The latter sort of bleeding is necessarily delayed until growth is about to begin, and is checked as soon as the foliage is sufficiently expanded to begin evaporation.

A bleeding similar to the last takes place at the hood-like tips of grass leaves, where the skin is nearly always ruptured. The little drops of water which accumulate here are commonly mistaken for dew, but are merely droplets exuded from the interior of the leaf, because the falling temperature of the air toward evening has diminished the evaporation from the leaves, while the roots in the warm soil are still absorbing water, and consequently producing an internal pressure. The movement of water in these cases of bleeding, it will be seen, is necessarily toward the point of exit, which may be above or below the point at which the pressure arises.

Secretion of Nectar.

A third sort of movement of water is that which takes place in the nectaries of flowers and leaves. The flowers of our common linden, for example, secrete a considerable quantity of sweet fluid, which is sometimes miscalled "honey," but is properly known as nectar. Honey, by the way, is nectar after it has been digested by the bees. At certain points in the flower there are groups of cells whose special business it is to withdraw water from the parts below, and filter it through their outer walls, after having added to it the materials which make it sweet. The movement of water in this case is extremely limited.

The Transfer of Food.

The last movement of water of which I shall speak is of those solutions which contain the food of the plant. These materials are not those absorbed from the soil, or gathered directly from the air, but they are the substances which have been manufactured by the leaves out of the materials obtained from the soil and from the air. Since these foods are put together in the leaves, necessarily the movement of water containing them in solution must be in a different direction from that which supplies the evaporation. The materials thus manufactured in the leaves must be carried either to those parts which are growing or to those places in which they are to be stored for future use. It is manifest at the first glance, therefore, that the direction of the movement must be in general *inwards* from the leaves, and, since the roots require for their nutrition a considerable amount of these substances, there must be a very decided *downward* movement to supply them.

Now it is plain that these solutions of food must keep out of the way of those portions of the water which are chiefly to supply the evaporation from the leaves. We have seen that the latter travel in the sap wood. The food currents, however, travel almost exclusively in the inner parts of the bark. You will therefore understand why stripping off the bark, or even cutting it, ensures the death of the tree eventually, even though the leaves remain long unwithered, since the roots depend upon the food formed by the leaves, they perish when severed from their base of supplies.

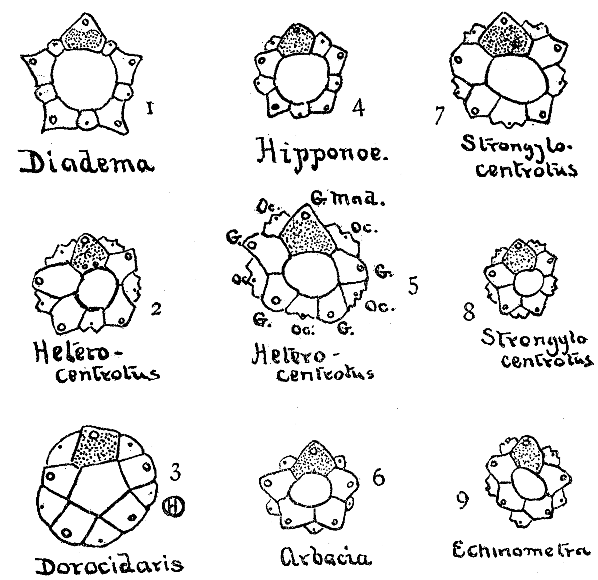
The movement of the evaporation stream is relatively rapid. The movement of this food current is relatively slow. We do know something of the mode of movement of these food currents. They are apparently brought about through the process known as diffusion, or osmosis, and are therefore necessarily slow. The cause of the movement is practically the same as that for the movement of oil in the lamp-wick, although it is by no means by the same method. The oil in the lamp-wick travels upward because at the top it is being destroyed *as oil* by reason of the heat of the flame. So the direction and existence of the current of water carrying food is because the various substances dissolved in the water are being altered at the place of growth or storage into new materials. The commonest of these food substances is sugar, and at the growing point of the stem, for example, the sugar is being constantly destroyed as sugar and is being converted into cellulose or protoplasm or some other material. So long as that alteration is going on, just so long will the sugar particles move toward that point.

But I must not impose further upon your patience. I have tried to sketch very briefly, and only in outline, the different movements which the water in the plant is undergoing. I have said nothing of the extreme variety of materials which may be found in this water in different plants, or even the variety found in the same plant at different times, but have endeavored merely to show you that there is going on constantly in the living tree a series of molecular and mass movements, of which too few people have any conception. To our imperfect knowledge let me hope that some of you may contribute facts which shall enable us some day to explain the many things which are now obscure.

NOTE ON THE SEA-URCHIN SKELETONS.

BY HENRY LESLIE OSBORN, PH.D., ST. PAUL, MINN.

IN looking through the drawings of students in the freshman class of the aboral ring in *Strongylocentrotus droebachiensis* from Portland, Maine, I came upon one which I at first supposed to be erroneous, but which, on comparison with the specimen, proved the specimen to be exceptional. The usual arrangement of the genital and ocular plates in this species is shown in Fig. 7 of our cut. The five genital plates and two of the oculars border upon the anal ring, the three remaining oculars being shut out by



the contiguity of the enlarged genitals. The arrangement found by exception is figured at 8. It consists in the exclusion of four oculars from the aboral ring, so that only one gets a share in forming the border. I seized the occasion to look into the cases of about fifty specimens which happened to be on hand in the laboratory, and found that the case of Fig. 8 occurred twice in that series and that all others were like Fig. 7, which is normal, and which I have observed in many more than fifty different specimens at different times. It is interesting to note that in Fig. 122 of Agassiz's "Seaside Studies," page 103, a drawing of a specimen of this species is given, in which three ocular plates border the aboral ring, and in which the plates are thus quite symmetrical. This must be of very exceptional occurrence, for I have never met it in the many specimens I have seen. I should be very glad to know if it has been at all generally observed.

In connection with the case of Strongylocentrotus, it is interesting to examine the aboral ring of other regular echinoids. In *Diadema* (Fig. 1) the ring is perfectly regular, with five genitals and five oculars of equal size; in *Arbacia* (Fig. 6) it is equally regular, but with five large genitals, which form a ring about the aboral area, and exclude from it wholly the five small genitals. In *Dorocidaris* (Fig. 3) the ring is nearly regular, four oculars barely reaching the ring, the fifth being shut out. In *Hipponoe* (Fig. 4) the case is nearly as in *Diadema*, one ocular, however, not reaching the ring. In *Echinometra* (Fig. 9), a very elongate urchin, but not elongate in the plane of the madreporic plate, the five oculars do not any of them reach the ring and the ring is very asymmetrical, being elongate in the major axis of the elliptical specimen. In *Heterocentrotus*, too (Figs. 2 and 5), the body is elliptical and the ring is asymmetrical, being longer in the direction of the major axis of the specimen. In this genus (one figured from the Bermudas [5] and one from the Philippine Islands [2]) there is only one ocular which borders the ring, a second barely reaching it in 5 or not really doing so in 2, this is not like the case presented in Fig. 8, the exceptional Strongylocentrotus, for there the lateral and not the median ocular is the one which surely borders the ring. A number of undetermined Echinoids at hand from the Pacific Ocean closely resemble Strongylocentrotus, and in them the aboral ring is like Fig. 7.

These comparisons have interesting morphological suggestions. *Dorocidaris* is a central form, as well as an early one palæozoölogically, in it the oculars are neither wholly on nor wholly excluded from the ring; from it *Diadema* is a departure toward and *Arbacia* from the ring, and all three of these are tolerably radial in symmetry. *Hipponoe* is a slight departure from the regular symmetry of the aboral ring, all the rest are not radial. The elongations of *Echinometra* and *Heterocentrotus* are in the same plane in each case, but the plane is not in the plane of the madreporic plate, as it is in the departures from radial and toward bilateral symmetry in clypeastrids and spatangids. The aboral pole of Strongylocentrotus is very much out of radial symmetry, though the shell in all other respects is very perfectly regularly radial. The meaning of the exceptional case presented in Fig. 8 might perhaps be understood as a reversion toward an ancestral form in which the oculars were all excluded from the aboral ring. I cannot think of any adequate physiological explanation of the relations of these bones in either Fig. 7 or Fig. 8.

Hamline Biological Laboratory, March 24, 1893.

THE CANALS OF MARS.

BY S. E. PEAL, SIBSAGAR, ASAM.

THE question as to the distribution of land and water on the planet Mars, and nature of the so-called "canals," is one on which there has of late been considerable speculation; and in the hope of throwing some little light on the subject, it may not be amiss to draw attention to a recent geological discovery relating to the distribution of land and water on our earth.

At no very distant period it was generally supposed that terrestrial continents and oceans had frequently — or at least occasionally — changed places, that oceanic islands, as a rule, were the summits of submerged or emerging ranges, the last relics, or forerunners, of extensive land masses. All this is now changed, and one of the most recent and important discoveries of modern geology is the fact that the great continental masses and deep ocean floors are permanent features of the earth's crust.

On p. 150, "Island Life," Mr. A. R. Wallace tells us that "there is the strongest cumulative evidence, almost amounting to demonstration, that for all known geological periods our continents and oceans have occupied the same general position they do now." And at p. 330, "during the whole period of geologic time, as indicated by the fossiliferous rocks, our continents and oceans have, speaking broadly, been permanent features of our earth's surface." Referring to ocean floors, Mr. J. Murray again says, "The results of many lines of investigation seem to show that in the abysmal regions we have the most permanent areas of the earth's surface." While M. Faye points out that "under the oceans the globe cools down more rapidly and to a greater depth than beneath the surface of the continents. At a depth of 4,000 metres the ocean will still have a temperature not remote from 0° C., while at a similar depth beneath the earth's crust the temperature would be not far from 150° C."

Last, Professor James Geikie, in his address to Section E, geography, of the British Association, says, "We must admit that the solid crust of the globe has always been subject to distortion, and this being so, we cannot doubt that the general trends of the world's coast-lines must have been modified from time to time by movements of the lithosphere. . . . It seems to be the general opinion that the configuration of the lithosphere is due to the sinking in and crumpling up of the crust on the cooling and contracting nucleus." "According to Professor Winchell the trends (of the great world ridges and troughs) may have been the result of primitive tidal action. He was of opinion that the transmeridianal progress of the tidal swell, in early incrustive times, on our planet, would give the forming crust structural characteristics and aptitudes trending north and south. The earliest wrinkles to come into existence, therefore, would be meridianal, or submeridianal, and such is certainly the prevalent direction of the most conspicuous earth features." "So far as geological research has gone, there is reason to believe that the elevated and depressed areas are of primeval antiquity — that they antedate the very oldest of the sedimentary formations. We may thus speak of the great world-ridges as regions of dominant elevation and of the profound oceanic troughs, as areas of more or less persistent depression."

The great areas of elevation and of persistent subsidence are very distinctly marked out on our earth by a meridianal-lobed arrangement, caused, as Professor G. H. Darwin thinks, by *tidal* rupture during early stages of crust formation. This great recent discovery is, therefore, one of the greatest importance to all seeking for the solution of the problem of the distribution of land and water on Mars.

Tested by our moon, and viewing the marea as "seas" now in some way solidified, the foregoing conclusions are borne out in the most remarkable manner on the hemisphere which is presented towards us.

From Walter to Cassini we have distinct evidence (of different kinds) of the existence along the prime meridian of a vast shoal or submerged continent lying north and south, bordered on the east by the series of marea, Nubium, O. Procellarum, and Imbrium, and on the west by Nectaris, Tranquilitatis, and Serenitatis, each series of three marea having a meridianal trend. Near the limb again, east and west, we see the well-known two series of vast walled plains, lying north and south, the great Sirsalis cleft, also north and south, 400 miles long, being a vast anticlinal surface-fracture.

That the persistent subsidence of ocean floors (an axiom in terrestrial geology) is also clearly seen in our moon, is well illustrated in the remarkable arrangement of the clefts in relation to the marea, viewed as areas of subsidence. In regard to this question, Mr. A. C. Ranyard in *Knowledge*, September, p. 173, says: "The evidence brought forward by Mr. Peal, with regard to the general subsidence of the great lunar marea seems to me conclusive." So that the two features of slow subsidence of ocean floors and meridianal arrangement of the land and sea areas due to primeval tidal rupture during crust formation, are seen on both globes of the earth-moon system.

But the arrangement of the land and sea areas on Mars is on a totally different plan, there is an entire absence of equatorial oceans, and of meridianally placed continents divided, as in our case and the moon, by wide troughs of subsidence. We see on that globe two vast polar oceans divided by a more or less continuous land girdle.

We may reasonably assume that on Mars the crust-formation began on the poles, and that, as time went on and further condensation took place, subsidence and formation of polar sea-basins would ensue, their floors, being the coldest and densest portion of the crust, persistently sinking in, would naturally cause the emergence of the equatorial land-girdle. The comparatively unbroken continuity of this latter would again be due to the absence of a large satellite causing tidal rupture: there would be no breaking-up of the emerging land girdle round the equator, during crust-formation, as in the earth-moon system.

Professor G. H. Darwin thinks that the effect of solar tides on Mars must be "inconsiderable," they might yet, however, be sufficient to cause and maintain a slight overspill from one polar ocean-basin into the other, as the northern or southern hemispheres were presented towards the sun.

During the equinoxes, also, for some months, twice a year, solar attraction would probably draw the water from each polar