effort is in fact carried gradually farther aft as the action of the wind takes place on the sails. Also, as the force of the wind inclines the ship, the centre of effort of the wind on the sails is carried, by this inclination, over to the lee side, by which, as also by the effect produced on the resultant of the water, which has been before mentioned, the distance between them is farther increased. It therefore appears that, the quantity and disposition of the sail set remaining the same, the ardency will increase as the force of the wind increases, and diminish as that force diminishes ; but as it is found in practice that ships very generally require their helms a-lee in light winds, although it is evident that the several circumstances which have been mentioned as cre­ating the tendency of ardency must still exist in a small degree, it would appear that the ardency must increase and decrease in a faster ratio than the force of the wind. Now, as the direct and lateral resistances vary respectively as the squares of the velocities of the ship in these two di­rections, it is evident that the lateral resistance will dimi­nish in a quicker ratio than the direct resistance, and that, consequently, as the wind decreases, the angle of lee-way, or that of the ship’s course, will be increased, which, it has before been proved, will draw the resultant of the water aft, and diminish the ardency ; therefore the increase and di­minution of the ardency of a ship will be in proportion to the difference of the ratios of increase and decrease of the direct and lateral resistances.

From the causes which have been assigned for a ship’s carrying a lee helm in light winds, it is evident the defect may be lessened by all those means of trimming either the sails or the ship, which have been mentioned as tending to increase the distance of the resultant of the water before the centre of effort of the wind.

But when a ship’s carrying a lee helm is occasioned, as it sometimes is, by the state of the sea, the waves of which, strike the ship on the weather bow, and in their passage cause a great immersion of the lee quarter, any attempt to bring the resultant of the water forward would, from the consequent greater immersion of the bow, and the neces­sary addition to the momentum, increase the effect of the impulse. The evil may be lessened by diminishing the quantity of head-sail, which will both bring the centre of effort of the wind aft, and diminish the violence of the pitching ; and also, if the inclination of the ship were increas­ed, that, by increasing the effect of the water on the lee bow, and diminishing its effect on the lee quarter, might in some cases prove advantageous.

In heavy weather, ships under a small quantity of sail very generally carry slack helms, partly in consequence of the position of the centre of effort of that sail, and partly- owing to the state of the sea. Under these circumstances it is generally impossible to carry enough of after-sail to re­medy this defect; and to trim the ship by the head would be only to increase it, on account of augmenting the pitch­ing. There is therefore no other remedy than that which would arise from such an original disposition of the masts as would render the power of creating a balance between the effects of the sails more easy. But here we would ob. serve, that before making any alteration in the position of the masts, great caution is necessary ; for possibly one of the first requisites in a ship is, that she should work quick­ly, which quality depends on the proportion of sail before and abaft the axis of rotation, and not on the position of the centre of effort of the whole surface of the sail. There­fore no alterations can be made in the position of the centre of effort of all the sails, or in the positions of the masts, un­less due consideration be given to the effect they would have on these proportions.

It may now be necessary to observe, that a ship may, on some occasions, be too ardent. In addition to the altera­tions which will suggest themselves in this case, from what has been already said, it may be observed, that as the cur­vature of the sails, and the inclination of the ship, both tend to increase the ardency, it may be diminished by taking in sail, especially those which, from their greater breadth, as­sume a greater degree of curvature.

It is sometimes objected by practical men, that trimming a ship according to the principles laid down by theory, has not the effect which was to have been expected ; but this often arises from an ignorance of the necessary degree of trimming, or from a mistaken notion of the effect which a certain degree will produce. In order, in some measure, to obviate this difficulty, the following table is given. It contains the weight which it will be necessary to move a distance of forty feet, either aft or forward, to produce an alteration of one foot in the trim of a ship. The length and breadth of the ship are given in the table, merely as being more correct data for the comparison of size than the class of the vessel or the number of guns.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Class of Vessel and number of Guns.** | | **Length.** | **Breadth.** | **Weight to be moved a Distance of Forty Feet.** |
|  |  | **Feet.** | **Feet.** | **Tons.** |
| First rate | ....120 | 205∙25 | 54·50 | 112 |
| Second do | .... 84 | 192·25 | 51·44 | 90 |
| Fourth do | .... 60 | 174·00 | 43·67 | 58 |
| Fifth do | .... 46 | 109·70 | 40·50 | 38 |
| Sixth do | .... 28 | 120·20 | 33·67 | 22 |
| Sloop | .... 18 | 111·25 | 30·50 | 14 |

If any other alteration in the trim be desired, it may be deduced from the results given in the above table, by a simple proportion. And since the effect produced on the centre of effort of the sails, by taking in or setting any sail, may be estimated in the manner described in the course of these remarks, the alterations necessary to be made in order to produce any desired effect may be easily deter­mined. Another source of error may arise from the various rakes of the masts ; from which the angle of incidence, and consequently the force of the wind, which is as some func­tion of the sine of the angle of incidence, varies considera­bly for the sails of each mast ; and if the trim of the ship be altered, there must be a corresponding effect produced in this angle ; by which the relative proportions of the force of the wind on the several sails will be altered, as will also its total effect on all the sails.

Most of the writers on naval architecture have consider­ed the problem of determining the angle which should be formed by the yard with the keel, under the different cir­cumstances of wind. Don Juan, whose highly scientific and thorough practical knowledge entitles his opinions to more than common attention, on a subject in which the re­searches of theory require to be aided by the deductions from experiment, has determined these angles for a ship of sixty guns, and has also given some general rules to guide any variations from them. When this ship was close-hauled, with all sail set, he found that the angle the yard should make with the keel should be 28o 47', and with the wind on the quarter, 50° 11' ; but when the wind was so high that only a small quantity of canvass could be set, these angles were respectively increased to 40o 42' and 56o 21'. He also arrives at the general conclusion, “ that, the greater the quantity of sail set, the less should be the angle made by the yard with the keel;” and also, as he makes the re­lation between the direct and lateral resistances enter into his investigations, “ the sharper and the more adapted for velocity a vessel is, the smaller should be the angle made by the yard with the keel ;” consequently frigates and smaller vessels should, under similar circumstances, have their yards braced sharper than line-of-battle ships ; and again, “ that the nearer the sails approach to plane surfaces, the less should this angle be.”