of these and other empirical researches, which have of late been conducted on an extensive scale and with great care, will be given in the latter part of this article.

It is of tides, most probably, the Bible speaks, when God is said to set bounds to the sea, and to say, “ thus far shall it go, and no farther.” Homer would be the earliest profane author who notices the tides, if indeed it be to them he refers (in the 12th book of the Odyssey) when he speaks of Cha­rybdis rising and retiring thrice a day. Herodotus and Dio­dorus Siculus speak more distinctly of the tides in the Red Sea. Pytheas of Marseille is the first who says any thing of their cause. According to Strabo, he had been in Britain, where he must have observed the tides of the ocean. Plutarch says expressly that Pytheas ascribed them to the moon. It is remarkable that Aristotle says so little about the tides. The army of Alexander, his pupil, were startled at first seeing them near the Persian Gulf; and Aristotle would probably be well informed of all that had been observed there. But in all his writings there are only three passages concern­ing them, and these are very trivial. In one place he speaks of great tides in the north of Europe ; in another, of their having been ascribed by some to the moon ; and in a third, he says, the tide in a great sea exceeds that in a small one.

The Greeks had little opportunity of observing the tides. The conquests and the commerce of the Romans gave them more acquaintance with them. Cæsar speaks of them in the fourth book of his Gallic War. Strabo, after Posido­nius, classes the phenomena into daily, monthly, and annu­al. He observes, that the sea rises as the moon approaches the meridian, whether above or below the horizon, and falls again as she rises or falls ; that the tides increase at the time of new and full moon, and are greatest at the sum­mer solstice. Pliny explains the phenomena at some length, and ascribes them to the sun and moon dragging the wa­ters along with them (b. ii. c. 97). Seneca (*Nat. Quest,* iii. 28) speaks of the tides with correctness ; and Macrobius (*Somn. Scip.* i. 6) gives a tolerable description of their motions. Such phenomena naturally exercise human cu­riosity as to their cause. Plutarch (*Placit. Phil.* iii. 17), Galileo *(Sgsr. Mund.* dial. 4), Riccioli in his *Almagest,* ii. p. 374, and Gassendi, ii. p. 27, have collected most of the notions of their predecessors on the subject ; but they are of so little importance as not to deserve our notice. Kep­ler, in accounting for the tides (*De* *Stella Martis,* and *Epit. Astron.* p. 555), had evidently been aware of the principle of gravitation, but not of the law. He says that all bodies attract each other, and that the waters of the ocean would all go to the moon were they not retained by the attraction of the earth. He then proceeds to explain their elevation under the moon and on the opposite side, because the earth is less attracted by the moon than the nearer waters, but more than the waters which are more remote. The honour of a complete explanation of the tides in a general way was reserved for Sir Isaac Newton. He laid hold of this class of phenomena as the most incontest­able proof of universal gravitation, and has given a most beautiful and synoptical view of the whole subject ; con­tenting himself, however, with merely exhibiting the chief consequences of the general principle, and applying it to the phenomena with singular address.

The investigation of the phenomena of the tides has been justly considered as uniting some of the greatest difficulties that occur in the various departments of natural philosophy and astronomy. It implies, first, a knowledge of the laws of gravitation, concerned in the determination of the forces immediately acting on the sea, and of the periods and dis­tances of the celestial bodics, which modify the magnitudes and combinations of these forces ; and, secondly, of the hy­draulic theories of the resistances of fluids, and of the mo­tions of waves and undulations of all kinds, and of the theo­retical determination of the form and density of the earth, as well as of the geographical observation of the breadth and depth of the seas and lakes which occupy a part of its surface ; so that the whole subject affords abundant scope for the exercise of mathematical skill, and still more for the employment of that invention and contrivance which en­ables its possessor to supersede the necessity of prolix com· putations wherever they can be avoided.

The history of the theory of the tides is naturally divid­ed into several periods in which its different departments have been progressively cultivated. The ancients from the times of Posidonius and Pytheas, and the moderns before Newton, were contented with observing the general de­pendence of the tides on the moon, as following her transit at an interval of about two hours, and their alternate in­crease and decrease not only every fortnight, but also in the lunar period of about eight years. The second step con­sisted in the determination of the magnitude and direction of the solar and lunar forces, by which the general effects of the tides were shown, in the *Principia,* to be the neces­sary consequences of these forces. The third great point was the demonstration of Maclaurin, that the form of an elliptic spheroid affords an equilibrium under the action of the disturbing forces concerned ; while the further contem­porary illustrations of the subject by Euler and Bernoulli, though they afforded some useful details, involved no new principle that can be put in competition with Maclaurin’s demonstration. The fourth important step was made by La­place, who separated the consideration of the *form* afford­ing mere equilibrium, from that of the *morion* occasioned by the continual change of that form ; while former theorists had taken it for granted that the surface of the sea very speedily assumed the figure of a fluid actuated by similar forces, but remaining perfectly at rest, or assuming in­stantly the form in question. Laplace’s computation is however limited to the case of an imaginary ocean, of a certain variable depth, assumed for the convenience of cal­culation, rather than for any other reason. Dr Thomas Young has extended Laplace’s mode of considering the phenomena to the more general case of an ocean covering a part only of the earth’s surface, and more or less irregular in its form ; he has also attempted to comprehend in his calculations the precise effects of hydraulic friction on the times and magnitudes of the tides. As far as the resistance may be supposed to vary in the simple ratio of the velocity, Dr Young’s theory is sufficiently complete, and explains se­veral of the peculiarities which are otherwise paradoxical in their appearance ; but there still remains a difficulty to be combated with respect to the effects of a resistance propor­tional to the square of the velocity, and this, it is hoped, will be in great measure removed in the present article, which, however, from the space that is allotted to it, must be considered rather as a supplementary fragment than as a complete treatise. This theory will be divided into four sec­tions : the first relating to the contemporaneous progress of the tides through the different seas and oceans, as collected from observation only ; the second to the magnitude of the disturbing forces tending to change the form of the surface of the earth and sea ; the third to the theory of compound vibrations with resistance ; and the fourth to the applica­tion of this theory to the progress and successive magni­tudes of the tides, as observable at any one port.

Sect. I—*Of the Progress of Contemporary Tides, as in­ferred from the times of High Water in different Ports.*

The least theoretical consideration relating to the tides, is that of their progress through the different parts of the ocean, and of its dependent seas. The analysis of these ought to be very completely attainable from direct obser-