series of independent organs or centres, as is seen in

the Insects, the external longitudinal fibres serving only as commissural or communicating portions.

3. Those ganglia of the Insects which are perfectly separate in the larval condition often exhibit a tendency to fusion in the perfect condition (Blanchard *ut antea*). Thus in the Coleoptera the last abdominal ganglion is always formed by a fusion of several original ones; the first and second abdominal often form a single mass with the metathoracic, whilst in the Chafer this last is united with the mesothoracic (*idem*). In like manner the fourth and fifth segments in the perfect insect are fused together. In the *Polydesmidae*, the two first segments which bear legs unite their nervous centres with the first subœsophageal, so as to form a short cord similar to that of the Ostracion and some other fish (Newport on Myriapoda, Phil. Trans. 1843). In the Scorpion the fusion has gone so far as to form a sort of medulla oblongata, giving rise to eight pairs of nerves (*idem*). In *Nitidula ænea* all the abdominal ganglia have united to form a short cord (Blanchard *ut antea*, plates); and in *Calandra palmarum* the ganglia of the whole body have approximated so as to form a continuous moniliform cord (so far ganglionic in appearance as that the distinction between the segments has not been obliterated), which is placed in the anterior portion of the body (*idem*, plates).

4. The ganglionic cord of Insects undergoes the same alteration at its posterior extremity that the spinal cord of the Vertebrata does by its withdrawal from the caudal vertebræ and the formation of a cauda equina, as may be clearly seen in Blanchard's plates (*ut antea*, e. g. in the *Nitidula ænea*, the *Calandra palmarum*, and the *Dyticus marginalis*).

5. In the Chilognatha, or higher order of the Myriapoda, the ganglia coalesce so as to form a uniform spinal cord, the commissural fibres no longer occupying intervening spaces as in the Chilipoda, but forming the external layer of the nervous cord (Newport on Myriapoda, Phil. Trans. 1843):

6. Whilst the true vertebrate fish *Orthogoriscus mola* exhibits exactly an opposite character in the ganglionic condition of its myelon (Owen's Lectures, ii. 173, on the authority of Arsaki).

SECTION IV.

A vertebra is the correlative in the osseous of a centre in the nervous system.

This appears to me to be the most general possible definition of a vertebra, and therefore the most philosophical. The general idea of the relation of the osseous and nervous centres involved in it, though not the relation of the segments of each one to the other, was thus expressed by Oken: "Bones are the earthy, hardened, nervous system; nerves are the spiritual, soft, osseous system—*Contentens et contentum*" (quoted by Owen, Report of Brit. Assoc. p. 242).

1. The number of vertebræ constituting the spinal cord always corresponds with the number of segments in the cord as indicated by

the number of pairs of nerves given off. When more than one pair perforate one piece of bone, it results from an ankylosis of several vertebræ, as in the sacrum; and the coccygeal vertebræ, which appear to be an exception to the definition, are not so in reality, the spinal cord passing into them in the fœtal condition, and being gradually withdrawn just in the same manner as is the case in some of the Coleoptera. As is clearly seen in them, too, the cauda equina represents the nerves of the vertebræ from which the cord has been withdrawn. Some Vertebrata, as *e.g.* the Python, retain the original relation of the vertebræ and centres throughout the whole of the spinal cord (Owen, Report *ut antea*, 221).

2. The same dependence of the vertebræ on the nervous centres is shown by the fact, that the tail which is reproduced by Lizards, in the case of the loss of that member, is a single bone, because although bone may be reproduced, the spinal cord cannot be (Owen *ut antea*, 254).

3. In accordance with this definition may also be cited the very long vertebra which is formed on that part of the spinal cord of the Anourous Batrachians which does not give off nerves, and which is not the result of ankylosis of several elements, but arises from one point of ossification (Martin St. Ange, Recherches anatomiques et physiologiques sur les Organes transitoires et la Métamorphose des Batraciens, Ann. des Sci. Nat. No. xviii. p. 401); and also the invariableness of the number of the vertebræ in the Mammalian's neck, resulting from the presence of the same number of nerves, and irrespective of the length of the vertebræ.

SECTION V.

A segment is the representative in the Articulata of a vertebra in the Vertebrata.

This view has been advocated by Geoffroy St. Hilaire, both in his "Mémoire sur la Vertèbre," in the ninth volume of the 'Mémoires du Muséum d'Histoire Naturelle,' and previously in a memoir read by him before the Academy in 1820. Nevertheless, the argument on which I would mainly rest it, is not yet universally admitted, for we find M. Emile Blanchard very recently asserting that nothing really indicates the analogy between the spinal cord of the Vertebrata and the ganglia of the Articulata.

1. We have seen what a close relation of correspondence exists in the Articulata between the segments and the ganglionic nervous centres; and we have endeavoured to prove that in the Vertebrata a vertebra is the correlative of one of the spinal nervous centres; and also that the spinal cord of the one class is the representative of the ganglionic cord of the other; whence it appears, that a segment of the Articulata and a vertebra of the Vertebrata must be homologous.

2. The ossification of the centrum of a true vertebra is first peripheral, and subsequently fills up the interior with osseous matter (Owen *ut antea*, 256). Thus if we suppose a vertebra stopped in the first stage, and forming the external instead of the internal sup-

port of the body, we have a segment of an articulate creature, with only an histiological difference, which must by no means be allowed to conceal from us the true nature of a part (Geoffroy St. Hilaire, *Sur la Vertèbre, ut antea*, p. 92).

3. If to this view it should be objected, that the including in the one case what is excluded in the other dispels all semblance of homology, it must be answered—

a. That notwithstanding this difficulty, the general homology of the vertebrate and articulate skeletons as wholes has long been admitted, though this more particular one of their parts has not been.

β. That the hæmal arch of the Vertebrata, whose normal office it is to enclose the main blood-vessels of the body, and which office it exclusively performs in many cases, is yet in others so developed as to enclose a mass of viscera, viz. in the thorax.

γ. In the Testudina we have an example of those vertebral elements which are usually internal, becoming external, and including not only all the viscera, but having the whole muscular system attached internally, as in the Articulata, and even the limbs arising from the inside instead of the outside of the thorax.

4. It presents no difficulty that the segments of the Articulata have no superior or inferior arches like vertebræ, because both the spinal cord and circulatory organs which those arches are respectively designed to protect are included within the body (St. Hilaire *ut antea*, p. 102).

5. To the order of development of a vertebra in the lateral processes for locomotion being produced subsequently to the body, we have an analogous case in that the Myriapoda are at birth and for some time afterwards apodal, and subsequently acquire their numerous legs (Newport on Myriapoda, Phil. Trans. 1841). This is also the case with some other articulate animals.

SECTION VI.

The brain of the Vertebrata is a modification of a series of four ganglia homologous with those of the spinal cord.

1. In the *Amphioxus* that part of the cord which must be regarded as the homologue of the brain, because it gives off five pair of cephalic nerves, is only distinguished from the other part of the cord by its pointed anterior extremity, its posterior part being entirely like the other ganglia; even its greatest vertical diameter is not greater (De Quatrefages on *Amphioxus*, Annales des Scien. Nat., third series, vol. iv.).

2. We have already noticed that the two large cephalic ganglia of the Centipede are the result of the coalescence of a series of four ganglia, as they appear in the foetal condition, each of these nervous centres supplying nerves to the senses. Closely corresponding with this arrangement is that displayed by many of the fish, as *e. g.* the Eel, where the brain is only a series of four closely arranged ganglia. And this same original scheme seems to me traceable throughout all the Vertebrata to man himself. There are, however, as the great

centralization and individuality of the organ would lead us to expect, many variations and modifications, which tend at first sight to conceal its real nature, as *e. g.* the removal of the olfactory ganglia to a great distance from the other elements of the brain, with which they only maintain their connexion by means of filiform crura, as in the Whiting and many fish; the amplification of the segments of the encephalon by the addition of supplementary ganglia, as the hypophysis, hypophysis, &c. as they occur in many fish, and some of which are retained in the higher orders, or the cerebrum in the cartilaginous fishes, and in all animals upwards to man, and which comparative anatomy teaches us is only to be considered as a special appendage to or development of the prosencephalic ganglia; or the extreme development of one pair of ganglia so as to obscure the others, as the cerebellum in the Sharks, Sawfish, &c. (Owen's Lectures, ii. 175); or the very diminutive size of a segment, as the cerebellum in many reptiles; or the coalescence of the pair, and consequent obliteration of the mesial division, just as is equally the case between the two halves of the spinal cord, as in the cerebellum.

3. Embryonic anatomy, too, comes in to strengthen the conclusion of comparative anatomy, that a series of four ganglia is the essential element of the brain, and that all the other parts of which it consists in adult life of the higher Vertebrata, including of course the cerebrum, are superadded.

The argument of the preceding sections, exclusive of Section I., and the conclusion to which it is intended to lead, may thus be stated:—

Considering that the head of the Insecta, Myriapoda, &c. is composed of a series of segments serially homologous with those of the body, as its brain is of ganglia serially homologous with those of the cord; that a vertebra is the general homologue of a segment as the spinal cord is of the ganglionic cord; and that the brain of the Vertebrata consists of a series of four segments; there appears a strong probability that its head in like manner shall consist of a series of four vertebræ.

3. MONOGRAPH OF THE SPECIES OF MYOCHAMA, INCLUDING THE DESCRIPTIONS OF TWO NEW SPECIES FROM THE COLLECTION OF H. CUMING, ESQ. BY ARTHUR ADAMS, R.N., F.L.S. ETC.

(Mollusca, Pl. VIII.)

MYOCHAMA, Stutchbury.

Testa inæqualis, adhærens; valva affixa dentibus duobus marginalibus, divaricatis, ad umbonem disjunctis, foveolâ trigonâ intermedîâ alteram testacæ appendicis extremitatem, cartilagine cornuâ connexam, excipiente; valva libera dentibus duobus inæqualibus, parvis, divaricatis, alterâ appendicis extremitate foveolâ intermedîâ insertâ; umbones valvæ liberæ internè, alterius externè, recurvi; impressiones musculares duæ orbiculares,