always so constituted further investigation should determine. As it is comparatively immense, its examination is not so difficult as is that of the smaller *Amœba*, the study of which, with this special object in view, would demand greater care and an eye trained by practice over the microscopically minute. The subject and the facts are important by reason of their bearings upon the minute examination of objects that may, perhaps, possess a more utilitarian purpose than either the common *Amœba* or the almost equally common *Pelomyxa*.

The examination in this case was made with Bausch & Lomb's homogeneous immersion one-eighth, Reichert's oil-immersion one-twelfth, N. A. 1.40, and Gundlach's homogeneous-immersion one-twentieth, N. A. 1.20.

Trenton, New Jersey.

GLACIATION IN WESTERN MONTANA.

BY HERBERT. R. WOOD.

THE evidences of glaciation in western Montana are very apparent from Helena to Hope (Idaho). They are shown by a series of parallel valleys with a north and south trend, and another series of rounded oblong isolated valleys, connected by narrow necks of land along river bottoms between mountain chains. The former follows the strike of the rocks, occurring along contact lines, synclinal folds, shore or marginal beds of the Sub-Carboniferous formations; the others cross the strike, and, like the former, are also largely the result of pre-glacial denuding forces. The direct evidences are erratic blocks, terminal moraines (frequently holding back lakes), clays, striæ, gravels, etc. The main range of the Rockies (5,550 feet, at Mullan, above the sea), consisting of Devonian, Carboniferous and Sub-Carboniferous, has a valley on the west in the upper Cambrian. Further north-west the glacial striæ run 45° north of west, the general course of valley being 30° north of west.

The elevation at the boundary here is 4,000 feet above the sea; 100 miles south of this it is 3,200 feet, in vicinity of Missoula. From the summit of the main range, as given above, to Hope, Idaho, 300 miles, the fall is over 3,000 feet (5,550 — 2,200). The fall from the boundary is not constant; at Libby, near Idaho, the height is 2,000 feet, forty miles south of this it is 2,500 feet. While the glacial action has been generally from the north, at 100 or 150 miles from the boundary seems to have been the end of the terminal moraines; and a series of glaciers came from the south — the higher elevations of the Bitter Root Range. The great Flathead Valley, which lies west of 114° and extends south from the boundary for 150 miles to Ravalli, is about 30 miles wide. In its southern portion a lake is situated, which is about 35 miles long, dammed by a terminal moraine 200 feet high. The lake is 1,000 feet in depth, its northern shore being a plain, extending for 30 miles, representing an old lake-bed. Another moraine extends across the northern part of this plain, making the boundary line of its northern shore. Such a glacier that could produce this excavation must have been 2,000 feet in thickness and 25 miles wide. Heavy beds of clays, 150 feet in thickness, cover the plain, with a few boulders and thin beds of sand in its lower layers, which is followed by gravels. The worn-down roots of a mountain range are noticeable at both the north and south shores of the lake. This valley runs along the shore line of the lower Cambrian quartzitic series. Some glaciated valleys enter this from the west. The direction of this great glacier seems to have been south-east, crossing a range of mountains 20 miles to the east, which it has left hummocky and worn. Ninety-eight miles west of this the Cabinet Range, 30 to 40 miles long, 7,000 to 10,000 feet high, on the borders of Idaho, shows marked glaciation, the striæ having a course 42° south of west. The height, at Libby on Kooterian, above the sea here is 2,000 feet. The glacial detritus piled along the flanks of this anticlinal is 700 feet in thickness, and represents the material from the gulches. At Hope Pend O'reille Lake the glacial action has undoubtedly been very great, the lake being 2,000 feet deep, with a mountain 4,000 feet above the sea to the north of it. The town is 2,000 above the sea. A number of islands in the lake are scoured down to the water's edge. They represent mountains which may have risen as high as that mentioned. The striations are 40° west of north, 42° west of north. A terminal moraine has dammed the river (Clark's Fork of the Columbia), which enters it from the east, and turned it a mile to the south. Pre-glacial action has been active here and at Libby (see above), some 6,000 feet of strata having been removed from the summit of the Cabinet anticlinal, most of it being pre-glacial denudation. Lake Pend O'reille may perhaps fitly be a glacial lake, a rock basin, which has been filled by the waters of the Columbia. The greatest length of the lake is along the strike of the rocks, though this has not been an important feature in moulding its form, but rather the action of glacier, boulders of diabase and granite being observed several hundred feet above the lake along the mountain side. At Clark's Fork, 20 miles east, I observed granite boulders, on a mountain, at a height of 1,800 feet, or about 4,000 feet above the sea. Heavy beds of gravels, clays, and boulders fall on the valley of the river (Columbia) for 60 miles, the general direction being east and west. At Thompson the glacier has scoured down a range to the south, the path of the glacier being here apparently south-west. A series of terraces extend along the north side of the river, with large blocks of slates (presumably of pre-Cambrian age). At Horse Plains a small valley running east and west represents an old post-glacial lake bed. The glaciers here came from the north, piling up heaps of clays and gravels along the north hummocky side of the valley. One large erratic block of limestone (upper Cambrian) measured $12 \times 15 \times 18$ feet. It was perched about 400 feet above the valley on a diabase dike. This point is 75 miles west of Missoula and about 2,460 feet above the sea. At Missoula a large gravel plain (an old lake-bed), of 40 or 50 miles square, lies in the midst of the lower-Cambrian rocks. To the north the cretaceous rocks dip into the mountains eight miles distant at an angle of 30° north-west. The glaciers have greatly denuded this cretaceous belt into low foot-hills in their path from the mountains (8,000 feet above the sea) 8 or 10 miles north. Moraines flank the mountains, large blocks of slates and quartzites from the Cambrian rocks resting at the mouths of creeks and stretching across the old lake beds. Around the mountains a series of beaches or beach-lines extend; I have counted 26 of them one above the other, extending upward for nearly 2,000 feet above the plain. These beach-lines I have traced for 50 miles. They seem to represent a pretty general upheaval following upon the close of the cretaceous period. The depth of the gravels which form the old lake-bottoms must be very great. They consist of Cambrian quartzites. To the south of Missoula extends a long valley (terraced) for 75 miles. It lies to the east of a gneissoid range or a bedded quartz porphyry porphroidal or gneiss coeval with Pilot Knob of Missouri and the older Archean gneisses. A glacier undoubtedly travelled to the north, cutting out a range of Cambrian rocks, dipping south, nine miles south of Missoula, connecting it with the old lake previously mentioned. To the north-west of Missoula are several small valleys, through which the Blackfoot River runs. They all run east and west or nearly so across the strike of the rocks, and are divided by low, rounded, hummocky ranges, over which the glaciers have passed. Stratified gravel deposits are exposed along river banks, 75 feet in thickness. One valley, about 12 miles long, running along the strike of the rocks, which dip east, has a moraine at its northerly end made of thickly scattered angular boulders and clays, and of a terrace-like nature, rising 200 feet above the river, which has here cut through it. Ten miles further north another moraine occurs, and five miles further north a great moraine of several hundred feet in thickness and holding ponds and small lakes in its surface. These seem to show, so far as a hasty examination would permit, points in the recession of a great glacier whose course was south-west. A few generalizations from these facts show pretty conclusively that.

1. The rivers are nearly all of pre-glacial origin, but probably post-cretaceous, one or two having been deflected in their courses by the glaciers.

2. The denudation has been largely, if not in greater part, pre-glacial.

3. No apparent upheaval has occurred since the glacial period, but a series of beach-lines indicate a pretty general elevation following the cretaceous period.

4. The general trend has been south, south-east, and south-west, but frequently deflected east and west by ranges and pre-existing valleys. The great Flathead glacier west of 114° shows a length of 150 miles from boundary. Along a line 150 miles south of boundary, which rapidly swings to the north as we go westward, the lower limits (moraines) of this series of glaciers is evident. To the south of these the glaciers have had a northerly trend, forming a series of valleys running north and south. Short glaciers, radiating from local heights, as at Libby, and Missoula and various other places, were common. Some of these have no doubt been persistent for some time since the glacial period proper.

5. With the recession of the glaciers the lakes were drained to the west.

6. Existing glacial lakes are four or five in number. They are rock-basins eroded no doubt greatly before the glacial period. In nearly all cases they are dammed by terminal moraines.

7. The area touched upon is 300 miles (E. and W.) by 100–150 miles (N. and S.). The fall being to the west and south as noted; on the map it may be found from the 49th parallel on the north to the 47th on the south, from the Rockies (main range on east) to Idaho boundary-line.

8. Terraced valleys of much interest occur, but to which no detailed study has been given.

THE SHRINKAGE OF LEAVES.

BY E. E. BOGUE.

PROBABLY every maker of botanical specimens has observed that the leaves when dry are smaller than when fresh. The wish to know how much the shrinkage might be led to the following measurements. The leaves were measured before they had wilted, and after they were perfectly dry.

The longest dimensions were taken in each case. The width or dimension across the midrib is first given in each case; the first column shows the measurements when fresh, and the second column the measurements when dry. All measurements are given in inches and parts of an inch.

Scarlet Oak (Quercus coccinea).

Fresh.	Dry.
$7\frac{3}{8} \times 12\frac{1}{2}$	$7\frac{3}{16} \times 12\frac{5}{16}$
$6\frac{1}{8} \times 11\frac{1}{2}$	$6 \times 11\frac{3}{8}$
$6\frac{5}{8} \times 12\frac{1}{2}$	$6\frac{9}{16} \times 12\frac{7}{16}$
$6\frac{1}{4} \times 12$	$6\frac{1}{8} \times 11\frac{13}{16}$

Arisæma triphyllum (Indian Turnip).

$4\frac{13}{16} \times 9$	$4\frac{3}{4} \times 9$
$5\frac{1}{4} \times 8\frac{3}{4}$	$5\frac{1}{4} \times 8\frac{5}{16}$
$4\frac{1}{2} \times 7\frac{3}{4}$	$4\frac{1}{2} \times 7\frac{1}{2}$
$4\frac{3}{4} \times 7\frac{3}{16}$	$4\frac{11}{16} \times 7\frac{1}{6}$
$5\frac{3}{16} \times 7\frac{1}{2}$	$5\frac{1}{8} \times 7\frac{1}{2}$

Asimina triloba (Common Papaw).

$4\frac{7}{8} \times 12\frac{5}{8}$	$4\frac{3}{8} \times 12\frac{5}{8}$
$4\frac{7}{8} \times 13$	$4\frac{1}{4} \times 12\frac{7}{8}$
$3\frac{7}{8} \times 10\frac{7}{8}$	$3\frac{13}{16} \times 10\frac{9}{16}$
$4\frac{1}{16} \times 12$	$4 \times 11\frac{7}{8}$
$5 \times 13\frac{7}{8}$	$4\frac{7}{8} \times 13\frac{3}{4}$

Arctium Lappa (Burdock)

$9\frac{5}{8} \times 15\frac{3}{4}$	$9\frac{1}{2} \times 15\frac{3}{4}$
$11\frac{5}{16} \times 17\frac{7}{16}$	$11 \times 17\frac{1}{4}$
$9\frac{1}{2} \times 14\frac{3}{4}$	$8\frac{7}{8} \times 14\frac{7}{16}$

Asclepias cornuti (Milkweed).

$4\frac{1}{2} \times 7\frac{15}{16}$	$4\frac{1}{16} \times 7\frac{13}{16}$
$4\frac{1}{2} \times 9\frac{1}{4}$	$4\frac{1}{16} \times 9$
$4\frac{1}{2} \times 9\frac{3}{16}$	$4\frac{3}{8} \times 9$
$4\frac{1}{8} \times 9\frac{1}{16}$	$3\frac{15}{16} \times 8\frac{7}{8}$
$3\frac{13}{16} \times 8$	$3\frac{11}{16} \times 7\frac{3}{4}$

Acer saccharinum var. nigrum (Sugar Maple).

$5\frac{7}{8} \times 5\frac{1}{16}$	$5\frac{3}{4} \times 5$
$6\frac{11}{16} \times 5\frac{7}{8}$	$6\frac{5}{8} \times 5\frac{13}{16}$
$7\frac{7}{8} \times 5\frac{7}{16}$	$7\frac{3}{4} \times 5\frac{3}{8}$
$7\frac{5}{8} \times 5\frac{7}{8}$	$7\frac{1}{4} \times 5\frac{13}{16}$
$6\frac{7}{16} \times 5\frac{1}{4}$	$6\frac{3}{8} \times 5\frac{1}{4}$

Abutilon avicennæ (Velvet-Leaf).

$8\frac{5}{16} \times 8\frac{5}{16}$	$8\frac{1}{4} \times 8\frac{1}{4}$
$9 \times 9\frac{5}{8}$	$8\frac{7}{8} \times 9\frac{1}{2}$
8×8	$7\frac{7}{8} \times 7\frac{13}{16}$
$3 \times 3\frac{1}{8}$	$2\frac{1}{16} \times 3$
$9\frac{3}{16} \times 8\frac{7}{8}$	$9 \times 8\frac{3}{4}$
$9 \times 9\frac{1}{4}$	$8\frac{3}{4} \times 9$
$8\frac{1}{2} \times 8\frac{1}{2}$	$8\frac{7}{16} \times 8\frac{1}{2}$

Rumex obtusifolius (Bitter Dock).

$5 \times 11\frac{1}{4}$	$4\frac{7}{8} \times 11$
$4\frac{11}{16} \times 8\frac{1}{2}$	$4\frac{7}{16} \times 8\frac{1}{8}$

Platanus occidentalis (Sycamore).

$8\frac{1}{4} \times 6\frac{1}{2}$	$8\frac{1}{16} \times 6\frac{5}{8}$
$8\frac{7}{8} \times 7\frac{1}{8}$	$8\frac{3}{4} \times 6\frac{7}{8}$
$9\frac{1}{4} \times 6\frac{1}{2}$	$8\frac{3}{4} \times 6\frac{1}{2}$
$7\frac{5}{8} \times 6\frac{1}{16}$	$7\frac{1}{4} \times 6$

Nymphæa odorata (Sweet-scented Water-Lily).

7×7	$6\frac{1}{4} \times 6\frac{1}{4}$
$10 \times 8\frac{3}{4}$	$9 \times 8\frac{1}{4}$
$8\frac{1}{2} \times 7\frac{3}{4}$	$7\frac{1}{2} \times 7$
14×14	13×13
$11\frac{1}{4} \times 10\frac{1}{2}$	$10\frac{3}{8} \times 9\frac{11}{16}$

Nelumbo lutea (Yellow Nelumbo).

$11\frac{15}{16} \times 12\frac{1}{2}$	$11\frac{5}{8} \times 11\frac{15}{16}$
$13\frac{1}{2} \times 14\frac{3}{8}$	$13\frac{1}{4} \times 13\frac{7}{8}$
$12 \times 12\frac{1}{4}$	$11\frac{5}{8} \times 11\frac{3}{4}$
$12\frac{3}{4} \times 13\frac{5}{16}$	$12\frac{1}{2} \times 12\frac{3}{4}$
$12\frac{1}{4} \times 12\frac{1}{4}$	$11\frac{13}{16} \times 11\frac{7}{8}$
$9\frac{1}{16} \times 9\frac{1}{2}$	$9 \times 9\frac{1}{16}$

The leaves were pressed enough to keep them from wrinkling. A piece the size of a mounting-sheet ($11\frac{1}{2} \times 16\frac{1}{2}$) was cut from a leaf of the Nelumbo, and was found to decrease from that size to $11 \times 15\frac{1}{16}$. It will be seen that the least shrinkage was in the Indian turnip (the measurements here referring to leaflets), and the greatest shrinkage in the water-lily. Petioles of the sugar-maple were measured and ranged from $2\frac{3}{4}$ to $4\frac{7}{16}$ in length, but were shortened by drying, if at all, less than $\frac{1}{16}$.

It will be noticed that in the velvet leaf the small immature one decreased more even than the largest one.

Ohio State University, Sept. 10.

LETTERS TO THE EDITOR.

Pre-Aino Race in Japan.

I MUCH regret that Prosessor Morse should think that I have intentionally misrepresented or carelessly disregarded his views concerning the pre-Aino occupancy of Japan, as he rather vigorously maintains in *Science* of Sept. 9. It can scarcely be said that I have claimed for myself the discovery that there was a race of people in Japan before the Ainos. The most I have endeavored to show is the possibility,— I do not even go so far as to suggest the probability,— that the pre-Aino inhabitants of Japan may have been the people who dug the pits in Yezo.

As regards the Aino occupancy of Japan, Professor Morse will find that the "historical records" of the country, which he mentions, have not been disregarded in my article, and, in fact, the evidences of the shell heaps are, to my mind, the least convincing of any, until the fact of the Aino origin of them is established. It is the historical evidence, the distribution of geographical place-names, and, last but not least, Japanese tradition, which are at present the strongest evidences in this connection.

An author may be criticised for sins of omission, and even for