

is, $-2^{\circ}4$, and in distance, $-0''74$. The elements above are perhaps affected by error of copy, but as they stand they will admit of some improvement.

With Dr. Duner's semi-axis and period, and Mr. Otto Struve's first approximation to the annual parallax, the mass of this system would be upwards of ten times the solar mass.

It will be remarked that the angles in the above orbit are expressed by Dr. Duner in decimals of degrees, and we may take this opportunity of directing attention to a very useful table of five-figure logarithms adapted to decimals of the degree published at Berlin in 1872 by Dr. C. Bremiker, which will be found available not only in double-star computations, but very generally for five-figure work. The figures closely resemble those in De Morgan's well-known tables (which are now apparently out of print), and consequently are exceedingly clear and readable, and the price nominal (one shilling). Several miscellaneous tables and various useful constants are appended. The work will be sent over in paper cover, and in binding this or any other set of tables for frequent use, we would recommend the strong gilding of all the edges as materially facilitating their working. When shall we have a table of *four-figure* logarithms to the same extent as tables for five figures are usually printed? Such a work would be by no means without its value.

(2) γ LEONIS.—Dr. Doberck, of Col. Cooper's Observatory, Markree, has calculated elements for this star, though the arc described is at present less than 30° , under which condition orbits widely different may be obtained. Peri-astron passage, 1741.11; period of revolution, 402.6 years; node, $111^{\circ} 50'$; λ , $194^{\circ} 22'$; γ , $43^{\circ} 49'$; eccentricity, 0.7390; semi-axis major, $2''00$.

There are several of the revolving double-stars of which much better orbits than have yet been published might now be found; as, for instance, θ Leonis and λ Ophiuchi. Of the fairly determined orbits, the shortest period appears to be that of 42 Comæ Beren—25.5 years, according to Mr. Otto Struve; and the longest that of Castor, 997 years, according to the very complete investigation of Herr Thiele.

THE MINOR PLANETS.—M. Leverrier, in his "Bulletin International" of the 8th inst., announces the discovery of No. 148 at Paris, by M. Prosper Henry, on the same morning. The planet is of 10.7 mag., and was found a little west of 70 Aquarii.—Circular No. 31 of the "Berliner Jahrbuch" contains new elements of Lachesis (120); the period of revolution at the next opposition in November is 2,028 days. In No. 30 appeared new, though still uncertain, elements of Austria (136); period 1,261 days.

THE AUGUST METEORS.—The extensive systematic plan of observation at the principal meteor epochs which has been for some time organised by the Scientific Association of France, at the instance of M. Leverrier, has again been attended with success, on the occasion of the Perseid shower. At Rouen on August 9, between 11h. and 15h., 200 meteors were noted, of which 180 came from the Perseus-radiant; at Rochefort, on the same night, 258 meteors were observed, nearly the whole conformable; and on the 11th, at the same place, 260, many with the same radiant.—About August 5th, in the neighbourhood of London, an unusual number of meteors, more than one as bright as stars of the first magnitude, diverged from Omicron in Andromeda.

Prof. Oppöizer's *definitive* elements of Comet 1862 (III.), with which the August meteor-stream is associated, are here subjoined:—

Perihelion passage, 1862, August 22.91192 G. M. T.	
Longitude of perihelion ...	$344^{\circ} 41' 32''$ } M. Eq. 1862.0
" Ascending node ...	$137^{\circ} 27' 10''$ }
Inclination to ecliptic ...	$66^{\circ} 25' 48''$
Eccentricity ...	0.9607588
Semi-axis major ...	$24' 53.142$
Period of revolution ...	121.502 years.

The point of nearest approach to the earth's orbit at the descending node is passed 19.357 days after perihelion; if in 1862 the comet had arrived at perihelion July 21.557, a little before noon on the 10th of August, it would have been distant from the earth less than twice the distance of the moon. It might not be without interest to determine the effect of so close an approach to our globe, upon the orbit of the comet; but in such an unusual computation it appears almost necessary that earth and moon should be treated as distinct disturbing agents; perhaps the ordinary methods might apply, if the intervals were taken sufficiently short and the elements changed with sufficient frequency.

THE SEPARATION OF THE ARAL AND THE CASPIAN

IN a note on the Hyrcanian Sea (vide NATURE, vol. xii., p. 51), it was stated that the waters of Aral, whose surface is now about 159 feet above sea level, formerly overflowed at their S.W. corner, when the lake possessed a depth of 50 feet more than at present. It is certain that the spur of Ust Urt, which formed a waste weir at the point in question, has been lowered by the action of escaping water; and the level at which the overflow took place, in the first instance, was probably some few feet higher than the figure of 209 which has been given. The greatest height ever reached by the water contained in the basin of Lake Aral may therefore be said with tolerable accuracy to be about 220 feet above the sea.

On the N.W., near the head of the Tchagan stream, where Aral must have overflowed to flood the country round the limits of Ust Urt, the barometrical height of a point situated in latitude $47^{\circ} 7' 27''$, and longitude (east from Greenwich) $58^{\circ} 17' 41''$, is 257 feet (a). This height approximates sufficiently to that which has been indicated for the overflow at S.W., to suggest that future levelling operations will find a point somewhere in this neighbourhood situated at less than 220 feet above the sea. There is, in addition, in latitude $43^{\circ} 15'$, a cleft in the eastern cliff of Ust Urt, by which, and probably by other similar clefts yet to be discovered, the waters of Lake Aral may have overflowed to the west; and in such a case they would, as they travelled down to the lower level of the Caspian Sea, have submerged many extensive, depressed tracts, which occur on the surface of the intervening country. The separation of the two seas, which has afforded subject for much discussion, seems thus actually to have been due to the cessation of the overflow of the basin upon the higher level. Nor is, perhaps, that separation so entirely complete as has generally been thought, for Lake Aral could possibly be filled and made to overflow again; and under such restored conditions, the physical aspects of the country lying between the two seas would very nearly resemble those which are possessed at the present time by the country on the lower courses of the Amú Darya, and are caused by the annual flooding from that river. In such a drowned condition, the Aralo-Caspian region was naturally included in the water-spread of the Hyrcanian Sea by all the classical historians and geographers who have described it; and though, perhaps, no possible overflow from Lake Aral could now exactly reproduce the physical aspects of 2,000 years ago, such difference as would be observable is susceptible of explanation by considerations to be presently entered upon.

Since the accidental circumstance of more or less water having existed in several depressions upon the surface of the Aralo-Caspian region is the only known variation which has attached to its physical aspects from the earliest historical times, there is a strong presumption that no phenomena of upheaval have occurred, and that over-

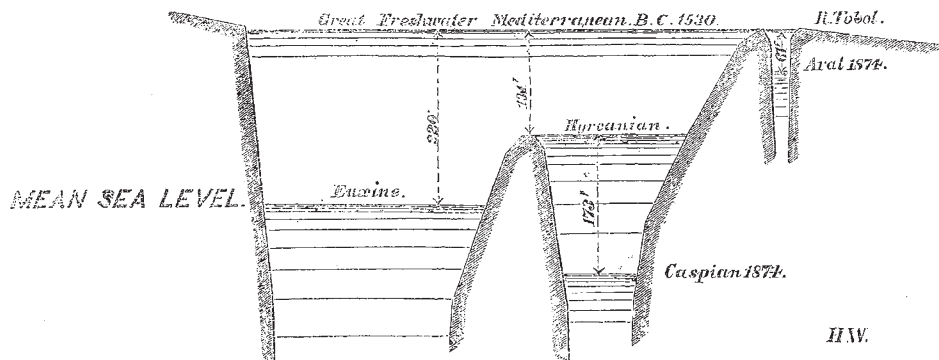
(a) These figures are taken from the Catalogue of Trigonometrical and Astronomical points in the Russian Empire. Edited by the Director of the Geodesical Department of the Military Topographical Staff.

flow could still take place in a northerly direction also from Lake Aral. Some sixteenth century maps show the river Obi flowing out of the lake of Kitay, which is one of the names of Aral; and by such an overflow may be explained that supposed irruption of Ocean into Asia which the most ancient Greek and Latin authorities have recorded. Nor would the demonstration of the possibility of this overflow in any way affect the reputation either of Herodotus or of Aristotle, who both maintained the isolation of the Hyrcanian from the ocean; for the overflow from Aral might or might not have taken place during a series of years, depending as it did upon the magnitudes of the annual floods of the rivers which supplied it, at the epoch when the winter broke up, on the highlands of Central Asia.

It was estimated in the note on the Hyrcanian Sea that when the Oxus discharged directly westwards, the water-spread of Lake Aral and the lands drowned by its overflow might have added about 70,000 square miles to the area of 140,000 square miles, which is possessed by the Caspian of to-day. If 30,000 square miles be added besides, for the volume which Oxus, Ochus, and Arius probably supplied, the total area of the Hyrcanian Sea would have been about 250,000 square miles, which would have formed a waterspread almost reaching up to the

ridge which divides the Caspian from the Black Sea, *i.e.* the level of the largest possible Hyrcanian Sea may have been 89 feet above mean sea-level, in the lowest of the two basins which formed it. The observations of Pallas have, however, placed beyond doubt that the ancient limits of the Caspian were situated at a much higher level than this; and since these limits, which are delineated in a map illustrating his works, did not owe their existence to the overflow from Aral, in conjunction with the volumes of water delivered by the rivers of the Caspian basin, they must have been formed by water flowing out of the Euxine basin. And this latter could not consequently have had at such a time a communication with the Mediterranean Sea.

We know that at the present day a very much larger volume than is required to compensate its surface evaporation is contributed by the various rivers supplying the Black Sea, and passes thence through the Bosphorus into the Sea of Marmora. Before this escape existed, the level of the Euxine would have been higher, and the surplus waters would have overflowed to the east by the channel of the Manytsch into the basin of the Caspian, whose level would, in turn, have been raised. The united waterspread of the two basins would have continued to rise, until the surface evaporation equalled the supply of water



it received; or until it found an escape into a lower level, and this latter circumstance was the one which almost certainly occurred, and in a northern direction.

The part of the ancient shore of the Caspian, which Pallas has delineated, and which is situated at a point called Cholok Komyr, in latitude $45^{\circ} 30' 25''$, and longitude (east from Greenwich) $44^{\circ} 51' 34''$, has a height of 221 feet above the sea (*b*). In other words, the great inland sea of fresh water, which extended from the western shores of the Black Sea to the eastern shore of Lake Aral, had its surface precisely on the level at which, it has been stated, there is a strong presumption that Lake Aral could overflow to the north and form a junction with the Frozen Ocean by the drainage lines of the Tobol and of the Obi. Under all the circumstances it is scarcely hazardous to say that this presumption becomes all but a certainty; and that the height of the low ridge, which divides the drainage on the north of Lake Aral, will eventually be found to be 220 feet or less, at its lowest point, above sea-level.

The actual original separation of the Aral and the Caspian may thus be referred to the rupture of the Bosphorus, and to that consequent rush of waters from the Euxine into the Mediterranean, which is known as the Deluge of Deucalion. The immediate result of this cataclysm would have been a fall in the level of the Caspian from 220 to 89 feet above the sea; and though actually isolated from Lake Aral, it would have appeared connected with it by marshes, alimented by the overflow of the latter

(*b*) See note (*a*).

basin. Though the Caspian level still continued to fall, from surface evaporation, the aqueous character of the intervening bed of the drained-off waters would thus have been preserved for a long time, and such a condition will explain the probable difference in physical aspect which would distinguish the long since desiccated Aralo-Caspian region if it were subjected once more to an overflow of Lake Aral. The cessation of this overflow would have, in the first instance, hastened the drying up of the higher levels of the intervening country, and accentuated to the Orientals upon the shores of the higher sea that isolation of the two basins which the Europeans upon those of the lower were not, and in fact could not be, acquainted with until very long afterwards.

HERBERT WOOD

GUN-COTTON WATER-SHELLS

IN the published accounts of Field Artillery Experiments which are just now being carried on at Okehampton, in Devonshire, considerable prominence has been given to the formidable nature of the so-called water shells, with which practice has been carried on against rows of targets, in the form of "dummy" soldiers, representing columns of infantry, shrapnel shells and common shells, filled with gunpowder, having been fired in comparison with them.

The term *water-shell* denotes not a shell of special form or construction, but simply a new system of bursting