Hist Otorhinolaryngol 2018; 1: 223-238

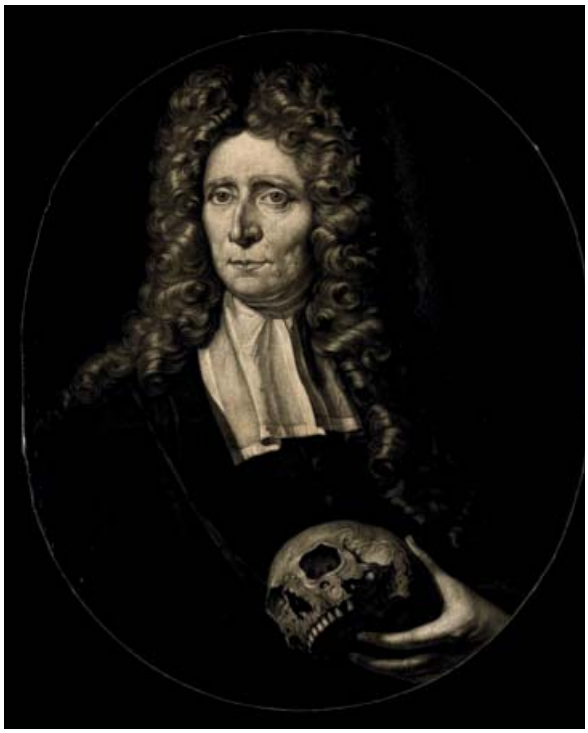
THE STRANGE AND EVENTFUL HISTORY OF JACOBSEN'S ORGAN[1]

John Riddington Young and George S. Stoyanov

Abstract
The vomeronasal organ was not in fact first described by Ludwig Jacobsen in 1809, but by Frederik Ruysch in 1703. Neither of these meticulous surgeons fully understood its function. Other anatomists (von Sömmering, Gratiolet, Dursy, Kolliker, Potiquet) described its morphology and in 1897, Robert Broom ascribed it with the function of an accessory olfactory organ. Little more was written in the twentieth century until Monti-Bloch developed the electrovomeronasogram showing its functionality (1994) and then a few years later Trotier (1998) postulated on the grounds of genetic coding that the organ was non functional. Jacobsen's Organ remains an interesting anatomical vestige.

Introduction

When Britain's wartime leader, Sir Winston Leonard Spencer Churchill said in 1934, "*It is a riddle wrapped in a mystery inside an enigma."* he was not talking about Jacobsen's Organ – but he might just as well have been. (He was in fact referring to Soviet Russia.) (1) The vomeronasal organ has been a well identified anatomical landmark in both amphibious and terrestrial animals for centuries and there is no doubt among zoologists about its function in amphibians, reptiles and most mammals. Its rôle however (if any) in *homo sapiens* remains uncertain. Recent interest has implicated it in the perception of pheromones, but this is still controversial. Jacobsen himself believed it to be an atavistic evolutionary remnant, but at the end of the last century, there appeared to be definite electrical evidence of function. The advent of genetic coding however has now cast doubt on this.



1.Portrait of Ruysch by his son-in-law, Juriaen Pool. In addition to describing the vomeronasal organ, he also discovered lymphatic valves, the central artery of the retina and is thought to have made one of the first descriptions of the malady now known Hirschprung's disease.In 1685, he was appointed as Professor of Botany to the Hortus Botanicus Amsterdam.

Frederik Ruysch

Ruysch was the most noted Dutch anatomist and botanist of the seventeenth century (Fig. 1).

John Riddington Young, TD, MPhil, FRCS, DLO,
West Barton, Horwood, Bideford, Devon, UK
riddingtonyoung@hotmail.com

George S Stoyanov,
Department of Anatomy and Cell Biology,
Faculty of Medicine, Medical University - Varna
„Prof. Dr. Paraskev Stoyanov", Varna, Bulgaria;
9002 Varna, Bulgaria, Marin Drinov 55 Str.
georgi.geesh@gmail.com

This paper is based on two individual lectures about the vomeronasal organ presented by the authors at the XIth Meeting of the International Society for the History of Otorhinolaryngology, which took place in Varna, Bulgaria on 29th September 2017.

2. Franciscus Sylvius. Ruysch's teacher at Leiden, born Franz de le Boë, was Ruysch's teacher. He was commonly falsely cited as the inventor of gin.

He was born on the 23rd March 1638, in Den Haag and died on 22nd February 1731 in Amsterdam at the grand old age of 93. Ruysch was the first to describe lymphatic valves, the central retinal artery, vomeronasal organ and several pathological conditions, including Hirschprung's Disease(2) intracranial teratoma, enchondromatosis, and Majewski syndrome (3)

He was the son of Hendrik Ruysch, a Dutch civil servant. Because of the early death of Frederik's father, he became an apprentice in an apothecary's shop while still a teenager. Clearly a young man of initiative (and perhaps a little foolhardiness!), he opened his own shop in Den Haag in 1661 and began preparing drugs. The problem was that he was not a fully accredited member of the Apothecaries' Guild. He was forced by the Town Authorities to close the shop and complete his unfinished apprenticeship. He eventually reopened it after he had been admitted as a confrater of the Guild on June 17, 1661. This year was to prove an eventful one for young Frederick: he got married to Maria Post, (the daughter of a wealthy architect), and his new-found wealth allowed him to enter Leiden University to read Medicine (4).

His teachers at Leiden included Franciscus Sylvius (1614-1672) (Fig.2). He was also a direct contemporary student with Neils Stensen, the Dane. Ruysch quickly qualified and obtained his medical doctorate (with a thesis on pleuritis) on July 28, 1664. Ruysch's main interest was anatomy, for which he had had a passion since his youth, when he would ask grave diggers to open graves so that he could perform dissections. He gained legitimate access to human cadavers in 1667, when he was appointed to the Praelector (head of anatomy) of the Guild of Surgeons of Amsterdam (Fig.3, p.225) A few years later the gained the Examinership of Midwives (Amsterdam), which appointment meant that he could also get his hands on lots of aborted foetuses and stillbirths. It is apparent from the hundreds of embalmed young bodies that Ruysch had a particular interest in paediatric anatomy (Fig.4, p.225).

Part of Ruysch's passion for anatomy was his great love of embalming and he developed many of his own his own embalming fluids. He prepared thousands of embalmed anatomical specimens, which he displayed to the

3. The Anatomical Lesson of Professor Frederik Ruysch, by Adriaen Backer 1670. Amsterdam Museum. Ruysch was appointed Praelector (Chief of Anatomy) to the Surgeons' Guild of Amsterdam in 1666. In this group portrait, he is wearing the big black hat. This is evidently why Gunter von Hagens, the contemporary anatomist wears a similar black fedora.

4. The Anatomical Lesson of Professor Frederik Ruysch, by Jan van Neck, 1683.Amsterdam Museum. Here (as in the famous Rembrandt group portrait of Dr Tulp's Anatomy Lesson) the demonstrator is wearing a big black hat. He is demonstrating the umbilical cord of a stillborn infant whilst his 10 year old son Hendrik (who followed in his father's footsteps, assisting in the preparations and qualifying as a physician in 1696) holds a child's skeleton.

5. Decorative arrangement of foetal skeletons with bones, blood vessels and vascular tissue. One disarticulated and two intact skeletons are shown, both weeping into pieces of mesentery. Ruysch's best known artistic creations are these tableaux non vivant which he fashioned around preserved foetal skeletons adorned with urinary and biliary calculi, insects, pearls, casts of blood vessels and lymphatics, and various other small natural elements. They were brilliant examples of anatomy but also memento mori reminding the viewer of the transience of life and also vanitas mundi (the vanity of the world). Engravings by Cornelius Huyberts of these tableaux appeared as large fold-out pages in Thesaurus anatomicus and Opera omnia. Sadly and indeed ironically, none of these complex creations have survived the ravages of time themselves.

public in his "Cabinet." (Fig. 5-6) This was a collection of specimens housed in a three storey house on Amsterdam's Bloemgracht (Flower Canal). They were acknowledged as one of Europe's most famous anatomical collections [5] Many other contemporary Dutch anatomists would keep their own personal anatomical collections, but Ruysch's were not only meant for the inspection of medical students and colleagues; they were open to the general public on two days of every week. By doing this, Ruysch is thought to have had two definite intentions; firstly a genuine wish to educate the commonalty and secondly to show his own artistic brilliance using the beauty of nature. We think it important to remember that he (and we must assume his audiences) did not find these babies in bottles of fluid in any way macabre; they were seen as both educational and as works of aesthetic beauty. His daughter, Rachel (a celebrated Dutch artist) helped him with his preparations.

Ruysch was particularly proud of his embalming skills. He had become famous for his meticulous technique of post mortem vascular injections and had developed his own secret embalming balsam, the formula of which is still unknown. Some Dutch historians [6] aver that it contained clotted bulls' blood, Berlin blue and orange mercury oxide which gave the specimens their rosy pinkness, whereas others [7] believe that the pigment was from cinnabar, a naturally occurring red coloured mineral (mercuric sulphide). The injected fluid gave his specimens, especially the ones of foetuses and infants, a reddish, al-

6. This intact tableau was found in Paris and is thought to be one of the remaining complete dry creations of Ruysch.

most life-like appearance. An interesting recent Brazilian paper has compared Ruysch with the contemporary anatomist and artist Gunther von Hagens [8]. They are both passionate embalmers and have each developed their own personal and highly successful method of embalming. More than this – during their lifetimes, they have both brought anatomy to life and raised it to a definite art form – Ruysch with his *Cabinet of Curiosities* and von Hagens with his *Body Works* exhibition.

7. Peter the Great. Shortly after taking power, Peter left Moscow and began an eighteen-month tour of western Europe. While studying shipbuilding in Amsterdam, he met Dutch scientists including Anton van Leeuwenhoek, Herman Boerhaave and Frederik Ruysch. He was particularly fascinated with Ruysch's collection of preserved anatomical specimens and spent many hours examining them, before eventually buying them.

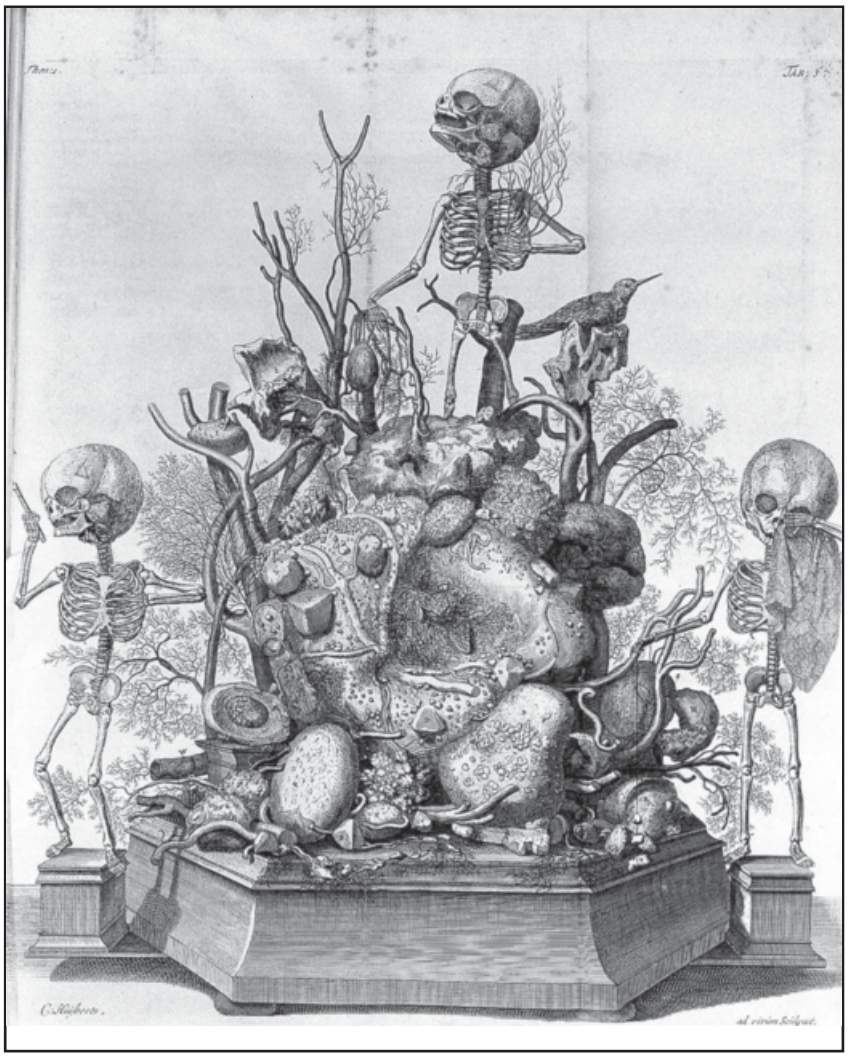
Ruysch had many of the most important international academic and political figures of the day visit his rooms, but perhaps the most distinguished visitor was Peter the Great, the twenty-five year old Tsar of Russia (Fig. 7). Petr Alexeyevich Romanov first visited in 1697 and there were unsubstantiated rumours that he fell in love with a beautiful embalmed woman (who was so realistic that she appeared to be sleeping)! It is recorded however that Ruysch, a generous teacher, gave Peter instruction in anatomy and allowed him to

8. Kunstkamera, (Peter the Great Museum of Anthropology and Ethnology) The present home of the remaining specimens from Ruysch's collection on the north bank of the River Neva, St Petersburg.

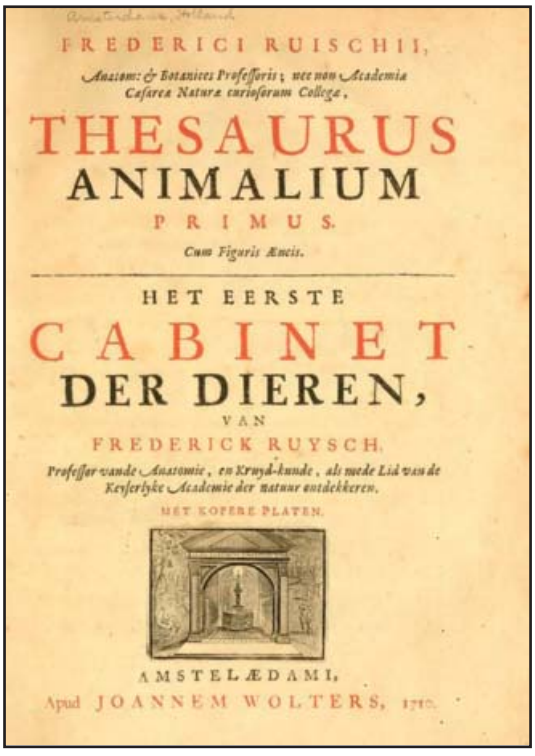
attend his lectures [9] The Tsar was very interested in Science and certainly enamoured of Ruysch's "Cabinet of Curiosities" and when it came up for sale in 1717, he bought it for 30,000 guilders. There are many rumours about details of the transaction but it is thought that the deal included the secret of the liquor. After the sale, Ruysch refused to help when everything had to be packed and labelled and the work took Albert Seba (a pharmacist from whom the Tsar had also bought a collection of insects) [10] more than a month. The Great Nordic War the following year further delayed the shipping which was divided between two ships. The collection eventually arrived in St Petersburg safe and sound and rumours about the sailors drinking the alcohol, are definitely untrue.

On arrival Ruysch "repository of curiosities" was first housed in the Kikin Palace, but in 1725 the purpose built *Kunstkamera* (where it still exists) was completed on the North bank of the River Neva (Fig. 8) near the city centre [11]. Of the original 2,000 dry and wet embalmed specimens of Ruysch, many of the dry specimens have perished, but in all there are still 916 still remaining (mostly in fluid) [12]. In 2003 a joint project by the Russian Kunstkamera and Leiden University restored some of the collection and "topped up" the jars (Fig. 9) with fresh preservative (albeit ethyl alcohol, without either cinnabar or bulls' blood!) [13]. (They have made an new catalogue which is available online at http://www.kunstkamera.ru/kunst-catalogue/index.seam?c=RUYSH).

9. Recently restored jar containing a five-month-old foetus with lace cap and piece of injected placenta from the shelves of the Peter the Great Museum of Anthropology and Ethnography (Kunstkamera) in St Petersburg.



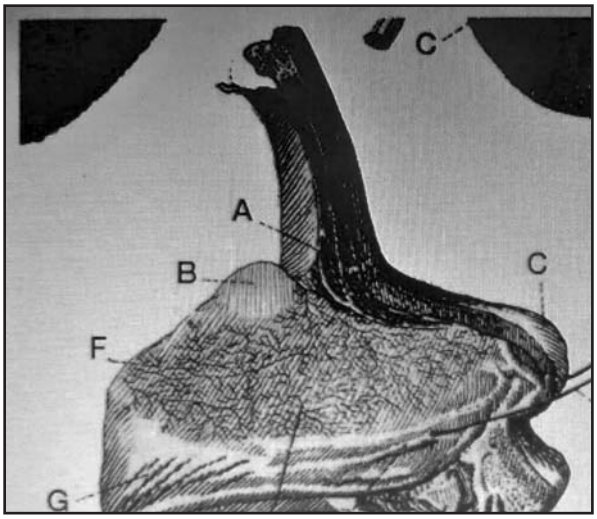
10. Image extracted from Ruysch's Thesaurus Animalium, (between 1701 and 1728).



10-11. Ruysch also published images of specimens in Opera omnia anatomicomedico-chirurgica (1721).

Luckily for posterity, Ruysch was meticulous in his descriptions and made a twelve volume catalogue embellished with beautiful engravings. He published images of specimens in *Thesaurus anatomicus*, (between 1701 and 1728) (Fig. 10-11, p.229), and *Opera omnia anatomicomedico-chirurgica* (1721) [12].

It is in the third volume of his *Anatomical Treasury* [14] that we first learn of the vomeronasal organ. (Fig. 13) Ruysch himself says that: *It appears on the anterior and inferior parts of the septum just above the palate, appearing laterally with its own duct.* He goes on to remark about the finding, that *I have read nothing among (other) authors about its function or existence.* He adds, *I deduce that it exists for the secretion of mucus.* Ruysch also includes an engraving [15] in which *hairs* are inserted into the canals on both sides of the septum. It is pertinent to add that Ruysch states that he is describing the nasal septum of an infant and indeed adds that it is *totally cartilaginous.* There have been more than one erroneous publications about Ruysch's engraving, stating that it is from an adult. One such states, *A Dutch military surgeon* (presumably referring to Jacobsen) *first described the structure in 1703 in a soldier with a facial wound.* [16]



13. An engraving from the third volume of Thesaurus Animalium (1703) showing the first known description of Jacobsen's organ. The specimen is a dissected nasal septum of a two year old child. The anterior is to the right. The two hairs (D) are in the bony vomeronasal duct (E). This specimen might still exist somewhere in the Kunstkamera.

Frederik Ruysch was elected a Fellow of the Royal Society in 1715.

A very similar image to the one published by Ruysch in 1703 appeared in 1809 [17] in an monograph on the human olfactory organ by the Prussian, Samuel Thomas von Sömmering (Fig.14). Although the figure has survived (in a paper by Pearling in 1934) [18], the text of his thesis is sadly lost.

14. Thomas Samuel von Sömmering was born in Turun, Prussia (now Poland) in 1774. He qualified in Medicine in Göttingen and discovered the retinal macula. In addition to his contributions to Neuroanatomy, he also invented an astronomical telescope and a form of electrical telegraph.

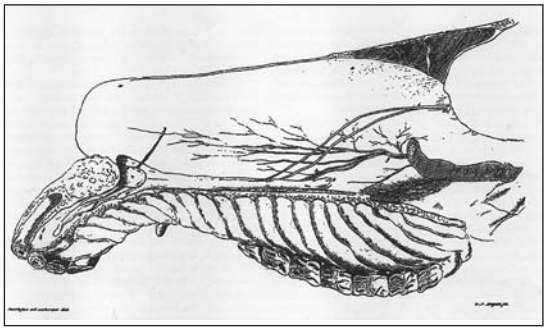
Ludwig Jacobsen

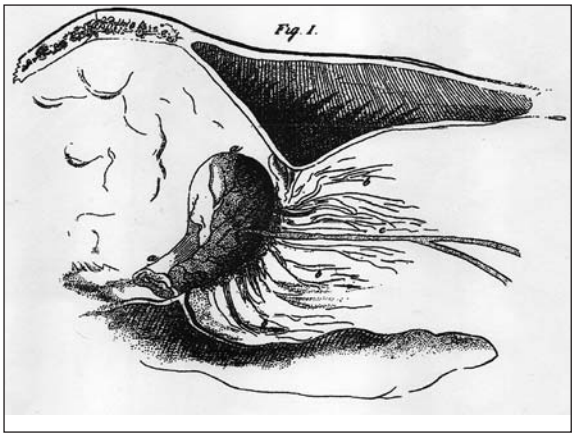
Ludwig Lewin Jacobsen was born in Copenhagen to a Jewish family (his father was Royal Jeweller to the Court of King Frederick). He had three great interests in life: Military and Veterinary Surgery and Comparative Anatomy. He received his early education at the German Lyceum in Stockholm, but returned to Copenhagen to study medicine. He graduated in 1804, and was appointed at his alma mater (surgical academy) as assistant surgeon in 1806. From 1807 to 1810 he was employed as tutor at Den Kongelige Veterinær og Landbohòjskole (the Royal Veterinary and Agricultural High School) in Copenhagen.

His work there was interrupted by the ongoing squabbles between Napoleon and Wellington. In 1807, the British needed Denmark on-side to prevent Bonaparte from compromising their Baltic trade routes. The Danes wouldn't play ball and wanted to remain neutral but time was crucial, because it was autumn and the Russian fleet was at the time snowed in. Britain had to take a firm hand and Wellington advised immediate attack on the Danish capital because of its critical strategic geographical position. Britain of course crushed the small Danish forces who had been left under control of a geriatric General. Much of the city was destroyed and the whole Danish fleet was confiscated by the United Kingdom. (This gave rise to the term *Copenhagenised*.) During this Second Battle of Copenhagen, Jacobsen worked tirelessly in the lazaretto of the Freemasons' Lodge as a military surgeon. After capitulation, he requested and obtained permission to inspect the British field-hospitals, of which he later (1809) published an interesting account in the *Bibliothek for Læger*. This was one of only two learned articles which he wrote during his lifetime.

15. Whilst in Paris Jacobsen studied with the great comparative anatomist, Baron Francois Georges Cuvier, whom he referred to as his spiritual father.

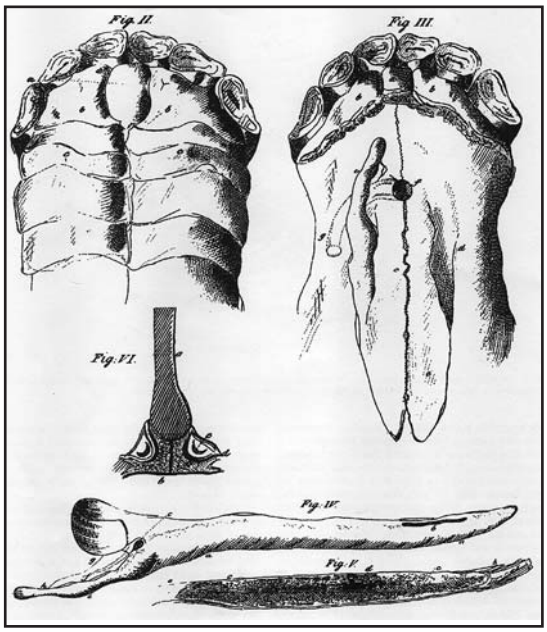
Later in that year he presented his discovery of the vomeronasal organ to the Danish Kongelige Danske Videnskabernes Selskab (Royal Academy of Science and Letters). It was entitled *An Anatomical description of a New Organ in the nose of domesticated animals* and was a detailed account about the comparative anatomy of the organ in animals (including amazingly tigers, and camels). For this he was awarded the Academy's Silver Cross, but perhaps more importantly he gained the patronage of the king of Denmark, King Frederik VI, from whom he received a royal scholarship to travel to France and Germany. Ludwig seized on this opportunity to visit Paris and study with Baron François Georges Cuvier (Fig. 15), the great comparative anatomist, whom he described as his spiritual father [19].





16, 17 above and 18, p.232
Jacobsen's engravings of vomeronasal organ in a horse.

It is hard not to assume that Jacobsen discussed his original discovery with Cuvier and the likelihood is that Cuvier urged Jacobsen to publish his findings. The reality however is that in 1811 the Frenchman published a paper himself about Jacobsen's new "organ" (Cuvier, 1811) and it is this article, *Description anatomique d'un organ observé dans les*



16, 17 (p.231), 18 Jacobsen's engravings of vomeronasal organ in a horse.

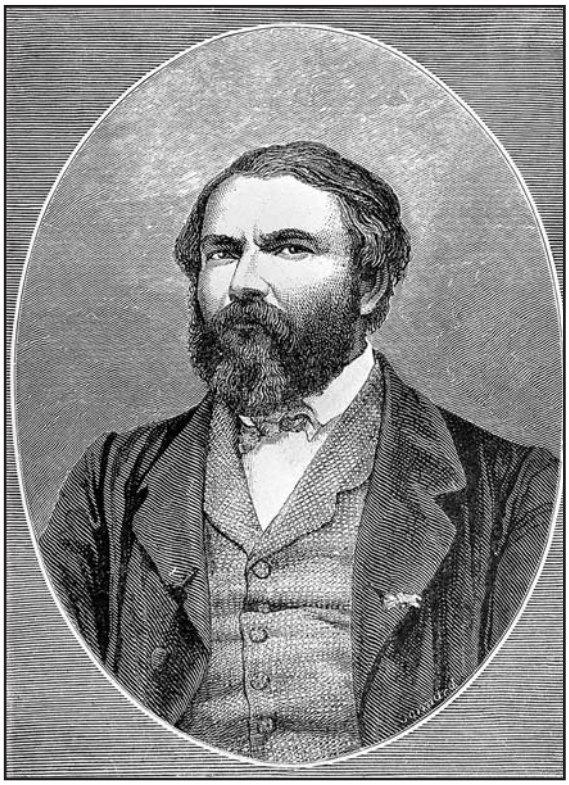
mammifières [20] which was for many years referred to as 'Jacobsen 1811.' To be fair to Cuvier, he did not plagiarise and gave full and due attribution to his student. In fact it is a pale shadow of the thesis which Jacobsen eventually got around to producing a couple of years later. Jacobsen's seminal work (Fig.16-18), published in 1813 was printed in Gothic script and in Danish and remained almost unknown. In 1950 it was translated into French by Danish scholars, but only 150 copies of that version were made and it was mainly unacknowledged. This was the article discovered in the library of the Agricultural University of Copenhagen and translated in 1998 by two Europeans, Trotier and Døving. They praised this original paper: *The fact that a richly innervated organ was hidden in the nasal septum of mammals and had escaped the attention of a great many anatomists was naturally a surprise to many and a source of envy to other contemporary anatomists. The thoroughness of his anatomical observations, and the many reflections that Jacobsen made on the function of the organ, are pertinent even for the scientist of today. In addition, he made a series of observations on the anatomy of the vomeronasal organ that have escaped the attention of later authors. Subsequent investigators sometimes have not even realized that Jacobsen had previously described various structures, such as the relationship between the organ and the accessory olfactory bulb* [19]. A very important point in this seminal paper however and one which is worthy of emphasis is that in his description of the vomeronasal organ, Ludwig Jacobsen (unlike Ruysch and von Sömmering) describes it in mammals other than humans. Indeed he specifically states this on two occasions saying that, *it is most developed in the rodents, next in the ruminants. The carnivores have less, and in the monkeys it becomes so small that we are prepared to see it vanish completely in man;* and further, *that humans, who possess a very well developed sense of taste, have only a rudiment of the organ.* [19,21]

At the end of that same year however, King Frederick of Denmark, who was on good terms with Jacobsen, asked him to join the French Army to learn more about Military medical organisation. Ludwig dutifully obeyed and in October 1813, joined with Napoleon's famous army surgeon, Dominique Jean Larrey, in Leipzig to engage with the Russians. The Battle of Leipzig was a disaster for the French however and during their attempted retreat, a French corporal blew up the bridge which was their only means of escape. Ludwig was cut off with hundreds of French troops. He was badly beaten up by the Cossacks who stole everything from him including his uniform. He was left for dead, caught a fever and hospitalised himself in the allies' field hospital in Leipzig. On his recovery, he was recognised "*as a scientist*" and promoted to surgeon to the Hanoverian League. Ironically therefore, he started the Battle on the Napoleonic side and finished on the British!

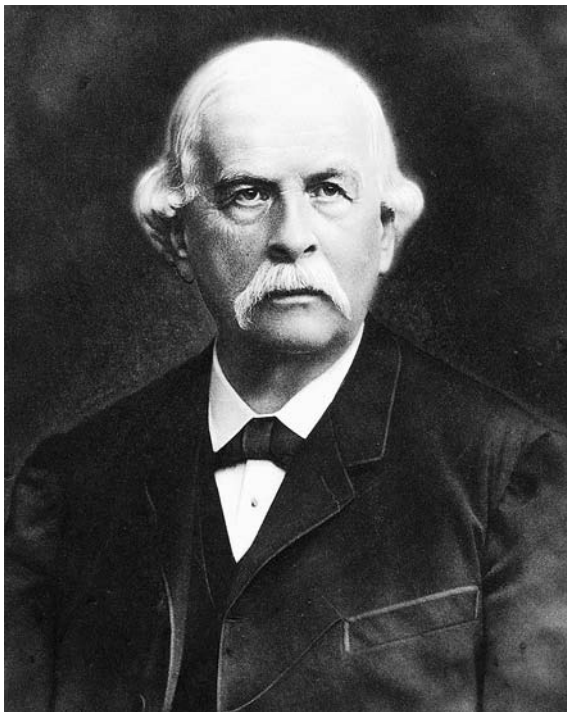
He returned to Copenhagen in 1814 and that same year received an honorary doctorate from Kiel University. (Two years later the same university conferred upon him the title of professor.) He made a number of anatomical observations, including electroreceptors in rays and salt glands in birds. He also invented a surgical instrument for the crushing of bladder stones (the lithotrite of Jacobsen). Jacobsen received many honours during his lifetime. He was awarded the Monthyon prizes (4,000 francs) by the Académie de Sciences in 1833, who had previously honoured him with a gold medal for his work on the renal venous system in birds and reptiles. In 1836 he was elected as an honorary member of the Royal Danish Medical Society. In 1829,

he was created a Knight of the Danebroge and he received the Silver Cross of the same order in 1836. In 1840, he was elected a foreign member of the Royal Swedish Academy of Sciences.

He did suffer from antisemitism during his lifetime. He was appointed as a professor by King Frederik, but this was opposed by the University of Copenhagen because of his Jewish faith. Evidently the University agreed to his appointment on the condition that he embrace Christianity, but *he refused to abandon the faith of his fathers* [22]. His religious belief also prevented also him attending the first meeting of natural scientists in Oslo in 1822; at that time an edict (which remained in force until 1840) forbade Jews from visiting Norway. He died in Copenhagen of typhoid fever in 1843.



19. Louis-Pierre Gratiolet, Professor of Zoology from Paris did his doctoral thesis on Jacobsen's organ. He mentions the nasopalatine canal in humans, but makes no further reference to our species. There are four plates of fine illustrations, none of which are of homo sapiens.



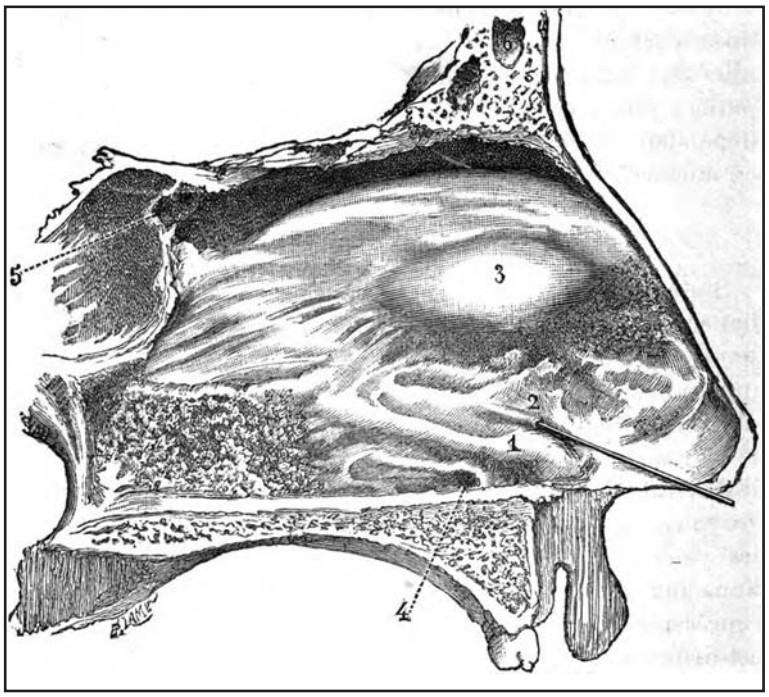
20. The Swiss, Rudolf Albert Kölliker was the first to describe Jacobsen's organ in adult humans. He discussed its possible functions, but concluded it to be an atavistic undeveloped embryonic feature "like the breast gland in man."

Further Interest

In 1845, Louis-Pierre Gratiolet (Fig. 19) published his extensive research on the mammalian vomeronasal organ. Although his doctoral thesis [23] mentioned *Steno's canal* in humans (Stensen's naso-palatine bony canal through the incisive foramen behind the incisor teeth in the hard palate), any direct reference to the human vomeronasal organ is missing. There are four plates of illustrations, none of which pertain to homo sapiens.

Charles Darwin in his "Origin of the Species" had stated in 1859 as one of his arguments for evolution of the species that *"ontogeny recapitulates phylogeny"* [24] and perhaps with this in mind, Emil Dursy looked in human embryos from 8-20 cm long and reported that he had found a small blind sac emptying into the nasal cavity in the lower frontal end of the nasal septum. He interpreted this as the homologue of Jacobson's organ which occurs in other mammals.

The Swiss, Rudolf Albert von Kölliker (Fig. 20) was the first to describe the vomeronasal organ in adult humans. Indeed some non-cli-



21. Potiquet included this fine illustration in his French article (1891). He suggested that the canal provided a nidus for infection and that this was why septal ulceration occurs at this constant point on the septum.

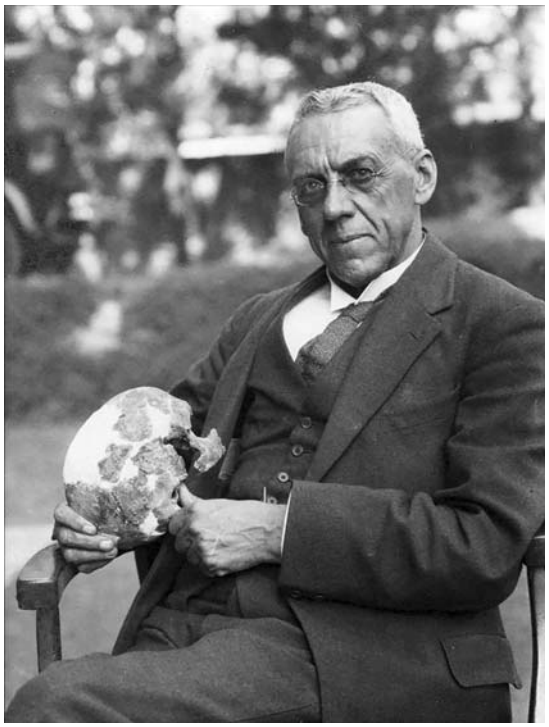
The French surgeon, Monsieur Potiquet clearly caught an impulse from von Kölliker's paper and in 1891 published an interesting monograph [27] extrapolating the comparison von Kölliker had made with the vermiform appendix.(Fig 21) Potiquet pointed out that in man the appendix might well be an atavistic remnant but is nonetheless important in surgical pathology, attracting as it does troublesome and not infrequent (and possibly lethal) inflammation. He proposes that the functionless Jacobsen's organ provides a similar nidus for pathological processes and chronic granulomata and puts forward the interesting suggestion that this is why perforations of the nasal septum usually occur at a constant site corresponding

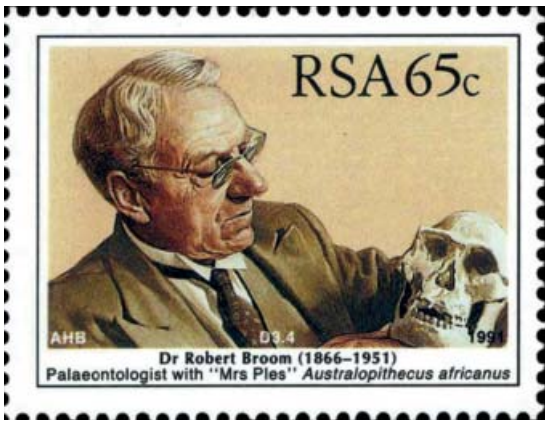
nical researchers have even suggested that it should more logically be named after him.[25] In 1877, he wrote about its existence and even published some illustrations of its histology. He wrote an interesting account of the possible functions of the organ, pointing out that it is unlikely to be merely a source of accessory mucus for the snout (or nose) (as suggested by Jacobsen) in view of the extremely rich efferent innervation to the nasopalatine nerve and the similarly abundant vascular supply. He added that it is also unlikely to *to have the purpose to take air and olfactory materials from oral cavity through Stensen's passage and thereby to distinguish harmful from harmless food products* (Cuvier's suggestion) *when one further thinks that the organ in question is enveloped by a rigid capsule and closed behind.* [26] He did not consider that it can be safely assumed that it has any sensory function *and so enable the organisms to somewhat directly obtain knowledge of chemical composition of their own secretions*. In conclusion, he considers it to be an atavistic undeveloped embryonic feature rather than functional. He likens it to the vermiform appendix and ends his paper by comparing it to *the breast gland in man.*

22. Wilhelm His of Basel. In His's attempts to stop everyone from calling the structure, Jacobsen's organ, he very satisfactorily succeeded in getting posterity to spell the eponymous name wrongly – Jacobson rather than Jacobsen !

to the vomeronasal canal. It is perhaps ironic that he cites syphilis as his example.

Every now and again, non-clinical anatomists have international conferences the sole purpose of which is to alter the time honoured names of things. One has to believe that the motivation is not merely to confuse working surgeons, but to bring more logic to their specialty. They clearly do not like eponymous names and consider them highly illogical. Not surprisingly therefore, Jacobsen's organ came under their attack as early as 1895. The Anatomische Gesellschaft was founded in 1887 and at the ninth meeting of the Society in Basel, it deemed that the organ of Jacobsen should be called: 'organon vomeronasale (Jacobsoni)' [28]. This was proposed by Wilhelm His (Fig. 22). It is ironic that although over a hundred years after his logical suggestion, many people (some might suggest the majority of rhinologists) still call the structure Jacobson's organ, they now spell Ludwig's name in a way that it would never have been spelt during his lifetime in his native Denmark. Your authors believe that this spelling error is is wholly and exclusively due to His's attempt to render it Latin, as in *organon vomeronasale (Jacobsoni).*





23. Robert Broom was the man who first properly understood the function of Jacobsen's organ. He was a Scottish obstetrician who emigrated to South Africa to take up his great passion in life - reptile palaeontology. He was however a great pioneer in human evolution and discovered one of the most complete australopithecine skulls.
24. The Republic of South Africa honoured their adoptive son by this commemorative stamp showing Broom with "Mrs. Pies" the name for the Australopithecus.

Robert Broom

The chap who probably first understood what Jacobsen's organ was all about was a man described as *one of the most charismatic figures in Victorian science* [29] the Scottish genius, Robert Broom (Fig. 23-24). He started life as the son from a poor family who became an obstetrician in Paisley, but he used his medical qualification to support his world travels pursuing his passion in life, palaeontology. In 1897 he settled in South Africa, where he did pioneer work on human evolution and discovered the most complete exemplar of an australopithecine skull.

He went back to Glasgow to defend his DSc thesis O*n the Comparative Anatomy of Jacobson's Organ* in which he presented work done in Australia and Africa with illustrations of the vomeronasal organs in 39 creatures including not only mammals, but marsupials, bats, whales and armadillos. "*It would seem*" averred Broom, "*that the organ of Jacobson is the organ of the body which is least liable to become altered by change of habit. I can almost identify an animal by examining this organ and often tell of its affinities.*"

Amphibians have a dual olfactory system, a phylogenetically older system for chemical perception underwater and a more advanced one for use in air. In evolutionary terms, Jacobsen's organ is thought to have developed from the older one. A good example is found

in the flicking olfactory forked tongue of ground snakes, which represents a persistence of the older (former underwater) system. The tongue is now used to explore the ground for non-volatile substances. When it is retracted into the mouth, the tips of the two tongue forks rest in the two pits on the roof of the snake's mouth (Jacobsen's organ). This is connected by a nerve to the accessory olfactory bulb. The incisive foramen in the primate bony palate represents these two pits. The olfactory nerve and area in the roof of the nose (let's call it the advanced system) is completely distinct. So we are left with two systems, neither of which in truth are very well understood. The upper advanced system is at least perceived even if there is no cortical representation. The lower system (associated with Jacobsen's organ) is thought to be not so much an olfactory link to consciousness, but rather a chemical clearing house for subliminal chemical stimuli.

Pheromones and Dissent

In 1939, Adolf Butenandt (Fig. 25) was offered the Nobel prize for Chemistry for his *Work on Sex Hormones*. At this time he refused the award: he was a patriotic German (and had signed the Loyalty Oath of German Professors to the National Socialist State). Adolf Hitler however, had been angered that the prestigious prize had been awarded to his outspoken critic Carl von Ossietzky in 1935 and had banned all loyal Germans from accepting the award. Butenandt therefore turned to other research during the war. He applied for government funding on research designated as *kriegswichtig* (important for the war), some of which focused on military projects like the improvement of oxygen uptake for high-altitude bomber pilots. [30]

25. Nobel Prize winner Adolf Butenandt isolated the first pheromone in 1959; he called it bombykol because he had found it in the silk moth Bombyx mori.

After the Second World War however, he accepted his Nobel Prize and in 1959 went on to isolate the first pheromone [31]. He called it *bombykol,* because he had discovered it as an attractant in silkworms (*Bombyx* mori). This was so powerful that *if any one female moth were to release all of her store in a single spray, there would be enough to bring a trillion males to her side.*[32] That same year the term *pheromone* was coined[33] to distinguish this new breed of chemical messenger (to others) from *hormones* which were chemical messengers to oneself.

Although it was assumed that the uptake of pheromones in mammals (including humans) might be associated with Jacobsen's organ, there was at that time no hard evidence to support this supposition.

The next chapter in this strange history began when David Berliner (a commercial biochemist) was working on the biochemical constituents of human skin in Utah (United States of America) in 1960. He had therefore placed flasks of skin extracts on the laboratory benches. He then noted a fascinating change in the social behaviour of his colleagues. Their mood became more relaxed and they started to play bridge at lunchtime (which they had never before done). He reached the end of that phase of his research and put the flasks in the department freezer. The bonhomie and games of bridge immediately stopped. A few months later, when the flasks were taken out again, the card playing resumed. Berliner made a mental note of this, but was too involved in other research to follow it up at the time. Then twenty five years later, he remembered the phenomenon and thawed out the "skin flasks" once more. To his utter surprise, the bridge playing resumed and lab

26. Luis Monti-Bloch developed his electrovomeronasogram (EVG) which provided clinical evidence that Jacobsen's organ is an accessory sense organ.

27. Ludvig Lewin Jacobsen (1783 -1843) from a lithograph by Em. Baerentzen & Co. produced in 1842 as a reproduction of a portrait painted by C.A. Jensen.

lunchtimes became more relaxed once again.

He thought that this might well be a pheromone phenomenon and spoke about it to his ENT colleague Luis Monti-Bloch (Fig. 26), who investigated it with the development of his *electrovomeronasogram (EVG).* He placed three electrodes in the human nose – one on the olfactory epithelium, in on the vomeronasal duct and a third (indifferent) electrode on a control part of the nasal mucosa. He then presented the subject with insufflated air from the flasks containing Berliner's skin extracts. The results were convincing [34].

The probes on the olfatory area and in the vomeronasal duct both showed recordable bursts of microelectrical activity when challenged by the skin aroma, but not the indifferent one on the control nasal mucous membrane. Monti-Bloch therefore cited this as evidence that the vomeronasal duct was an accessory olfactory sense organ and named the chemical stimulant in the skin flask, *vomeropherin*.

Didier Trotier, however – a non-clinical neurobiologist working in France stated very clearly in 2011 that; *The genes which code for vomeronasal receptor proteins and the specific ionic channels involved in the transduction process are mutated and nonfunctional in humans* [35].

Conclusion

The history of Jacobsen's organ is circuitous and fascinating. Ludwig Jacobsen (Fig. 27) himself doubted that it served any useful purpose in humans, but it would appear that there is no final agreement. The jury is still out. Indeed, people cannot even agree on how it should be spelled.

References

1. Churchill WLS. *Broadcast on the BBC Radio,* 1st October 1939. The statement was made about the predicted action of Soviet Russia in the war which had just been declared against Germany.

2. Leenders E, Sieber WK. Congenital Megacolon observation by Frederick Ruysch, 1691. *J Ped Surgery* 1970;5(1);1-3.

3. Boer L, Radzium AB, Oostra RJ. Frederik Ruysch (1638–1731): Historical perspective and contemporary

analysis of his teratological legacy. *Am J Med Genet A* 2017;173(1):16–41.

4. Kidd M, Modlin IM. Frederik Ruysch: master anatomist and depictor of the surreality of death. *J Med Biography* 1999;7;69-77.

5. Israel J.I. *The Dutch Republic: Its Rise, Greatness and Fall, 1477-1806*. Oxford: Clarendon, 1995, p.907.

6. Driessen H, Reve JJ. *De Kunstkamera van Peter de Grote. De Hollandse inbreng, gereconstrueerd uit brieven van Albert Seba en Johann Daniel Schumacher uit de jaren 1711-1752*. Hilversum: Verloren, 2006, p.338.

7. Kooijmans L. *Death Defied: The anatomy lessons of Frederik Ruysch. Translated by Diane Webb.* Vol. XVIII, History of Science and Medicine Library. Leiden: Brill, 2011.

8. Precht BLC, Fontes EB, Babinski MA, De Paula RC. Frederik Ruysch (1638-1731): Life and lessons from a memorable anatomist. *Eur J Anat* 2014;18(3):209-212.

9. Luynedijk-Elshout AM. Death enlightened: A study of Frederik Ruysch. *JAMA* 1970;212(1):121-126.

10. Nevorov O. *His Majesty's Cabinet'and Peter I's Kunstkammer.* In *The Origins of Museums*. Ed by Impey O., MacGregor A. Oxford: Clarendon, 1985, pp.54-61.

11. Anemone A. The monsters of Peter the Great: The culture of the St. Petersburg Kunstkamera in the Eighteenth Century. *The Slavic and East European Journal* 2000;44(4):583-602.

12. Mulder W, Radzium AB. Frederic Ruysch anatomical collection in St. Petersburg: history, storage and restoration. *Am J Med Genet A* 2004;173(1):16–41.

13. Mazierki D. The Cabinet of Frederick Ruysch and the Kunstkamera of Peter the Great: Past and Present. *J Biocom* 2012;38:E31-E40.

14. Ruysch F. *Thesaurus Anatomicus Tertius.* Amsterdam: Wolters.,1703, p.48, n.61, para.5.

15. Ruysch F. *Thesaurus Anatomicus Tertius.* Amsterdam: Wolters, 1703, p.50, Pl. IV, fig.5.

16. Wright K. The Sniff of Legend. *Discover* 1994;60-67.

17. Sömmerring S. *Abbildungen des menschlichen hoerorganes. Abbildungen der mesnchlichen organe des Geruches*. Frankfurt am Main: Varrentrapp & Wenner, 1809, p.24.

18. Pearlman SJ. Jacobson's organ (organon vomero-nasale, Jacobsoni): its anatomy, gross, microscopic and comparative, with some observations as well on its function. *An. Otol Rhinol Laryngol* 1934;43:739–768.

19. Trotier D. Doving KB. Anatomical Description of a New Organ in the Nose of Domesticated Animals by Ludwig Jacobsen (1813). *Chem Senses* 1998;23;743-754.

20. Cuvier FDG. Description anatomique d'un organe observé dans les mammifières. *Ann Mus Hist Nat Paris* 1811;18:412-424.

21. Jacobson LL. Anatomisk beskrivelse over et nyt organ i huusdyrenes naese. *Veter Salesk Skrift* 1813;2:209–246.

22. Singer I, Kramer F. *Jewish Encyclopaedia.* New York: Funk & Wagnalls, 1906.

23. Gratiolet LP. *Recherches sur l'organe de Jacobson*. Paris: Thése pour le Doctoral Médecine. 1845.

24. Darwin C. *On the Origin of the Species*. London: Murray, 1859.

25. Bhatnagar KP, Smith TD. The Human Vomeronasal Organ. V. An Interpretation of its Discovery by Ruysch, Jacobson, or Kölliker, with an English Translation of Kölliker (1877). *Anat Record B* 2003;1:4-15.

26. Kölliker RA. *Über die Jacobson'schen Organe des Menschen.* Leipzig: Engelmann, 1877.

27. Potiquet M. Du canal de Jacobson. De la possibilité de le reconnaitre sur levivant et de son rôle probable dans la pathogie de certains lesions de la cloison nasale. *Rev Laryngol Otol Rhinol* 1891;12:737–753.

28. His W. *Die Anatomische Nomenclatur*. Leipzig: Veit, 1895, p.58.

29. Watson L. *Jacobson's Organ and the remarkable nature of smell.* London: Penguin, 1999, p.25

30. Trunk A. Biochemistry in Wartime: The Life and Lessons of Adolf Butenandt, 1936–1946. *Minerva* 2006;44(3):285–306.

31. Butenandt A, Beckmann R, Stam D, Hecker E. Über den Sexual-Lockstoff des Seitenspinners Bombyx Mori. *ZeitschrNaturforsch* 1959;14:283.

32. Watson L. *Jacobson's Organ and the remarkable nature of smell.* London: Penguin, 1999, p.56.

33. Karlson P, Kuscher M. Pheromones; a new term. *Nature* 1959;183(4653):55-56.

34. Monti-Bloch L, Jennings-White C, Dolbert DS, Berlioner D. The Human Vomeronasal System. *Psychoneuroendocrinology* 1994;19:673.

35. Trotier D. Vomeronasal organ and human pheromones. *Eur Ann Otorhinolaryngol Head Neck Dis* 2011;128(4):184-90.

Introduction