

PERCEPTIONS OF BROACHING-TO: DISCOVERING THE PAST

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ABSTRACT

The article contains results of an investigation into old bibliographical sources about the use of the term “broaching-to”, or versions of it, in texts of nautical or other content. Several citations of such terms have been identified: in voyager’s records, in nautical journals, in training manuals, in old encyclopaedias. Most remarkably, reference to broaching-to was found in a famous old British poem, inspired by a real mid-18th century ship disaster.

Keywords: *ship, broaching-to, sailing, surf, broadside scudding, Falconer*



From Falconer (1804)

1. INTRODUCTION

Even though essential scientific progress about the phenomenon of broaching-to was realised only after the middle of the 20th century, the subject has been alive in the nautical bibliography for a considerably longer period. In the Merriam-Webster dictionary, next to the definition of the word *broach* [“to veer or yaw dangerously so as to lie broadside to the waves – often used with *to*”], one learns that use of the term in a nautical context is traced to the year 1705. Indeed, as will be

analysed in later sections of the paper, several book excerpts and other texts from the 19th, 18th and even 17th century survive, which authenticate explicit use of the term “broaching-to” by seamen, for characterising what they apparently perceived to be one of the most dreadful conditions that a ship could encounter during her operation. One comes across some quite captivating descriptions of real occurrences of broaching-to along with efforts to avoid it; attempts of defining the phenomenon formally; and steering practices



devised specifically for dealing with it in the “difficult hour”.

It is a fair conjecture that, the broaching behaviour of sailing ships should have been influenced by phenomena that could not play any role for modern motor ships. Especially, the arrangement of sails, and the incurred significant destabilising wind forces, should have been very influential for turning suddenly, despite all efforts, a ship broadside to the weather. The combination of wind and waves should have placed more heavy demands upon the Master of the old days. From our investigation comes out that, broaching was mostly feared when a vessel was heading towards the shore; especially when lying very near to a steep shore. Moreover, it was often discussed within a scenario of the ship sailing at high speed, rushing *before the weather* (“scudding”)

Besides Conolly’s (1972) vivid descriptions of broaching-to behaviour of a few, at that time modern, ships, generally we maintain no recollection of the past of the subject beyond, say, a 50-year horizon. However, a glimpse into that, long-gone, world when navigation was, in its own capacity, an adventure reveals that the avoidance of broaching-to was a central issue of sail-powered seafaring. The objective of the current paper is thus, to shed some light about how broaching-to was regarded in that, almost forgotten, era. Notably, some seeds of pre-mature scientific thinking may also be traced.

2. DEEPING INTO THE PAST

William Dampier (1699) “A New Voyage Round the World”

At the dusk of 17th century, Captain William Dampier describes his experiences of navigating around the globe:

“; and besides, often very violent and fierce, so that a Ship with her sails loose, would be in danger to be over-set by them, or at least lose Masts or Yards, or have the Sails split, besides the Consternation that all Men must needs be in at such a time, especially if the Ship, by any unforeseen accident, should prove unruly, as by the mistake of the Man at Helm, or he that Conns, or by her broaching to (*author’s note: it appears as “too” but it is corrected in an Errata Table that is included in the book*) against all endeavours, which often happens when a fierce gust comes; which though it does not last long, yet would do much damage in a short time, and tho’ all things should fall out well, yet the benefit of it would not compensate the danger.”

3. A SAILOR TURNED FAMED POET - THE 18TH CENTURY

3.1. William Falconer’s “The Shipwreck”

A celebrated poem written by a sailor, William Falconer, that was published in 1762 under the title “The shipwreck” describes quite movingly the poet’s tragic experiences on board the Britannia that foundered with only three of her crew surviving (Anderson 1795). The drama unfolded off the shore of Attica; at the very spot where, according to the myth, the ancient king of Athens Aegeus had jumped into the sea (henceforth giving his name to the Sea in front), disillusioned by a wrong sign alluding to the loss of his son, the mythical hero Theseus, in his battle against the Minotaur in Minoan Crete.

William Falconer was a native of Scotland and “bred to the sea in which he spent the greatest part of his life”. Unable to steer clear of his destiny, he went down deep in the Mozambique Chanel with the frigate Aurora, in the winter of 1769 (Knight 1837). The true story and proceedings surrounding his poem come out from the following extract:

“... he served on board the *Britannia*, a merchantman, bound from Alexandria to Venice, which touched at the Island of Candia (*author's note: this is today's Crete*), whence, proceeding on her voyage, she met with a violent storm, that drove her on the coast of Greece, where she suffered shipwreck near Cape Colonne (*author's note: nowadays Cape Sounion, in Attica*), three only of the crew being left alive. The dangers which he really experienced he feelingly described in his next performance intitled *The Shipwreck*, a Poem, in three Cantos, by a Sailor, 4th 1762. He inscribed it to the Duke of York and prefixed a chart of the ship's way and a section of the ship itself, in order to render the poem completely intelligible.”

In the following passage of Canto III is conveyed the poet's anxiety, as the final moment is approached: the ship is nearing the shore at high speed while any attempt to change course is feared to lead to broaching-to:

“While shoreward now the bounding vessel
flies,

Full in her van St. George's cliffs arise;
High o'er the rest a pointed crag is seen,
That hung projecting o'er a mossy green.
Nearer and nearer now the danger grows,
And all their skill relentless fates oppose.

For, while more eastward they direct the prow,
Enormous waves the quiv'ring deck o'erflow.

While, as she wheels, unable to subdue
Her sallies, still they dread her broaching-to*:
Alarming thought! For now no more a-lee
her trembling side could bear the mountained
Sea,

And if pursuing Waves she scuds before,
Headlong she runs upon the frightful shore;”

Remarkable is the definition of broaching-to, supplied in a footnote of Anderson (1795):

*“Broaching-to is a sudden and involuntary movement in navigation, wherein a ship, whilst scudding or sailing before the wind, unexpectedly turns her side to windward. It is generally occasioned by the difficulty of

steering her, or by some disaster happening to the machinery of the helm.”

We shall refer to the condition of scudding later. Broaching (without *-to*) is mentioned also earlier in the poem, referring to the placing of the ship obliquely to the weather. However here is alluded a voluntary change of heading:

Canto II:

“Forbid it, Heaven, that, in this dreadful hour,
I claim the dangerous reins of purblind power!

But should we now resolve to bear away,

Our hopless state can suffer no delay.

Nor can we, thus berest of every fail,

Attempt to steer obliquely on the gale.

For then, if broaching sideward to the sea,

Our dropsy'd ship may founder by the lee;

No more obedient to the pilot's power,

Th'o'erwhelming wave may soon her frame
devour.

3.2. Falconer's Dictionary of the Marine

However, Falconer's name is probably better known to mariners from another of his books: His “*Dictionary of the Marine*” firstly published in 1769. There we find also how he describes “broach-to” (Falconer 1780):

“To BROACH-TO, in navigation, to incline suddenly to windward of the ship's course when the sails with a large wind; or, when the ails directly before the wind, to deviate from the line of her course, either to the right or left, with such rapidity as to bring the ship's side unexpectedly to windward, and expose her to the danger of oversetting.

It is easy to conceive that a ship will carry much more sail before the wind than when she makes a progress with her side to it's direction; because when the current of wind as nearly endways on her hull, the pressure of it on the masts must be considerably diminished as she yields to it's impulse and flies before it; and that if she carries a great sail at this time, it can



only press her fore-part lower down in the water. But if, when she carries a great extension of sail, her side is suddenly brought to the wind, it may be attended with the most fatal consequences, as the whole force of it then pours like a torrent into the cavities of the sails. The masts therefore unavoidably yield to this strong impression, acting like levers on the ship sideways, so as nearly to overturn her, unless she is relieved by some other event, which may be also extremely pernicious, such as the sails rending to pieces, or the masts being carried away.

It is generally occasioned by the difficulty of steering the ship; by the negligence or incapacity of the helmsman; or by some disaster happening to the helm or its machinery, which renders it incapable of governing the ship's course.

The difference between broaching-to and bringing *by the lee*, may be thus defined. Suppose a ship with a great sail set is steering south, having the wind N.N.W. then is west the *weather*, and east the *lee-side*.

If by some deficiency in the steerage her head turns round to the westward, so as that her sails are all taken aback on the weather-side before she can be made to return to the course from which she has deviated, she is said to *broach-to*.

If otherwise her head, from the same cause, has declined so far eastward as to lay her sails aback on that side which was the lee-side, it is called bringing her by the lee."

From the above one realises the importance attributed to the sails for the occurrence of broaching-to; a matter that, still, has not been properly investigated.

3.3 John Hamilton Moore (1791) "The Practical Navigator"

A definition of "broach-to" appears in this 18th century book by J. Hamilton Moore, who portrays himself as "Teacher of Navigation, Hydrographer and Chart Seller". Although more concise, his definition conveys an identical meaning:

"Broach to: Is when a Ship, on a sudden, lays her Broadside to the Sea, and is dangerous in bad Weather."

4. SOME PRACTICES FOR DEALING WITH BROACHING-TO IN THE 19TH CENTURY

4.1 Journal "The Life-boat" (1855), extract from article "Management of ships in a surf and broken water" (Vol. II, No 18).

(Author's note: According to the Merriam-Webster Dictionary, surf – date 1685 - is the swell of the sea which breaks upon the shore; and the foam, splash, and sound of breaking waves).

This 1855 article contains a lengthy discussion about operational practices for avoiding broaching-to and also some interesting deliberations about what causes the phenomenon:

"On the second point, running before a broken sea, an equal variety of management is observable, as practised on the coast, yet all alike intended to meet the one great risk of "broaching-to", which nearly all agree in considering to be the greatest danger to which a boat can be exposed, and to be that which calls for the most skill and management to obviate it.

As before observed, the greater number of skilful boatmen on the coast are in the habit of checking a boat's way through the water or of

backing her against a heavy sea on its approach. Their practice is to stop the boat's way by backing their oars until the crest of the wave has struck the boat's stem and passed her midship part, then to give way again, running in on the back of that wave, as far as they may be able to, then watching for the approach of the next, and repeating the same operation until they arrive at the beach, being careful, by steering with oars at the quarter or stern to keep the boat as far as possible, end on to the direction in which the sea is running. It must be here observed, that this management is so far varied according to the character of the boat; that in cobsles, and other square sterned boats which have their bows better formed for meeting a sea than their sterns are, their position is reversed before entering the broken water, and they are taken in stern foremost and bow outwards, but the same principle being acted on o rowing back to meet each heavy wave instead of running from it. In a sailing boat this principle can only be so far acted on as to diminish the boat's speed through water by taking her in under a very educed amount of sail, which is commonly one and by towing weights or instruments lade for the purpose.

The advocates of this system of management have certainly reason on their side, in addition to experience; for as all acknowledge that there is greater danger in running before a broken sea than in going off against it, it is obvious that the more the former operation be assimilated to the latter the safer it must be also, which is therefore effected by an alternate progressive and retrogressive movement, the latter being effected at the particular moments when the progressive motion would be dangerous. The true theory on which this practice is founded we will endeavour presently to explain.

Proceeding then to the opposite practice of giving a boat speed, in fact running away from the sea, which constitutes the other important distinction in practice. The principle then acted on is to escape from the danger as fast as possible and other expedients are then resorted

to prevent the risk of broaching-to. The most common of these is to trim the boat by the stern, by bringing all moveable weights aft (this supposes her stern to be outwards; if she were being taken in stern foremost, she would then be trimmed by the head). The force of the sea or wind on either quarter has then less power to beat it off, and cause the boat to broach-to, than it would have if the stern were light. Another expedient is to tow a pig of ballast, or a basket, or other instrument, which by its weight or hold on the water has the effect of a drag on the rear end of the boat, and prevents its being beat to leeward by the sea, thus keeping her end on to it. On the coast of Norfolk the following ingenious plan is commonly practised. The boatmen there employ an instrument for the above purpose called a "drogue"; it is a conical shaped canvas bag, of the form of a common candle extinguisher, about 2 feet diameter at the base or mouth of the bag, and 6 feet long, having a small opening at the other end or apex of the cone. When running before a heavy sea in broken water, the drogue is thrown over from the stern, and towed by a stout rope with the large end foremost, when it instantly fills, and from the resistance it opposes to the water, holds the stern back and prevents the boat's broaching-to: as soon as the danger is past the large tow rope is let go, and the drogue then towed with the smaller end foremost by a small line attached to that end, it then immediately collapses is emptied of water and offers but little resistance.

The steering with an oar on each quarter is another expedient, employed to prevent broaching-to, as when running, a boat will not answer her helm on being overtaken by a sea.

The recommendation to watch for an opportunity and avoid a sea, equally in running as on going off, could only be practised at those localities where the beach is steep.

In reply to the question, as to whether any particular kinds of boats are more liable than others to broach-to, the answers given are so



conflicting and contradictory as to afford no information on the point.

In reply to another question as to the cause of a boat's broaching-to, the almost invariable answer is, "because the stern is thrown out of the water and the rudder therefore ceases to act". From our own observation we have formed the opinion that this is not the case, although it is quite true that at the moment of broaching-to, a boat will not answer her helm.

The phenomenon of broaching-to, we believe, may be correctly accounted for as follows: - on a boat encountering a heavy broken sea or roller end on, if she be stationary or is being profiled in a contrary direction to the wave, she will receive its blow, and it will quickly pass by her, her own inertia preventing her being carried away by it. If however she is being propelled in the same direction as the waves, and running rapidly through the water with her stern towards them, on a wave overtaking her, its first effect is to throw her stern up and to depress her bow, but so far from her rudder being out of water, both it and her stern are buried in the crest of the wave; in consequence, however, of her previous motion being in the same direction as that of the wave, she now offers so slight resistance to it, that instead of its passing her, she is hurried along with it at a rapid rate over the ground, her stem high up still immersed in the crest of the sea, and her bow low down at its base; as the wave approaches shoaler water, its inshore surface approaches more and more nearly to a perpendicular, and the tendency of the boat to run down this steep inclination added to the momentum she has already from her previous motion, causes her to run her bow under water, when her buoyancy at that end being destroyed her stern still light is pressed onward by the summit of the wave, and the undercurrent from the last receding wave at the same time acting on her bow, she is instantly, if a short boat, turned "end over end," or if a long one, capsized quarter wise. If she have so high a bow that it does not become altogether immersed, or if, as in a life-boat, the end of the boat is

occupied by a water-tight air-case to the height of the gunwale, so as to prevent the admission of the water over the bow, the effect then is that the boat is instantaneously turned round broadside to the sea, when again, unless she be a life boat of a superior description, she is almost certain to be upset. In the circumstances thus described, the sole cause of a boat's running herself under water or broaching-to is that of running from a sea instead of awaiting it, and suffering it to pass by; and the cause of the rudder being useless to keep the boat end on to the wave, is not that it is thrown out of the water, (although at other times it doubtless is so), for it is actually buried in it as is also the stern of the boat up to her gunwale, but it is because it is stationary in it the crest of the wave having acquired an actually progressive motion equal to that of the boat. If on the other hand the wave passes the boat, as its crest advances from the stern to the fore part, the rudder and stern are thrown out of the water; steering oars are therefore a most valuable auxiliary aid when running before a sea, but we would recommend the use of a rudder as well.

We have been rather prolix in our account of the phenomenon of broaching-to, because it is a very interesting one, which it is important should be understood in order to arrive at the proper management and to obviate its disastrous effects, which have been more fatal to the lives and property of boatmen on our coasts than those proceeding from any other cause whatever."

Further exchanges appear in subsequent issues of the same journal. From there we collected the following passage, referring to the occurrence of broaching-to events near to the English coast town Deal, located to the North-East of Dover (Vol II, No 19):

"...nevertheless, we are positively informed that boats have been lost by broaching-to when running for the shore at Deal; and we have known a Suffolk yawl of 18 or 20 tons burden, broach-to, upset, and drown the greater part of

her crew, when running under sail for the shore on as steep a beach as that at Deal.”

4.2. Henry Coleman Folkard (1863) “The Sailing Boat”

Under the unsurprising heading “Causes of ship capsizing” is found a description of broaching-to. Even more enlightening for the reader is the discussion that ensues, on the “drogues”. These were (and still are) used for helping the ship to keep her course and avoid broaching (and bow diving):

“The action of the sea upon a boat running into a heavy surf, may be thus described: - when on the top of a heavy wave or roller, the bows are lifted high out of the water; then, as the sea recedes, the boat is hurled forward, and the bows are buried under water; when the sea acting powerfully on her head and fore gripe, twists her round, broadside to the waves, called “broaching to;” and the sea then runs over the gunwale into the boat; the next motion that inevitably follows, is a heavy lurch on the other side and another sea breaks completely over, and fills or capsizes the boat. This may happen either under sail or oars. There is considerable difficulty in preventing a boat from broaching to, when stem and stern are alternately lifted out of the water by the waves; and should the boat broach to and meet a very heavy roller, broadside on, the chances are fifty to one that she will be swamped.

Drogues* are now a good deal used on the Eastern Coast, in both sailing and rowing boats; they serve to check the boat's way, and keep her end on to the waves; and are, therefore, of great assistance to the crew, in preventing the boat from broaching to. Experience teaches, that when a heavy breaker follows the boat up astern, it is useless to attempt running away from it: then a question naturally arises, what must be done on the impulse of the moment. “For your lives men! back her astern; hard at it every one of you! and let the man in the stern-sheets creep

forward a moment, to lighten the boat's stern!” By this effort the wave strikes the boat kindly, and passes on; but if allowed to follow her up astern, so surely as such an experiment is tried, the sea will either curl over the stern, or the boat will broach-to and take it over the gunwale.

* A drogue is a conical shaped collapsible bag, about two feet in diameter at the mouth, and four feet six inches in length. When towed by the mouth, the drogue fills with water, and draws heavily; thereby checking the progress of the boat. A tripping-line is made fast to the apex or pointed end, and by slacking the towing-rope and hauling on the tripping-line, the drogue collapses, and may be drawn on board very easily.“

Even in our days, drogues [and indeed multiple (“series”) drogues] are considered as indispensable drag devices onboard sailing boats, intended to be used in heavy weather (consult for example Hinz 2003).

4.3. John McNeill Boyd (1860) “A Manual for Naval Cadets.”

Drawing upon his experience from the Royal Navy, Captain Boyd advises young cadets of the time about broaching-to and how to avoid it through operation. In the first paragraph he is probably alluding to a condition like “surf-riding”. His discussion on the drogues should also be noted.

“The great danger when running before a broken sea, is that of broaching-to. The cause of a boat's broaching-to when running before a broken sea or surf is, that her own motion being in the same direction as that of the sea, whether it be given by the force of oars or sails, or by the force of the sea itself, she opposes no resistance to it, but is carried before it. Thus if a boat be running with her bow to the shore and her stern to the sea, the first effect of a surf or roller on its overtaking her, is to throw up the stern, and as a consequence to depress the bow;



if she then has sufficient inertia (which will be proportional to weight) to allow the sea to pass her, she will in succession pass through the descending, the horizontal, and the ascending positions, as the crest of the wave passes successively her stern, her midships, and her bow, in the reverse order in which the same positions occur to a boat propelled to seaward against a surf. This may be defined as the safe mode of running before a broken sea.

But if a boat on being overtaken by a heavy surf, has not sufficient inertia to allow it to pass her, the first of the three positions above enumerated alone occurs, - her stern is raised high in the air and the wave carries the boat before it, on its front, or unsafe side, sometimes with frightful velocity, the bow all the time deeply immersed in the hollow of the sea, where the water, being stationary or comparatively so, offers a resistance, whilst the crest of the sea, having the actual motion which causes it to break, forces onward the stern, or rear end of the boat. A boat will in this position sometimes, aided by careful oar steerage, run a considerable distance until the wave has broken and expended itself. But it will often happen that, if the bow be low it will be driven under water, when the buoyancy being lost forward, whilst the sea presses on the stern, the boat will be thrown (as it is termed) end over end; or if the bow be high, or it be protected, as in some life-boats, by a bow air chamber, so that it does not become submerged, that the resistance forward acting on one bow will slightly turn the boat's head, and the force of the surf, being transferred to the opposite quarter, she will in a moment be turned round broadside by the sea and be thrown by it on her beam-ends, or altogether capsized. It is in this manner that most boats are upset in a surf, especially on flat coasts, and in this way many lives are annually lost amongst merchant seamen when attempting to land after being compelled to desert their vessels.

Hence it follows that the management of a boat, when landing through a heavy surf, must as far as possible be assimilated to that when

proceeding to seaward against one, at least, so far as to stop her progress shoreward at the moment of being overtaken by a heavy sea, and thus enabling it to pass her. There are different ways of effecting this object:-

1st. By turning a boat's head to the sea before entering the broken water, and then backing in stern foremost, pulling a few strokes ahead to meet each heavy sea and then again backing astern. If a sea be really heavy and a boat small, this plan will be generally the safest, as a boat can be kept more under command when the full force of the oars can be used against a heavy surf than by backing them only.

2nd. If rowing to shore with the stern to seaward, by backing all the oars on the approach of a heavy sea, and rowing ahead again as soon as it has passed to the bow of the boat, thus rowing in on the back of the wave; or, as is practised in some lifeboats, placing the after-oarsmen, with their faces forward, and making them row back at each sea on its approach.

3rd. If rowed in bow foremost, by towing astern a pig of ballast or large stone, or a large basket, or a canvass bag termed a "drogue" or drag, made for the purpose, the object of each being to hold the boat's stern back and prevent her being turned broadside to the sea or broaching-to.

Drogues are in common use by the boatmen on the Norfolk coast; they are conical-shaped bags of about the same form and proportionate length and breadth as a candle extinguisher about two feet wide at the mouth and four and a half feet long. They are towed with the mouth foremost by a stout rope or a small line termed a tripping-line, being fast to the apex or pointed end. When towed with the mouth foremost they fill with water, and offer a considerable resistance, thereby holding back the stern; by letting go the stouter rope and retaining the smaller line, their position is reversed, when

they collapse, and can be readily hauled into the boat.

Drogues are chiefly used in sailing-boats, when they both serve to check a boat's way and to keep her end on the sea. They are however a great source of safety in rowing-boats, and many rowing life-boats are now provided with them."

5. ADDITIONAL REFERENCES TO BROACHING-TO

With the opportunity of the establishment of the "Society for the improvement of Naval Architecture" (forerunner of RINA) in London, Hutchinson (1791) advises that, in bad weather the best helmsman should be employed:

"... and if the waves run high, when carrying a pressing sail, large, by such bad steering there is great danger of broaching the ship to; therefore none but the best helmsman should be permitted to steer at such times."

Later on, Hutchinson advises how to avoid broaching-to even when the foremast is lost. He refers to broaching-to in connection to scudding, a condition quite uniquely connected with sailing boats: The following entry appeared in one of the oldest editions of encyclopædia Britannica (Several Authors 1796):

"Scudding, the movement by which a ship is carried precipitately before a tempest. As a ship flies with amazing rapidity through the water whenever this expedient is put in practice, it is never attempted in a contrary wind unless when her condition renders her incapable of sustaining the mutual effort of the wind and waves any longer on her side, without being exposed to the most imminent danger of being overset.

A ship either feuds with a sail extended on her foremast, or, if the storm is excessive, without any sail; which in the sea phrase, is

called *scudding under bare poles*. In sloops and schooners and other small vessels, the sail employed for this purpose is called the *square sail*. In large ships, it is either the foresail at large, reefed, or with its goose-wings extended, according to the degree of the tempest; or it is the fore-top sail, close reefed, and lowered on the cap; which last is particularly used when the sea runs to high as to becalm the foresail occasionally, a circumstance which exposes the ship to the danger of broaching-to. The principal hazards incident to scudding are generally a pooping sea; the difficulty of steering, which exposes the vessel perpetually to the risk of broaching-to; and the want of sufficient sea-room. A sea striking the ship violently on the stern may dash it inwards, by which the must inevitably founder. In broaching-to (that is, inclining suddenly to windward) she is threatened with being immediately overturned; and, for want of sea-room, she is endangered by shipwreck on a lee-shore, a circumstance too dreadful to require explanation."

In another encyclopaedia was found a section offering advice for selecting the shape of a life-boat, with specific reference to the avoidance of broaching-to (Several Authors 1816). We are informed also that, the invention of the life-boat was claimed by William Wouldhave and that his proposed design was firstly built in 1789:

"The curvature of the keel has however been demonstrated to be the principal or only error in the construction of the vessel and we would recommend to those who in future may construct such vessels to preserve the spheroidal form of the body of the boat, yet, so as to leave a straight keel and a sufficient quantity of gripe to hinder the boat from broaching to, on receiving the stroke of the waves on her ends."

In an American navigation textbook (Bowditch 1821) we learn about the difference between "broaching-to" and "bringing by the lee":



“To broach to. To incline suddenly to windward of the ship's course, so as to present her side to the wind, and endanger her oversetting. The difference between broaching to and bringing by the lee may be thus defined: Suppose a ship under great sail is steering south, having the wind at N.N.W. then west is the weather side, and east the lee-side. If, by any accident, her head turns round to the westward, so that her sails are all taken a-back on the weather side, she is said to broach to. If, on the contrary, her head declines so far eastward as to lay her sails aback on that side which was the lee side, it is called bringing by the lee.”

At the same time (and side of the Atlantic), Guest (1824) narrates his experiences of sea travel:

“On the 25th, at 3, A.M. finding we could not, with any degree of safety, lay to any longer, we commenced scudding, under a close reefed foresail but soon found we could only scud under our bare poles, which we continued to do until 6 A.M.. The vessel then broached to, and lay with her broad side to the wind, in the trough of the sea (which is the most dangerous situation that a vessel can be in:) a most tremendous sea was rolling down upon us, which we expected would soon swallow us up. I shall never forget the frightful looks and behaviour of the man who was at the helm when the vessel broached to. Although he was a very experienced seaman, he exclaimed calling on his God and Saviour -we are gone! we are gone! nothing can save us!”

Fishbourne (1846) in his lectures on naval architecture argues for selecting a less fine stern compared to the bow:

“The reason why short vessels do not run well.- It is notorious that vessels with fine after bodies, particularly if they be short, run badly. It is because there is so little action in the after body in such case, for the water cannot turn in upon it, there is even a danger in such vessels of their broaching to against their helm. The

after body then should be greater than the fore body, in some ratio inverse of this action of the water.”

In the shipbuilders guide of Partington (1826) we are advised that the use of sliding keels could save a ship:

“... no misfortune, similar to that of broaching to, can ever befall a vessel furnished with sliding keels.”

About these keels we learn from another passage referring to a 66 ft vessel:

“ She has three sliding keels inclosed in a case or well; they are each 14 ft in length; the fore and the after keels are 3 ft broad each, and the middle keel is 6 feet broad. The keels are movable by means of a winch, and may be let down 7 feet below the real keel; and they work equally well in a storm as in still water.”

Short references expressing the fear of broaching-to appear in numerous narratives of legendary expeditions around the globe. Two of them are mentioned below:

- In the search for a North-West passage from the Atlantic to the Pacific (Parry 1824).
- In the tales of the voyages of the ship H.M.S. Samarang in the islands of the Eastern Archipelago (Belcher 1848).

6. REFERENCES

Robert Anderson (1795) *The Works of the British Poets: With Prefaces, Biographical and Critical*, Printed for John & Arthur Arch; and for Bell & Bradfwte; and J. Mundell & Co. Edinburgh.

Edward Belcher (1848) *Narrative of the Voyage of H.M.S. Samarang, during the Years 1843-46; in the Islands of the Eastern Archipelago*; Published by Reeve, Benham,



and Reeve, King William Street, Strand.

Smith, London.

Nathaniel Bowditch (1821) *The New American Practical Navigator*. Published by Edmunt M. Blunt, New York.

John McNeill Boyd (1860) *A Manual for Naval Cadets*. Published by Longman, Green, Longman, and Roberts, 548 pages.

Joe. E. Conolly (1972) *Stability and Control in Waves: A Survey of the Problem*. Journal of Mechanical Engineering Science, Vol. 14, No 7.

William Dampier (1699) *A New Voyage Round the World*, Published by J. Knapton.

Several Authors (1797) *Encyclopædia Britannica: Or, A Dictionary of Arts, Sciences, and Miscellaneous Literature* (1997), Edinburgh, Printed for A. Bell and C. MacFarquhar.

Several Authors (1816) *Encyclopædia Perthensis; or Universal Dictionary of the Arts, Sciences, Literature &c*. 2nd edition. Edinburgh, Printed by John Brown, Anchor Close.

William Falconer (1780) *A Universal Dictionary of the Marine; or, A Copious Explanation of the Technical Terms and Phrases Employed in the Construction, Equipment, Furniture, Machinery, Movements, and Military Operations of A Ship*. Printed to T. Cadell, in the Strand, London (see <http://southseas.nla.gov.au/refs/falc/>)

William Falconer (1804) *The Shipwreck: a poem in three cantos*. With a life of the author by James Stanier Clarke. Printed for William Miller, Old Bond Street, London.

Edmund Gardiner Fishbourne (1846) *Lectures on Naval Architecture, Being the Substance of Those Delivered at the United Service Institution*. Published by John Russell

Henry Coleman Folkard (1863) *The Sailing Boat: A Treatise on English and Foreign Boats, Descriptive of the Various Forms of Boats and Sails of Every Nation; with Practical Directions for Sailing, Management &c*, Published from Longman, Green, Longman, and Roberts, 317 pages.

Moses Guest (1824) *Poems on Several Occasions To which are Annexed, Extracts from a Journal, Kept by the Author While He Followed the Sea, and During a Journey from New-Brunswick, in New-Jersey, to Montreal and Quebec*. Looker @ Reynolds, Printers, Cincinnati.

Earl Hinz (2003) *Heavy Weather Tactics Using Sea Anchors and Drogues*, Paradise Cay Publications, 2nd Edition, 164 pages, ISBN-10 0939837374.

William Hutchinson (1791) *A treatise founded upon philosophical and rational principles: towards establishing fixed rules, for the best form and proportional dimensions in length, breadth and depth of merchant ships in general; and also the management of them to the greatest advantage by practical seamanship*. Printed in Liverpool by Thomas Billinge, Castle Street.

Charles Knight (1837) *Penny Cyclopaedia of the Society for the Diffusion of Useful Knowledge*, Vol. IX, Dionysius-Erne, Charles Knight and Co, 22 Ludgate Street, London.

John Hamilton Moore (1791) *The Practical Navigator, and Seaman's New Daily Assistant: Being an Epitome of Navigation: Including the Different Methods of Working the Lunar Observations. With Every Particular Requisite for Keeping a Complete Journal at Sea*. Printed for and sold by R. Law and Son, London, 296 pages.



Edward Parry (1824) *Journal of a Second Voyage for the Discovery of a Northwest Passage from the Atlantic to the Pacific: Performed in the Years 1821- 22-23, in His Majesty's Ships Fury and Hecla, Under the Orders of Captain William Edward Parry.* Published by J. Murray, London.

Charles Frederick Partington (1826) *The Shipbuilders' Complete Guide; Comprehending the Theory and Practice of Naval Architecture with its Modern Improvements.* Published by Sherwood, Gilbert, and Piper, London.

Unknown Author (1853) *The Life-boat, Or, Journal of the National Life-Boat Institution.* Published by the Royal National Life-Boat Institution for the Preservation of Life from Shipwreck (Great Britain).