

VII. *On the Blow-hole of the Porpoise.* By FRANCIS SIBSON, *Esq.*

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THE Porpoise inspires through the blow-hole which includes the nostrils, and is so placed that the animal can breathe with only a very small portion of its head above the water. A large passage leads down from the external opening to two canals that pass directly downwards through the skull, between the cranial and facial bones; these nasal canals are separated from each other by a thin plate of bone (Plate XII. fig. 1.3–26.27)\*. The two canals, after passing down through the skull, coalesce to form a muscular tube that opens at its lower part into the pharynx, by a constricted aperture. Through this aperture the mouth of the larynx rises, after the larynx itself has projected quite through the pharynx, dividing it into two channels.

Connected with the channel that leads from the external opening down to the two bony conduits is a series of pouches; these are composed of aponeurotic walls, folded on themselves in many wrinkles, so as to be capable of great distension†.

The two largest and most dilatable of these pouches are seated on each side and in front of the outer passage, into which they open separately (fig. 1.2–1).

Deeper than, and between these two anterior lateral pouches, is the anterior central pouch, which is placed upon the combined maxillary bones, and communicates with the nasal canal by a large opening guarded by two oblong cartilages; this sac has a muscular coat (fig. 1.2–2).

The openings into the two nasal canals are just behind and below this anterior deep pouch.

Immediately above the apertures of the two bony canals are two other horizontal apertures that communicate with two corrugated dilatable pouches (fig. 1.2–3). These posterior deep sacs are immediately behind the external channel, and are seated between it and the frontal bone; their openings look downwards to the bony canals, their summits rise directly upwards in front of the frontal bones.

The five pouches are under complete muscular control.

When filled, their apertures can be closed, and their contents retained; or the apertures can be thrown open, and their contents pressed out.

The pouches, when distended with air, doubtless act so as to float the external

\* Figure 1 must be looked at, not in the direction of the plate, but sideways.

† See *Cyclopædia of Anatomy*, i. 580, fig. 269, Article *Cetacea*, by Professor OWEN.

opening uppermost, and retain that opening above the surface of the water during sleep and during the act of copulation.

The muscles that open and close the blow-hole, and that act upon the various sacs, form one of the most complicated yet most exquisitely adjusted pieces of machinery that either nature or art presents.

The blow-hole is stretched open, in front, by two muscles (fig. 2-6) that act from the superior maxillary bones, to draw forward the cartilaginous mass in front of the outer opening; behind, by muscular fibres (fig. 2-7) that act from the frontal bones on the posterior and lateral edges of the blow-hole.

To close the blow-hole, two sets of muscular fibres (fig. 2-5) spring from the frontal bone, pass obliquely forwards and inwards, one to each side of the opening, and are inserted into the gristly mass (fig. 2-4) in front of the blow-hole. When they act, they draw this gristly mass forcibly backwards, and close the blow-hole by pressing its anterior and posterior walls together, and compressing them against the posterior pouches and the prominence at the centre of the frontal bone.

A set of muscular fibres (fig. 2-8) arises from the circuit of a depression formed on the cranium to each side of the bony canals; these fibres pass over the anterior lateral pouch, blending with the muscles that close and open the blow-hole. On removing this, a covering of muscular fibres (fig. 2-8 *a*) that cling round the sac is exposed; these arise from the anterior lateral part of the superior maxillary bones, and pass upwards and backwards to form a muscular envelope for the pouch on its inner and posterior surface; the fibres return forwards to be inserted into the outer and anterior walls of the blow-hole.

A fan-like muscle (fig. 2-9) arises from the circuit of the depression to be inserted into the posterior and lateral walls of the blow-hole; this assists in opening it by spreading apart its walls.

On removing this fan-like muscle, a remarkable series of similar fan-like muscles (11.12.13.14.15\*) is exposed. These lie one above the other, and arise by muscular fibres from the circuit of the depression; the fibres of each converge to a tendinous aponeurosis thinner than paper.

Four or five of these fan-like thin muscles may be removed by careful dissection, one after another; they act to expand different parts of the outlet of the anterior lateral sac, to draw backwards and expand the posterior walls of the great respiratory canal, and to compress the posterior deep sacs.

On removing these, two remarkable muscles (fig. 1. Archives, fig. 7-22.23) are brought into view that have each a double muscular origin, one from behind forwards from the frontal bone (22 *a*. 23 *a*\*), meeting another from before backwards and inwards from the superior maxillary bone (22 *b*. 23 *b*\*). These two origins combine in each to form a tendon; these tendons (22.23) pass forwards in front, and below the neck of the anterior pouch, where they unite with their fellows; each of these tendons

\* These numbers refer to drawings that are in the Archives of the Royal Society.

gives off a slip that ascends in front of the neck of the sac, and passes over it to be inserted into the anterior wall of the outlet.

When the posterior or frontal bellies of these muscles act on both sides, they will form a sling which will draw backwards the anterior wall of the breathing canal, and compress it against the posterior wall, thus closing the canal below the openings of the anterior sacs. They will, I conceive, at the same time contract the outlets of the sacs.

The anterior heads, or those from the maxillary bone, will draw forward the sling formed by the combined muscles and open the breathing canal.

These two muscles cross each other, so that in the same muscle the anterior belly is most superficial, while the posterior belly is deepest.

The most superficial of these tendinous slings is blended with the tendinous structure common to a very strong pair of muscles (24\*). These muscles arise from the superior maxillary bones to the side of the anterior deep pouch, and ascend over the sides of that pouch to be inserted into the strong gristly tendon (fig. 1-24) at the top of it. The combined muscle forms a long arched musculo-tendinous bridge over the anterior deep sac, that, when it contracts, compresses the sac. The tendinous bridge just described passes backwards underneath the two tendons (fig. 1-22.23) that close the deep portion of the breathing canal; it then turns upwards behind those tendons, and is reflected forwards over them to form the insertion of two other muscles (fig. 2-10) that are superficial to the muscles just described. The combined musculo-tendinous web formed by these two muscles and their common tendon, superficial to the muscles described above, arches over the anterior deep sac; with those muscles it combines to contract the anterior deep sac.

A distinct set of fibres (40\*) arises from the side of the inlet of the osseous canal; these fibres pass forwards and upwards over the neck of the anterior deep pouch, to be inserted into the central tendinous web covering that pouch, the outlet of which, this muscle, I conceive, contracts.

Another muscle, (41\*) just behind this, seems to have a similar function.

The anterior deep pouch (2.) differs from the other pouches in having no superficial wrinkles, and in having a regular muscular coat; it seems indeed to be rather a pouch-like dilatation of the breathing canal, than one of the regular sacs.

Each posterior deep pouch (fig. 1. 2-3) is situated behind the breathing canal, between it and the frontal bone. Its opening is horizontal, and looks downwards, and is half-surrounded in front by a cartilage (fig. 1-21).

Several fan-like, half-pouch formed muscles (16.17.18.19\*), that arise from the frontal bone, contract and empty the posterior pouch.

To contract the mouth of the pouch there are two muscles. One (fig. 1-20) springs from the side of the central protuberance of the frontal bone, and forms a tendon that passes forwards and inwards encircling the inner side and front of the outlet;

\* See figures in the Archives.

it splits into two tendons, one of which (20 *a*) is inserted into the outer side of the edge of the bony canal, and the other (20) into the partition of that canal.

The other muscle (21\*) arises close to the insertion of the last muscle, takes a sweep round the posterior and inner sides of the outlet of the pouch, and is inserted into the cartilage at the margin of that outlet in front.

It appears that when the blow-hole is closed, the posterior pouches are compressed and emptied, while the anterior pouches are distended with air from the lungs. The anterior pouches will then cause the head and blow-hole to rise to the surface. When the blow-holes are open, the muscles that compress and empty the anterior sacs likewise expand the blow-hole; it is clear that the anterior sacs that may be filled when the blow-hole is closed, will be emptied when it is open; while the posterior sacs that are emptied when the outer passage is closed, may be filled when the passage is open.

The anterior and posterior sacs alternate in their contraction and dilatation, the former being dilated and the latter contracted when the outer passage is closed, and the latter being dilated and the former contracted when the outer passage is open. Thus, first one then the other set of pouches may be dilated with air, to buoy up the head.

The two passages (figs. 1.3–26.27) that descend through the cranium, are each surrounded by a muscular coat; they join below the septum (fig. 3–27), which may be regarded in the light of a vomer, and form an increasing cylindrical pouch, which is analogous to the upper part of the pharynx behind the soft palate. This pouch contracts suddenly, where it opens into the pharynx (fig. 3–34). Through the contracted outlet or communication of the pouch-like channel with the pharynx, the mouth of the larynx rises (35). This outlet is acted upon, and the mouth of the larynx is compressed and retained, by a sphincter (34). The whole tube is surrounded by oblique fibres (fig. 1–27) descending from before backwards. Exterior to this muscular investing coat, is a strong layer of muscular fibres (28) that arise from the superior maxillary bone, in front of the canal, and descend downwards and backwards until they turn the edge of the hard palate; there they part into two sets; one set (28 *b*) passes backwards strengthening the canal behind, another (28 *a*) descends a little forward to the os hyoides.

The epiglottis (36) is long, firm and convex, and ends in an expanded lip. The arytenoid cartilages (37.35) are very large, strong and elongated, being seated immediately below, and contiguous to, the epiglottis.

When the mouth of the larynx is opened, the long arytenoid cartilages are drawn downwards from the epiglottis and apart from each other by the crico-arytenoid muscles (39). The mouth of the larynx is closed by the action of the thyro-arytenoid (38) drawing the arytenoid cartilages over to the epiglottis.

The remarkable apparatus described above forms the breathing passage of the

\* See figures in the Archives.

Porpoise. The adjustments of the apparatus are such that the animal can close or open the outer passage either above or below the anterior pouches. When the outer passage is closed, the posterior pouches can be distended and the anterior are emptied; and when the passage is open, the anterior pouches can be distended and the posterior are emptied.

The pouches evidently serve to buoy up the head, so that when the Porpoise rises from the deep, the opening for breathing comes first to the surface; and if the animal remains at the surface, either in sleep or in the act of coition, the air in the pouches will float the blow-hole above the level of the water, when the whole body of the animal is below the level.

The Porpoise, I believe, does not spout. The blow-hole of the whale is in principle the same with that of the Porpoise. I was led, some years since, to think, from the examination of a Rorqual, that the spouting of the whale consists in the regurgitation from the stomach of the sea-water that it must swallow plentifully with its food. I was induced to form this opinion from noticing *the direction of the first stomach*, which may be described as an expanded pouch of the œsophagus, and which is so placed as to send its contents, when it is contracted, directly upwards through the œsophagus, provided the communication be open, *and the form of the larynx* boat-shaped below, and capable of being completely closed.

Apart from all speculation, the blow-hole of the Porpoise, forming a part of its mechanism of respiration, must in itself be regarded as one of the most intricate and nicely adjusted apparatus that has yet been observed.

#### DESCRIPTION OF THE PLATE.

#### PLATE XII.

Fig. 1. (Must be looked at, not in the direction of the plate, but sideways.) It represents the cranium of the Porpoise, a section of the blow-hole or nasal canal, and the sacs.

Fig. 2. The cranium of the Porpoise with the muscles that close and open the blow-hole, and also those acting upon and emptying the sacs.

Fig. 3. A section of the pharynx and of the naso-pharyngeal canal leading from the larynx to the nostrils, exhibiting the larynx.

Besides the engraved figures there are five others, deposited in the Archives of the Royal Society, exhibiting, in various stages of their dissection, the muscles that act upon the sacs and the passages of the blow-hole.

The same numbers refer to the same parts in all the figures.

Nos. 1.1. Figs. 1.2 (figs. 4.8. Archives of the Royal Society). The two anterior superior lateral sacs. Membranous.

- No. 2. Figs. 1.2 (figs. 7.8. Archives of the Royal Society). The anterior inferior sac. Muscular.
- Nos. 3.3. Figs. 1.2 (fig. 8. Archives of the Royal Society). The two posterior sacs. Membranous. The sacs communicate with the nasal canal.
- No. 4. Fig. 2. Semicartilaginous mass in front of the blow-hole.
- No. 5. Fig. 2. Muscle, arising from the frontal bone, inserted into the semicartilaginous mass (4) in front of the blow-hole; with its fellow it draws that mass backwards to close the blow-hole.
- No. 6. Fig. 2. Muscle that, with its fellow, opens the blow-hole by drawing forwards the semicartilaginous mass in front of the blow-hole.
- No. 7. Fig. 2. Muscle that dilates the outlet by drawing backwards its posterior wall.
- No. 8. Fig. 2. Muscle that compresses and empties the anterior superior sac (1).
- No. 8 *a*. Fig. 2. Deeper muscle that envelopes, compresses and empties the anterior superior sac, and dilates the outlet of the blow-hole by drawing forwards and sideways its anterior and lateral walls.
- No. 9. Fig. 2. Fan-shaped muscle that dilates the blow-hole by drawing backwards and outwards its posterior and lateral walls.
- No. 10. Fig. 2. Muscle that, with its fellow, arches over, compresses and empties the deep anterior sac (2).
- Nos. 11.12.13.14.15 (figs. 4.5.6. Archives of the Royal Society). The dilators of the nasal canal. Fan-shaped muscles, that arise like No. 9. from the circumference of the fronto-facial ridge, and are inserted into and expand various portions of the walls of the nasal canal.
- Nos. 16.17.18.19 (figs. 6.7.8. Archives of the Royal Society). Compressors of the posterior sacs (3).
- No. 20. Fig. 1 (fig. 8. Archives of the Royal Society). Muscle that divides into two tendons (20 and 20 *a*.) and constricts the opening of the posterior sacs (3).
- No. 21. Fig. 1. Cartilage in front of the opening of the posterior lateral sac (3), into which is inserted
- No. 21 *b* (fig. 8. Archives of the Royal Society). A deep muscle that surrounds and constricts the opening of the posterior sac (3).
- Nos. 22.23. Fig. 1. Are sections of the tendons of the two following double-headed muscles 22 *a*. 22 *b*. 23 *a*. 23 *b*.
- Nos. 22 *a*. 23 *a* (fig. 7. Archives of the Royal Society). Are the two heads that with their fellows of the opposite side act from behind forwards to tighten the tendons 22.23, and so close the nasal canal below the openings of the anterior superior sacs (1), and, I conceive, constrict the openings of those sacs.
- Nos. 22 *b*. 23 *b* (fig. 7. Archives of the Royal Society). Are the two heads that act

from before backwards to open the canal by relaxing the tendons, 22.23 (see p. 32).

No. 24. Fig. 1. Is the tendon of

No. 24 *b* (fig. 7. Archives of the Royal Society). One of a pair of muscles that, like No. 10. fig. 2, arch over and compress the anterior deep sac (2).

Nos. 25.25. Fig. 1. Oblong cartilages, one to each side of the opening of the deep anterior sac (2).

No. 26. Fig. 1. 27. Fig. 3. The vomer separating the two nasal canals.

No. 27. Fig. 1. The upper portion of the naso-pharyngeal canal.

No. 28 *c*. Fig. 3. The naso-pharyngeal canal into which the mouth of the larynx (35) ascends through an opening in the pharynx (34).

Nos. 28.28 *a*. 28 *b*. Fig. 1. Muscular fibres that strengthen the naso-pharyngeal canal and the pharynx.

No. 29. Fig. 1. Muscle that descends to the os hyoides from the palatal bone.

No. 30. Fig. 1. The anterior part of the pharynx.

No. 31. Fig. 1. The os hyoides.

No. 32. Fig. 1. The constrictor of the pharynx.

No. 33. Fig. 1. The thyroid cartilage.

No. 34. Fig. 3. The sphincter of the opening in the pharynx, through which the larynx communicates with the naso-pharyngeal canal, after passing through the pharynx and dividing it into two channels.

No. 35. Fig. 3. The mouth of the larynx.

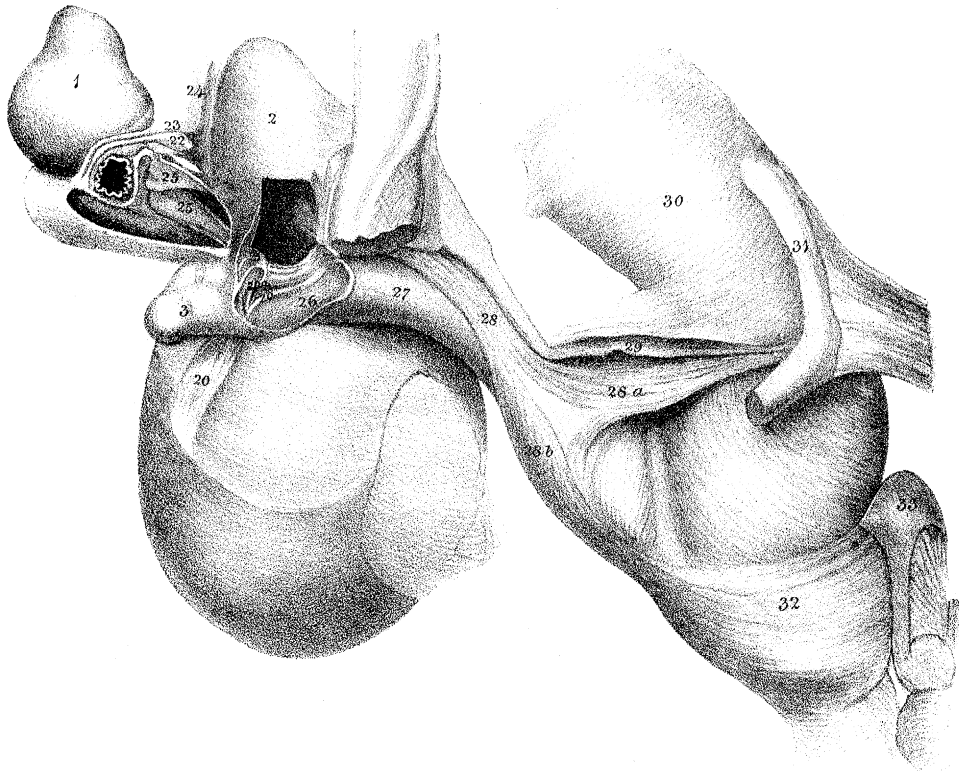
No. 36. Fig. 3. The epiglottis.

No. 37. Fig. 3. The arytenoid cartilages.

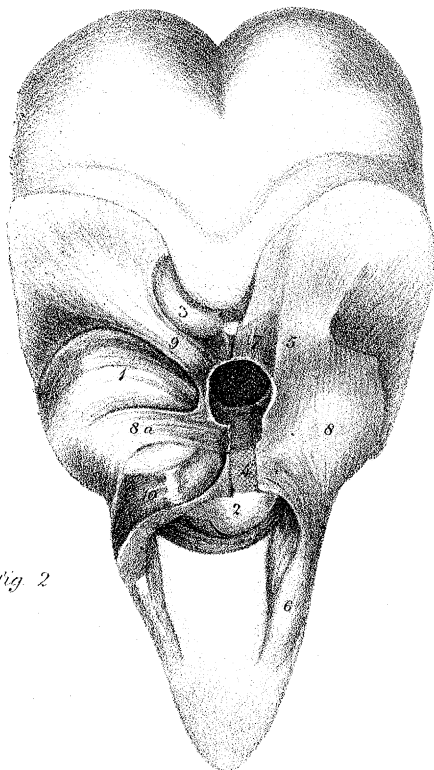
No. 38. Fig. 3. The thyro-arytenoid muscle.

No. 39. Fig. 3. The crico-arytenoid muscle.

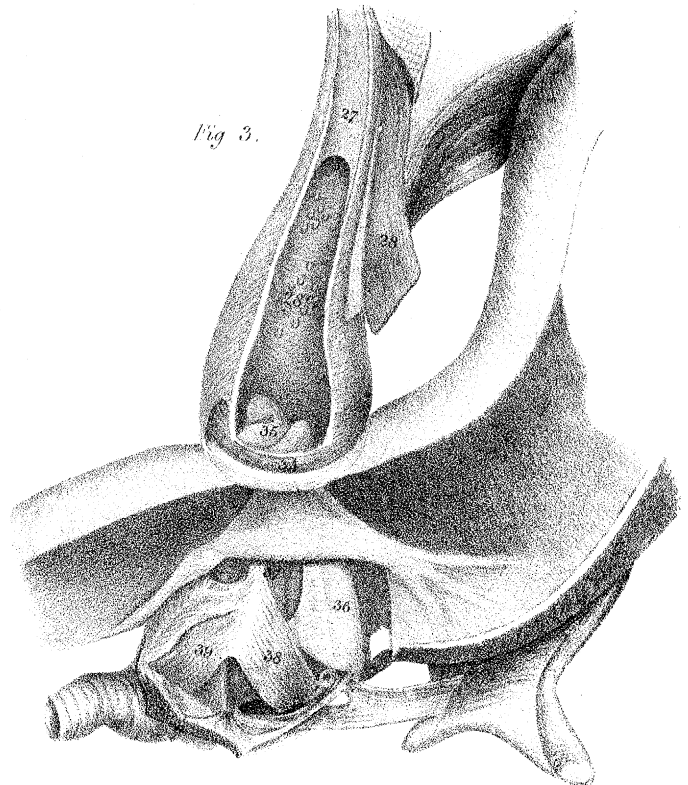
Nos. 40.41 (fig. 8. Archives of the Royal Society). Constrictors of the mouth of the deep anterior sac.



*Fig. 1.*



*Fig. 2.*



*Fig. 3.*