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ZOOLOGY.—*A comparative study of the most ancient and the recent marine faunas.* AUSTIN H. CLARK, U. S. National Museum.

The earliest aquatic fauna that we know, that of the Cambrian rocks, was in its broader aspects singularly similar to the aquatic fauna of the present day. Every one of the numerous component species falls at once within a definite phylum as outlined by recent types, and in a definite class within that phylum. Many of the species can be recognized as members of families still existing, while a few can be assigned even to recent genera.

This can only mean one thing, that as far back as Cambrian time animal evolution, broadly speaking, had already reached the plane it occupies today. In the ages intervening between the Cambrian and the present time the emphasis has shifted back and forth from one type to another within the phyla, classes, or families, leaving the broader aspects of the animal world unchanged.

The variations from horizon to horizon probably result not so much from any evolutionary development of the animals concerned as from physical alterations in environment favoring now one type or subtype, now another. Until the physical and chemical conditions under which the creatures lived and the mechanical stresses they were forced to meet are better understood in relation to animal forms in general it will not be possible to draw any satisfactory evolutionary lines.

In Cambrian times crustaceans were represented by phyllopods, trilobites, and merostomes; among the echinoderms there were crinoids, cystideans, and elasipod holothurians; chætognaths, brachiopods, and graptolites were present; of the annelids we know polynoids, nereids, gephyreans, and *Tomopteris*-like forms; of the mollusks pteropods and gastropods; and there were sea-anemones and other cœlenterates, and sponges.

As a supplement to this varied Cambrian fauna we know from the Ozarkian rocks cephalopods and pelecypods, and from the Ordovician polyzoans, echinoids, brittle-stars, starfishes, and fishes. There is no evidence that these were not also present in the Cambrian.

The significance of this imposing list of Ordovician and pre-Ordovician animals becomes more evident if we contemplate the missing animal types, which are the following: the ctenophores, flatworms and roundworms, rotifers and gastrotrichas, priapulids and sipunculids, heteropods, archiannelid, oligochæte, myzostomid, hirudinid, and onychophorid worms, nemerteans, phronids, insects, pterobranchiates, balanoglossids, tunicates, and vertebrates except for fishes. Other than the insects and the vertebrates, primarily terrestrial, all of these various types are soft bodied creatures which can not reasonably be expected to occur as fossils; they could only be preserved by the merest accident.

Occurring together in the rocks and therefore presumably having lived under approximately identical conditions are phyllopods and trilobites, merostomes, cystideans, and elasipod holothurians, chætognaths, annelids of the *Tomopteris*, polynoid, nereid, and gephyrean types, brachiopods, gastropods, sponges, and sea-anemones. It is scarcely to be doubted that all the other forms also existed under similar conditions.

It is most interesting that of all the numerous types of animals known from Cambrian rocks only a single major type, the graptolites, and two minor types, the trilobites and the cystideans, with the addition of a third, the merostomes, if we can not consider the king-crabs as their recent representatives, have become extinct.

But the numerous types found associated in the Cambrian to Ordovician rocks no longer live together. A segregation has taken place so that now groups of them occur in very definite regions.

All of the recent phyllopods are non-marine, though some occur in very saline water.

Exclusively marine are the pelagic chætognaths and *Tomopteris*-like worms, the abyssal stalked crinoids and elasipod holothurians, the littoral to abyssal echinoids, brittle-stars and starfishes, brachiopods, sea-anemones, cephalopods, and polynoid and gephyrean and practically all nereid worms.

Only the pelecypods, gastropods, sponges, and polyzoans are found both in the sea and in fresh water, and of these only a few groups, more or less distinctive, live in the latter.

In order to explain the segregation of these various types as they are represented at the present day the common features in each group must be first determined. Differences in salinity evidently have nothing to do with it, for phyllopods exist not only in fresh water, but in water with a much higher salinity than the present oceans, though they are never marine. The question of food seem also to be of slight significance, for in the fresh waters of the present day there are vast hordes of insects, obvious intrusions from the land, supported by food of the same nature that in the sea supports a large array of littoral types absent from fresh water.

The exclusively non-marine types are conspicuously feeble; they have a short larval or preadult stage and highly resistent eggs capable of withstanding a wide range of conditions.

The pelagic marine types, relatively large, are poor swimmers, and have a prolonged helpless larval stage.

The exclusively abyssal marine types are weak and fragile, unable to swim, or at least swim well, and have a helpless larval stage.

The animals of the marine littoral extending downward for various depths are either attached or burrowing, or able to cling firmly to other objects; with very few exceptions their young are helpless drifters.

The animals occurring in both fresh water and the sea are attached or burrowing, good crawlers, or good swimmers. They differ from the animals of the marine littoral only in having more varied younger stages, their fresh water representatives lacking a prolonged helpless larval period and developing from origins apparent in the marine types various peculiarities, enabling them to travel or to be carried overland.

To put this in another way, of the various types of animals represented in the Cambrian to Ordovician seas only those which live attached, or burrow in the mud, or are good crawlers or swimmers, and in addition have adaptable larval stages or asexual methods of reproduction, have been able to maintain themselves in the sea and also in fresh waters. Helpless drifting young prevent animals of medium or of large size from persisting in fresh water, though in the sea they may occur from the littoral to the abysses. If the adults are also helpless drifters, a pelagic marine life is the only kind of existence possible at present. If the adults are feeble bottom livers, they can only occur in the abysses. If the adults are feeble but the young are capable of transportation overland, they can exist in fresh water in temporary pools or elsewhere where they will be safe from their enemies.

The segregation at the present time of the numerous types found living all together in the Cambrian thus seems to be dependent on certain physical factors which differentiate the sea from ponds and lakes and rivers.

The most important one is size. The present bodies of still fresh water are too small to support large and slow breeding drifting animals with helpless drifting young, and therefore also such animals as feed on these. The larger ponds and lakes abound in plankton, but the planktonic animals are all small to minute, and rapid breeders.

Contrasting the present with the past we see in Cambrian rocks living apparently as littoral types various weak and feeble animals now confined to those regions of the sea where no motion of the waves exists. This suggests in Cambrian times the absence of a surf line on the shores, or at any rate absence of such gales and storms as are frequent at the present day.

It is possible to explain the shrinkage of the epicontinental seas and the appearance of a surf barrier in terms of the assumed difference between the Cambrian and the recent seas.

The evidence seems conclusive that in the past the seas were much less salt than at the present day. All through the ages the water from the rains percolating through the ground and collecting in rivers running to the sea has been carrying to the latter the salts which it has taken from the land, while in its evaporation from the surface of the sea to fall again upon the land as rain it has left the salts behind.

Undoubtedly there have been from time to time considerable additions to the amount of water on the surface of the earth; but, generally speaking, there is no reason for supposing that the sea has not been gradually increasing in salinity throughout the ages.

An increase in the amount of salts dissolved in water diminishes the vapor pressure. Thus the saltier the sea the less will be the evaporation from its surface, and hence the greater the proportion of the earth's water held permanently in the ocean basins as compared to the water in the lakes and ponds and rivers, and to the water vapor in the air.

If the present oceans were of fresh water their surface would be far below the present level, and numerous land connections would appear by which a general interchange of faunas now unconnected would be possible.

This water taken from the sea would greatly increase the lake and marsh areas on the land, and at the same time result in more or less extensively blanketing the earth with clouds. An extensive envelope of clouds about the earth would have two most important consequences. In the first place the sun's heat would be far more equably distributed. There would be no frigid poles nor superheated tropic zone. Hot and cold regions would be small and localized, and would occur only where the sun shone through the clouds. In the second place, an equality of temperature on the earth's surface, or even a fair approximation to it, coupled with fresh water seas, would mean a minimum of atmospheric circulation, and a general state of calm unbroken by storms such as we know today. Wave action would be very slight and there would be no destructive surf line. Ocean currents would be very slow.

The difference between the fauna of the oldest rocks and the fauna of the recent seas on close examination seems to be not so much a real difference in the animal types themselves as an apparent difference resulting from (1) more extensive land connections; (2) more equable distribution of the sun's heat; (3) more tranquil conditions, on land and in the sea; and (4) more extensive epicontinental waters.

These four factors are capable of very simple explanation, in large part if not indeed entirely, on the basis of the ever increasing saltiness of the sea.

BOTANY.—Pseudochaetochloa, *a new genus of grasses from Australia.* A. S. HITCHCOCK, U. S. Department of Agriculture.

Recently a fine collection of grasses was received from Mr. W. M. Carne, botanist of the Department of Agriculture of Western Australia. The plants were collected mostly in western and northwestern Australia. Many species were not previously represented in the National Herbarium. Among the specimens was one which could not be identified with any described species and possessed characters which did not agree with those of any genus as now delimited. It appears best to recognize the species as the type of a new genus rather than extend the characters of *Chaetochloa* (*Setaria*), to which it is allied. In *Chaetochloa*, a large genus of Paniceae, found in all the warmer regions of the earth, the spikelet is in the main like that of *Panicum*, but the inflorescence is interspersed with sterile branches or bristles. The fertile floret in *Chaetochloa*, *Panicum*, and their relatives, is indurate, differing distinctly from the sterile floret with its membranaceous nerved lemma, and the palea