the time there was not wind enough to do more than to swing the spider to the same angle from the vertical that he was then making above the horizon. It seemed the more surprising, as the spiders were large, and ought, by all the laws of gravity, to have fallen to the earth at once. And what was their objective point, aiming, as they did, for the clouds and stars? But I content myself with the statement of the facts, leaving to others the how, why, and whither.

E. T. QUIMBY.

Hanover, N.H.

Improvement of western pasture-land.

In his article in SCIENCE, p. 186, Professor Shaler's opening sentence, "that the greater part of the United States west of the meridian of Omaha is unfit for tillage," leaves a somewhat wrong impression. The greater part of Nebraska is west of that meridian; but nearly the whole state, as far as longitude 99°, produces crops of the cereal grains, grasses, corn, fruit, and roots, more surely, even, than the middle states. This area embraces 30,000 square miles. Large sections west of the 99th meridian produce almost equally well, as our statistics show. His suggestions, however, apply to the proper management of the grasses outside of this area, and are of very great importance.

A remarkable peculiarity of our Nebraska flora is its changing character. While not confined to the grasses, it is especially conspicuous among them. When I first crossed this county (Lancaster) in 1865, buffalo-grass (Buchloe dactyloides) covered much of the uplands. By 1871 nearly all of this species had disappeared; and its place was taken by blue-joints (Andropogon furcatus, etc.), interspersed with Boutelouas, Sorghum nutans, Sporobolus, etc. Again, in 1878, the blue-joints disappeared from entire townships, and the Boutelouas usurped their place. Similar phenomena were observed in almost every county in the state, and even in sections where settlements had not penetrated. During the last two years Sorghum nutans has been gaining in eastern Nebraska over all other species. On the whole, the species indigenous to moist regions have been gaining on the buffalo-grasses to such an extent that the latter have almost entirely disappeared east of the 100th meridian, and from large areas farther west. In extreme north-western Nebraska, on tributaries of the Niobrara, I have observed, since 1865, a remarkable exchange of buffalo-grass for Boutelouas and other grasses in different years. This tendency, therefore, is common, though not to the same extent, in the drier as well as the moister portions of the state. When old Fort Calhoun, above Omaha, was occupied by the military, twenty-five years ago, Kentucky blue-grass was brought in baled hay to that post from the south. It spontaneously took root, and spread in every direction, and now it can be found on prairies thirty miles away. Many of our farmers in eastern Nebraska are looking to that species now for a grass to give late fall and early spring pasturage.

Under favorable conditions, the wild native grasses produce a remarkable amount of hay. The blue-joints range in productiveness from one to three tons and more per acre. The latter large yield has been realized even at the 99th meridian on the wide Elkhorn-river bottoms. All the facts noted in the moist as well as dry sections of the state confirm Professor Shaler's theory; namely, that the natural conditions on the plains are most favorable to a changing grass vegetation, and that it is possible, through the agency of man, greatly to improve on the native species.

SAMUEL AUGHEY.

Apparent attractions and repulsions of small floating bodies.

As I thought it worth while, in the interests of clear teaching, to object (SCIENCE, i. p. 43) to certain things in Professor John Leconte's explanation of the 'Apparent attractions and repulsions of small floating bodies,'[1] it seems my duty, now that Professor Leconte has replied (SCIENCE, i. p. 249) to my criticism, to justify that criticism, or, failing in that, to acknowledge my error.

A statement in his explanation of the behavior of two moistened floating bodies, to which I particularly objected, was the following: "But when brought so near that their meniscuses join each other, the radius of curvature of the united, intervening, concave meniscus . . . is less than that of the exterior concave meniscuses, . . . and its superior tension acts upon both bodies toward a common centre of concavity."

The parts omitted from this sentence are merely references to a diagram. Professor Leconte now states that he should have said *superior force* instead of *superior tension*. I, however, objected to the statement on quite other grounds. After quoting it, I said, "We do not think physicists generally will admit that a liquid film tends *to draw a solid, to which it is attached, toward the centre of concavity of the film*. Indeed, if this were so, the tendency of a column of water raised between two floating bodies by surface-tension would be to lift those bodies. Similarly, a column of liquid sustained in a fine tube would tend to lift the tube."

I have quoted myself thus at length, — using italics, which I did not use before, — because Professor Leconte appears to understand me as denying that what he calls the 'capillary forces' — such, for instance, as the force exerted upon the enclosed air by the film of a soap-bubble — are directed toward the centre of concavity of the film. I spoke merely of the force exerted upon *the body to which the edge of the film is attached;* and the force exerted by the film upon such a body is certainly not directed toward the centre of concavity of the film. If we coil a rope round a cask, and set a man to pull at each end of the rope, the pressure on the cask will be everywhere directed toward the centre of curvature of the coil: but the pull on the men will not be toward the centre of curvature of the coil; it will be tangential to the coil. In the same way, the action of a meniscus upon the water beneath it, or the air above it, is directed toward the centre of concavity of the meniscus; but the action of the meniscus upon the body to which it is attached is tangential to the liquid surface, and perpendicular to the bounding edge of the meniscus.

Professor Leconte, however, has chosen to make the statement I have quoted above; and to my criticism thereon he replies, "Indeed, it is obvious that the elastic reaction of the common meniscus, formed when two such floating bodies are brought near to one another, *does not tend to lift them;* for the *vertical* component of the capillary forces, directed toward the centre of concavity, is exactly counterbalanced by the weight of the adhering liquid elevated between them, while the *horizontal* component is free to draw them together." He makes a similar statement concerning the action in a capillary tube.

It is, indeed, obvious, that the weight of the water must be sustained; but how and where is this weight applied to the floating bodies or to the tube? If it is applied by means of the surface-film, and at the line where the bounding edge of that film meets the floating bodies, or the wall of the tube, Professor Leconte's

[1] Amer. journ. sc., December, 1882.