Having the three sides of the spherical triangle ℓ Ca, the angle at C can be calculated, and it proves to be 53° 15′ 26″ for the 1st January, 1755.

Owing to the Second Rotation the Pole P is carried round C as a centre, at the annual rate of 40.9″. Between 1755 and 1850 there are 95 years, which multiplied by 40.9″=1° 4′ 45 5″ for the increase of the angle at C, which becomes 54° 20′ 11.5″ for 1850, when the Pole has reached P′.

We then have P′C=29° 25′ 47″ Ca=26° 37′ 3″ and the included angle P′Ca=54° 20′ 11.5″ to calculate P′a.

By calculation P′a=24° 54′ 21.2″ and found by observation, 24° 54′ 21.4″.

For 1st January, 1890, the angle C becomes 54° 47′ 27.5″ and by calculation, as before, P′a=25° 5′ 55″, and by the Nautical Almanac 1890, 1 January=25° 5′ 54.8″.

Hence the polar distance can be calculated for 135 years to within one second; and, considering the uncertainty of refraction, it is probable that the calculation is more correct than observation.

Such a result speaks for itself, and may well excite admiration of General Drayson's perseverance during many years of tedious calculation, until his labors have at last been rewarded by the splendid discovery of the radius of the circle described by the Pole of the Heavens, and the centre of that circle.

Had Newton with his marvellous intellect known, as we do *now*, that an almost tropical climate existed in what are now Arctic regions, and an Arctic one as low as 54° of latitude; that the axis of the earth varied its inclination to the plane of the Ecliptic; and that vast elevations and depressions had occurred upon the surface of the Globe causing its centre of gravity to vary its position by the consequences of these movements, as in transferring enormous quantities of the waters of the sea from one locality to another; who can doubt that he would have discovered the manner in which the Pole of the Heavens would have moved in obedience to the law of gyration? And with such catalogues as we now possess, he might have achieved the same results as have been obtained by Drayson in discovering, as he has done, the details of the Second Rotation. At all events he would certainly have attributed the Precession of the Equinoxes to the true cause of this, and not to the assumed joint action of the sun and moon on the protuberant Equatorial Zone.

A SEGREGATION OF FRESH-WATER FISHES.

BY THEODORE GILL, M. D., PH. D., WASHINGTON, D. C.

One of the most remarkable facts in zoögeography is the segregation of the greater part of fresh-water fishes represented by the ostariophysal orders, that is, the families *Characinidae, Cyprinidae, Siluridae* and their subdivisions. These are all genetically related, and must have developed from a common stock early accommodated to the fresh water and subsequently differentiated into many families and a host of genera with many hundreds of species. The few marine representatives of that host are the *Ariinae*, or *Tachisurinae*, and the *Plotosidae*, and these must have diverged from primitive fresh-water types.

Another case of segregation of a widely distinct series of families has never been recognized, and attention should be directed to it. It is that of the haplomous fishes.

The *Haplomi* are teleocephalous fishes with a pneumatic duct and abdominal ventrals, and were considered by Prof. Cope to be an order of physostomous fishes, including *Esocidae, Umbridae, Cyprinodontidae* and *Hypsaeidae*. These are evidently related to each other, although not very closely, and are mostly fresh-water forms. There are two other families which have hitherto found no satisfactory resting place which I am disposed to associate with the typical haplomes—*Percopsidae* and *Aphredoderidae*.

If the six families thus associated are really genetically related, we would have another series of families segregated as a fresh-water group, and which must have been long established. The only one of these six families with marine representatives is *Cypronodontidae*, and this seems to be the most generalized and most nearly related to the Synentognathous fishes, on one hand, and the Perciform, on the other. Whether the salt-water Cyprinodontids are the descendents of primitive salt-water fishes or have reverted to the sea in later times, is now an open question. This I do not propose to discuss at present, reserving it for future consideration, as well as numerous collateral questions which may suggest themselves. My only object at present is to draw attention to the zoögeographical fact mentioned and the morphological problem involved.

It is noteworthy that all the families enumerated are represented in the United States, and half of them (*Hypaeidœ*, or *Amblyopsidae, Percopidae* and *Aphredoderidae*) are found nowhere else. The *Esocidae* and *Umbridae* are represented in Europe as well as America. The *Cyprinodontidae*, or *Poeciliidae*, are generally distributed. All the families are remarkably well defined. Finally, it may be suggested that the unwonted position of the anus (jugular or thoracic) of two (*Amblyopsidae* and *Aphredoderidae*) is possibly more than a mere coincidence, and may be an inheritance from common ancestors.

BIOLOGICAL INVESTIGATION IN BOTANY.

BY J. CHRISTIAN BAY, BACTERIOLOGIST OF THE IOWA STATE BOARD OF HEALTH, AMES, IOWA.

A couple of smaller notes on the biological question, as far as botany is concerned, were published by me in this journal. To the first of these, What is biology? this little note is to be regarded as an appendix. My first paper contained, originally, a number of notes on the modern methods of biological investigation in botany; I kept them back in order that they should not be misunderstood.

A short time ago I received Professor N. Wille's inauguration speech in taking the chair of botany at Christiania, Norway. Professor Wille has said, in a few words, what I wished to say on the occasion above referred to. Therefore, I shall quote him:

"The so-called plant-biology is a child of the Darwinian theory of selection. It should be called, more correctly, *oecology*. This branch of investigation should embrace, as nearly as possible, the science of all life-phenomena of plants, *minus* physiology: in other words, oecology is the science of the mutual relationship between the plant and the surrounding nature, when this relationship does not rest upon physical and chemical causes.

"Oecology has still retained many reminiscences from the teleological conception of earlier days, when nature as a whole was thought of as created for the sake of being principally of use to, or a plaything for, the human race. Plant oecologists, or as they like to call themselves, plant biologists, have the idea that everything must be useful or developed in a certain way in order to be of use for certain purposes.

"We shall give an example of one of the typical representatives of this line of study. He placed an ant on the leaf of *Sonchus*, and found that the ant tore the cuticula, so that the milk juice from the leaf came out. The resin