two modifications, the appearance of the substance does not show that we are dealing with a metastable system. Consequently, if the physical constants of this system should be determined, various values would be found, which would depend on the previous thermal history of the substance.

If this system is kept without special precautions, the material soon takes up enough water to be transformed after some time into the α-modification. I hope to report shortly on the quantitative side of these phenomena.

SUMMARY OF RESULTS.

From the above it is evident that:

1. The non-metals as well as the metals, which are produced from their melts without special precautions are metastable systems in consequence of allotropy [1]).

2. That the chemical compounds as well as the elements are metastable systems in consequence of polymorphy [2]).

3. That the physical as well as the mechanical constants of all solid substances, as hitherto known are fortuitous values; these being functions of the previous thermal history [3]) of the substances, and they have to be redetermined with the pure α-, β-, γ- . . . modifications.

Utrecht, June 1915. VAN 'T HOFF-Laboratory.

Anatomy. — *"On the vagus and hypoglossus area of Phocaena communis"*. By Dr. H. A. VERMEULEN. (Communicated by Prof. BOLK).

(Communicated in the meeting of November 27, 1915).

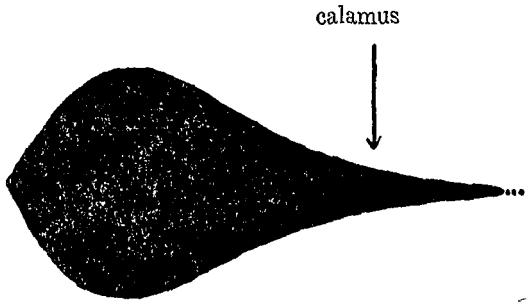
Nucleus motorius dorsalis vagi. This, for nearly $^2/_7$, stretches out spinally from the calamus. (Series of 493 sections of 15 μ, 138 being spinal and 255 frontal from the calamus, figs 1 and 7). It appears with a few small cells (12—15 μ) dorsally from the lateral portion of the canalis centralis, which exhibits at this place on section the form of a groove running horizontally, fairly wide in the middle and pointed at the sides. It is quite obliterated; a normal

1) This is also the case with substances showing dynamical allotropy.

2) This is also the case with substances showing dynamical isomery.

3) Strictly speaking: a function of the previous thermal, electrical, photochemical. . . . history, or generally, of the whole previous history.

epithelium is not visible in any single section. The appearance of the dorsal motor vagus nucleus is not constant in its most spinal portion, its first appearance is followed frontally by several sections



Phocaena communis fig. 1.
Dorsal motor vagus nucleus.

in which not one cell is to be seen. Spinally from the commencement we see cells at about the same level, and these might be erroneously taken to be cells belonging to the nucleus in question. A careful examination however, shows us that they lie rather more laterally, and further that they are of a somewhat larger type than the vagus cells which first occur. On the same level we can also distinctly see accessorius roots appear, and now and then we find the XI nucleus, with its somewhat larger elements, present at the place where it can be most clearly demonstrated, viz. on the border of anterior and posterior horns. Although only in a few sections, it has been demonstrated here that the XI nucleus may continue medially, i.e. in the direction of the central canal. My experiences in Camelides and in the giraffe have convinced me that the cells just mentioned, spinal from the dorsal motor vagus nucleus, though rather more lateral and somewhat larger, are accessoriuscells and that at this place another portion of the link in the original connection between X and XI nucleus is to be found. I shall return to this point later. The dorsal motor vagus nucleus is still very poorly developed, many sections after its appearance sometimes a few cells are to be seen successively in a horizontal direction, and again they are combined in a small group. Of these groups, which consist of 6—8 cells, it can sometimes be demonstrated that cells of the distinct vagus type have left their place and have shifted in a ventrolateral direction. During the development of the nucleus it remains at first above the groove-like central canal, sometimes distinct commissura cells occur here, so that in this animal, though less developed than in Camelides and even less than in Camelopardalus

giraffe, the two nuclei are connected right and left by a commissural nucleus in a very small region. Sometimes it also grows out laterally and projects over the pointed end of the central canal (fig. 2). Directly spinal from the calamus the nucleus has plainly shrunk in size; it becomes loose in form and its medial pole turns upwards. After this we see a peculiar opening of the canalis centralis. This has already widened to a groove 2.2 mm. in length and in the middle 9.5 mm. broad. Soon the groove deepens pit-like towards the back, and when it breaks through at the back wall of the oblongata it is 1.5 mm. deep and 0.830 mm. wide. The pointed ends of the central canal can still be found in many sections as tapering bulgings of the base of the IV ventricle. The latter, by

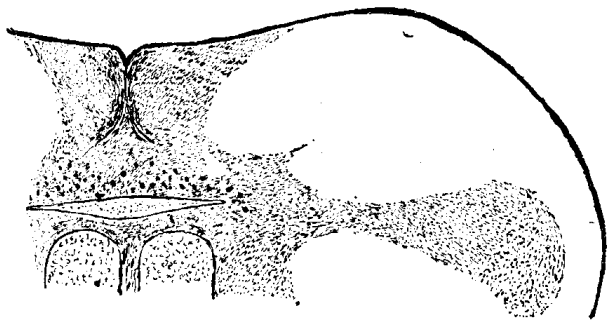


Fig 2. Phocaena communis.
Nucleus motorius commissuralis vagi.

reason of the said conditions in the caudal portion, assume a shape unusual in mammals, as the irregular walls of the deepest part are perpendicular and the base stretches out right and left like a groove (fig. 3). Well developed epithelium is neither present here, and the place of opening is therefore entirely filled with cell-remnants. The dorsal motor vagus nucleus has now grown thicker and has quite turned upwards again; it is strongest in the middle, has crept up against the above-mentioned perpendicular portion of the ventricle wall and soon spreads out with scattered cells in a curve laterally under the ependyma. In a few sections a distinct continuation is to be seen in a ventro-lateral direction, on the significance of which I shall venture shortly to express an opinion (fig. 3). In this region the nucleus contains two types of cells differing in size; it is often loosely built and very different in size, with a maximum of 40 cells. These conditions hold for many sections further frontally. Meanwhile the groove-like continuations of the base of the IV ventricle have grown smaller; soon they disappear, the perpendicular walls keeping their place for some time. The nucleus, especially in the medial portion, has become thicker; it shows at this place a club-like

growth in a medio-ventral direction, which curves dorso-laterally, growing narrower at the same time, after which the whole ends in a point under the ependyma in the direction of the side wall of

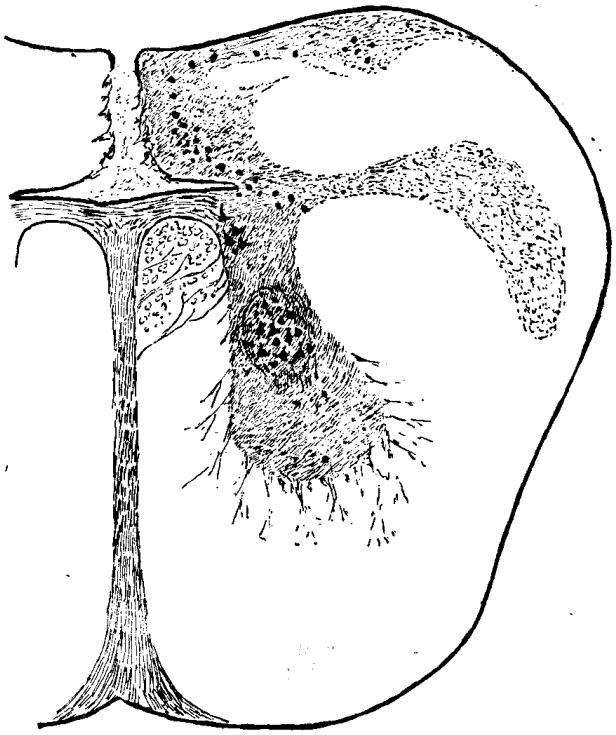


Fig 3. Phocaena communis.

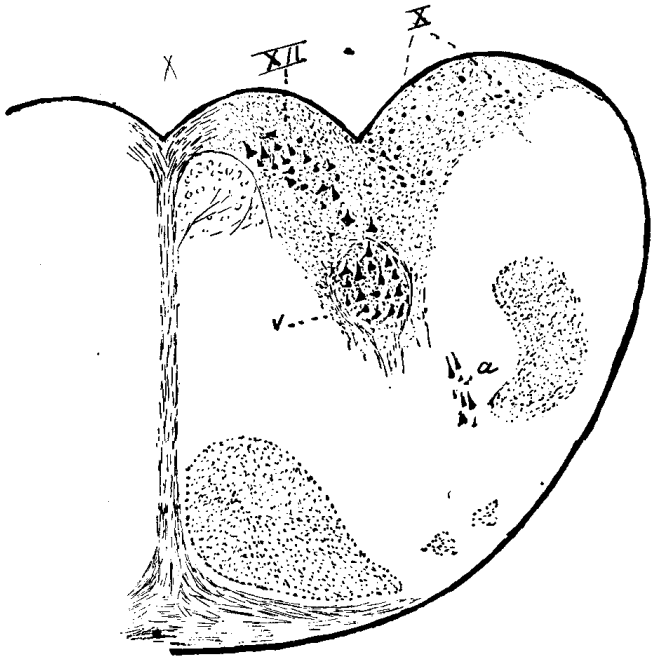


Fig. 4. Phocaena communis.
a. Ambiguus. *v*. Anterior horn.

the oblongata. When most developed this side wall is almost reached (figs. 4, 5, and 6).

The medial out-grown portion frequently shows gaps, so that the number of cells differs greatly in successive sections. Still more so is this the case with the lateral part of the nucleus which in general is also much looser, sometimes we see a more or less horizontally running row of cells, arranged in a double row, then again the row is broken and one or two tiny groups of cells can be seen lying laterally. The maximum number of cells contained by the nucleus is here 100. In this region the base of the IV ventricle is fairly flat, and this can be better seen in a frontal direction. Simultaneously the nucleus stretches itself out, and the medial out-growth and the lateral pointed part of the nucleus come to lie in one line. Further frontally the whole diminishes in size, and very laterally, though even more centrally, there is a small group containing 12—16 cells, sometimes arranged in two rows, which nearly touch the side wall of the oblongata. The cell-type and the occasional occurrence of connecting cells with the main nucleus establish the identity of this group. Of this elongated vagus nucleus the tail-end first disappears and then the dorsal portion of the thickened medial part. Of the rest a more central group of scattered cells remains longest.

Nucleus ambiguus. Of the nucleus ambiguus in Phocaena I have

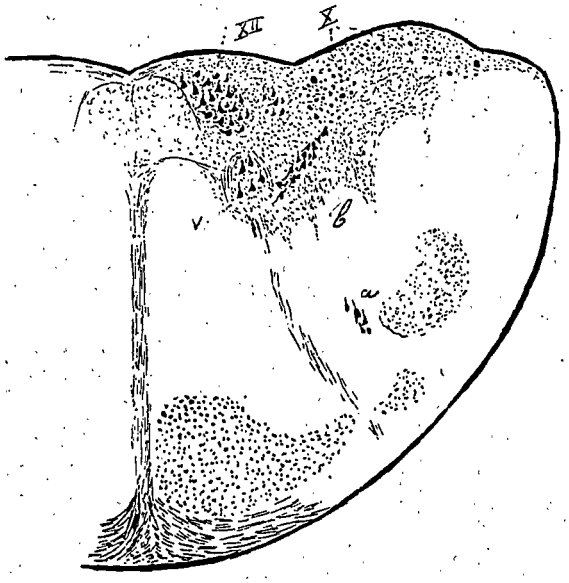


Fig. 5. Phocaena communis.

a. Ambiguus.
b. Connection between anterior horn and dorsal motor vagus nucleus.
v. Anterior horn.

not detected anything before close to the calamus. At this height, as has been mentioned above, we can see how the lateral pole of the nucleus motorius X dorsalis sends out cells in a ventro-lateral direction (fig. 3). Laterally from nucleus XII these cells penetrate downwards. The phenomenon is only to be observed in a few sections spinally and frontally from the calamus, after which the ambiguus, very poorly developed, appears. According my opinion we have here a proof that the nucleus ambiguus originates in the nucleus motorius dorsalis vagi, a theory which has been supported by KAPPERS on phylogenetic and ontogenetic grounds, and demonstrated by schemata in his work: "Weitere Mitteilungen uber Neurobiotaxis. VII. Die phylogenetische Entwicklung der motorischen Wurzelkerne in Oblongata und Mittelhirn, Folia neurobiologica. Bnd. VI. 1912." Throughout scores of sections the ambiguus is still poorly developed, and

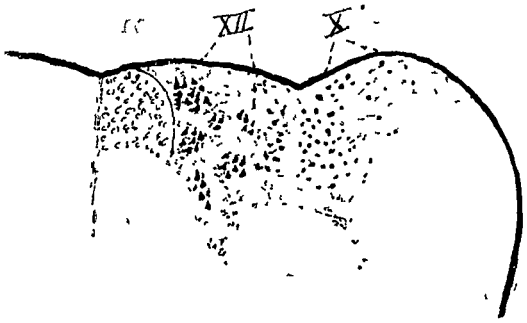


Fig. 6. Phocaena communis.

only rarely it contains as many as 8, 10 or at the most 12 cells. Frequently we see a few cells perpendicularly under each other. Rather more frontally the development improves, and occasionally as many as 24 cells can be counted in two or three groups perpendicularly above each other. Then follow many sections in which we fairly constantly find 10—12 cells, after which a stronger development again commences at the place where the tongue nucleus is quite separate from the cervical grey matter. We then see two groups lying one above the other, the dorsal one containing not more than 8, and the ventral one at the most 15 cells; sometimes the dorsal group projects somewhat laterally. This order is repeated. In an entire series of sections practically nothing whatever is to be seen of the nucleus, after which a gradual development follows, when it begins to appear in several groups.

Frequently we then see one dorsal, one ventro-lateral and one ventro-medial group, in other cases only one or two of these groups. At the frontal pole of nucleus XII the frontal outgrowth has already

commenced. Very soon this consists of a complex of 75 rather scattered cells which increase in number, after which the nucleus here too frequently divides into two groups, a lateral one and a medial one. The lateral group contains the largest number of cells and the cell type is larger than that of the medial group. This medial group is of varying size, diminishes, sometimes disappears, to reappear again and increase. We can clearly see cells from the lateral group entering a more ventral level. The medial group disappears for good, the lateral one decreases rapidly, and then gradually becomes larger again. On a closer examination, however, it will appear to have then reached the facialis region.

In Phocaena the ambiguus passes directly into the nucleus facialis The frontal pole of the ambiguus in this animal may be considered to extend in this series about 90 sections frontally from the nucleus motorius dorsalis vagi (fig. 7).

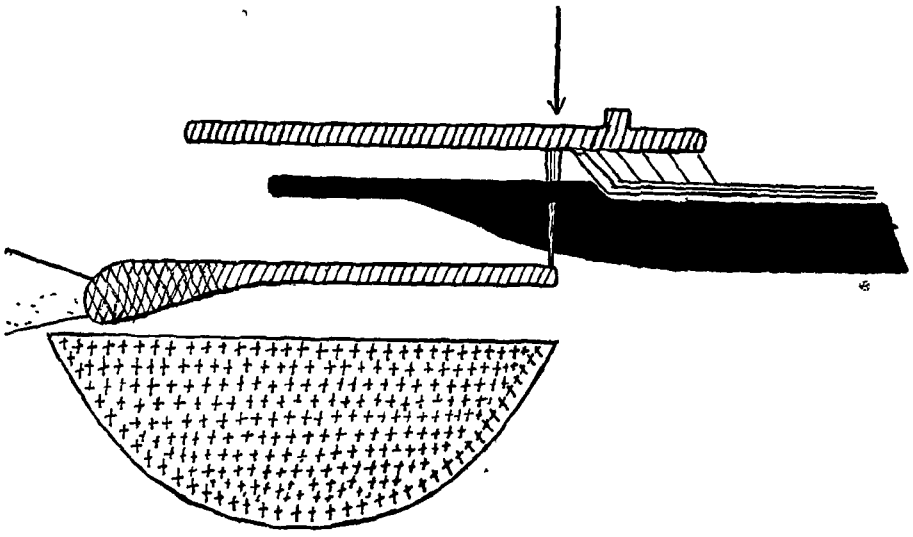


Fig. 7. Phocaena communis.

EXPLANATION OF THE MARKS:

↓ = calamus, = oliva inferior, = Nucl. IX, = Nucl. X, = Nucl- XI, = Nucl. XII + Cervicale I, = connection between X dorsalis and X ventralis, = Nucl. VII.

Nucleus hypoglossi. The direct transition of the motor cervical column into the tongue nucleus is very distinctly seen in Phocaena (fig. 4 and 7). In the vicinity of the calamus we see that the

large cells of the anterior horn, which has meanwhile grown much shorter, have united into an oval-shaped complex which is surrounded by a fibre system. At the calamus a few cells have left the complex and now lie under the lateral point of the newly opened central canal · (fig. 3). Somewhat frontally from the calamus no traces of similar XII cells are to be seen, but they very speedily reappear and in a few sections the direct connection between the tongue nucleus and the cervical anterior horn gray matter is quite plain (fig. 4). There are then 12—18 large XII cells to be seen laterally under the base of the IV ventricle, under that the remains of the anterior horn still well developed and clearly defined, and between are the connecting cells. The separation of tongue nucleus from the cervical gray matter is evidently difficult, for about 100 sections frontally from the calamus a small group of anterior horn cells can still be observed ventrally from XII.

The cells in this group are larger than XII. cells, and the group also shows distinct remains of the surrounding fibre-system (fig. 5). Even when it has broken up, distinct anterior horn cells are still found in the immediate neighbourhood of the ventral pole of nucleus XII. A remarkable phenomenon presents itself here Laterally from the anterior horn rest a cell group occurs, which develops in the direction of the nucleus motorius dorsalis vagi. It varies in strength and exhibits the cell type of the tongue nucleus, sometimes we see a few cells and again an elongated group of 25—28 cells. In several groups there is an actual bridge between the rest of anterior horn and vagus nucleus (fig. 5).

As regards the development of the tongue nucleus itself, we see the medial portion appear first, in the angle between the ventricle base and the fasc. long. posterior. As long as the rest of the anterior horn is still present, this group is well developed, it is rather crowded and contains cells which are but slightly smaller than the anterior horn cells. This medial group grows out in a lateral direction under the ependyma and simultaneously some cells of a smaller type belonging to the ventral group make their appearance, they can be easily recognised owing to the remarkable difference in size from the few front horn cells still present in their immediate vicinity. Very soon the ventral pole strengthens and then forms a whole with the cell group which has already developed in a dorsolateral direction to such a degree as to form a direct connection at that place between the cervical grey matter and X. dorsalis. In the same preparations we see that cells of smaller type have appeared between the lateral portion of the tongue nucleus and the adjacent vagus

nucleus (nucleus intermedius?) The whole tongue nucleus has now become triangular, with the base towards the ependyma; the ventral pole then contains the smallest cells, except for a few lying medially which have distinctly kept the anterior horn type. We now see repeatedly a clear division into 3 groups, a medio-dorsal, a latero-dorsal and a ventral group; the whole may contain as many as 80 cells. The cells between tongue and vagus nucleus are often so numerous that they quite connect the two nuclei. Further frontally the whole diminishes owing to all the groups becoming looser in construction; the bridge which had meanwhile disappeared between the *ventral* pole of XII and the vagus nucleus again makes its appearance, though in a less degree, and soon the tongue nucleus arranges itself in several small groups, 4, 5 and occasionally even 6 separate groups appearing. In the same region the connecting link between XII and X dorsalis is again complete (fig. 6). Now the ventral portion disappears, and we see the rest of the nucleus divide again into a medial and a lateral portion, the lateral portion with large cells and the most strongly developed. Then the medial portion disappears, and finally the lateral. When the medial has disappeared, a few cells of the ventral pole again make their appearance in some sections.

Nucleus accessorii. It is a very remarkable feature in Phocaena that the accessorius nucleus can be traced frontally to *within a few sections spinally from the calamus.* There it can be seen, though very poorly developed, with usually no more than 2 or 3 cells, at the place most clearly to be defined, viz. on the lateral border of anterior and posterior horns. Its efferent roots follow the much curved posterior edge of the posterior horn. In some sections, in which nucleus XI is present, the direct connection with the nucleus motorius X dorsalis can be observed. This takes place with but a few cells and can also be demonstrated repeatedly in more spinal regions (fig. 8). There we can frequently see the XI nucleus also at the above-mentioned place and likewise how it spreads in ventro-lateral direction, along the dorso-lateral edge of the anterior horn. At other places, on the contrary, it spreads along the lower edge of the posterior horn, and contains then 8—10 cells of a fairly small type. Frequently we see ventro-laterally from the posterior horn a separate cell group of the XI nucleus with 8—10 cells, and also radiations of it in the direction of the medial group at the well-known place. The efferent XI root runs beneath the former group. Here, too, connecting cells are to be seen from the medial group to X. dorsalis

(fig. 8). As usual the XI nucleus disappears and reappears periodically. In this region several sharply outlined longitudinally running bundles have appeared in the middle-horn and also ventrally from it. These are stronger in a spinal direction, and in some of the sections have driven the medial group of XI cells, on the border of anterior and posterior horns, somewhat upwards, i.e. in the direction of the lateral group of XI cells, lying near the latero-caudal edge of the posterior horn. Since, further spinally behind the spinal pole of X dorsalis, the posterior horn turns much upwards, the lateral

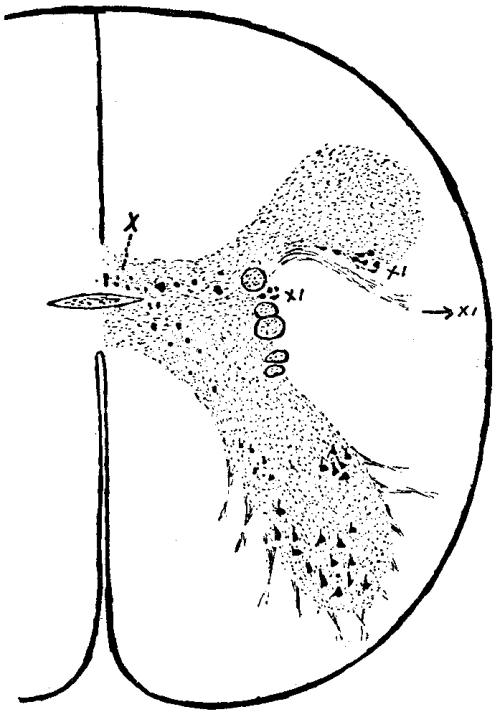


Fig. 8. Phocaena communis.

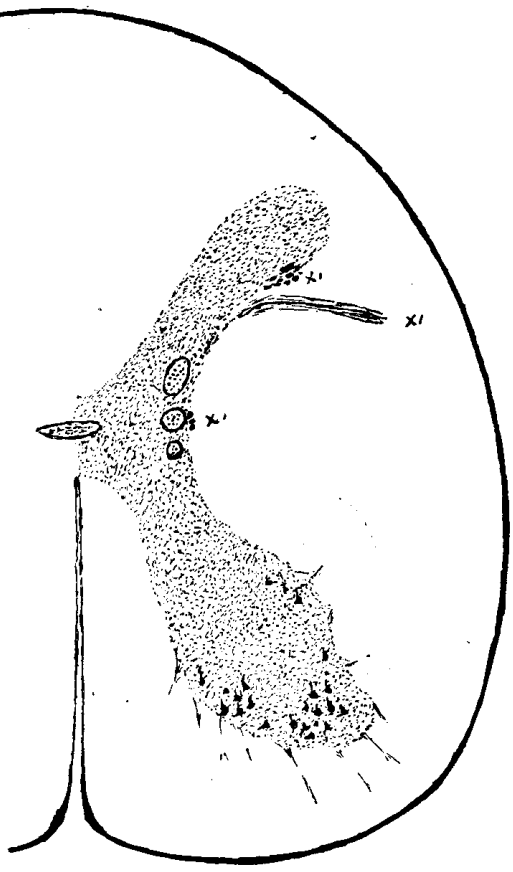


Fig. 9. Phocaena communis.

group of the accessorius nucleus diverges more and more from the medial group, and as the efferent XI roots continue to follow the posterior horn, we see these in this level arise in a region lying more dorsally than frontally (fig. 9).

Of the XI nucleus of Phocaena cells are thus to be observed:

a. On the border of anterior and posterior horns,

b. medially, in the direction of, and in connection with X dorsalis,

c. ventrally from it, along the dorso-lateral edge of the anterior horn,

d. very lateral, near the latero-caudal border of the posterior horn.

The opinion that these last cell-groups lying latero-dorsally belong to nucleus XI I base upon the following considerations:

1. The cells are of the same type.

2. They occur periodically, like the medial nucleus group at the well-known place.

3. They send out distinct continuations near the calamus, in the direction of the medial group.

4. The efferent XI roots follow the shiftings of these latero-dorsal groups, which shiftings have to do with the position of the posterior horn, which is pointed the most upwards spinally.

The XI nucleus in Phocaena in general has relatively small cells and is poorly developed at most places.

The oliva inferior of the porpoise commences immediately behind the calamus and continues frontally as far as into the region of the nucleus facialis. It is particularly well developed, commences with small cells at the base of the raphé, and immediately grows out parallel to the front wall of the oblongata. Very soon it becomes thicker, the cell type becomes larger, and cells of the same type appear in the raphé (I of fig. 10).Rather more frontally a second, quite independent, group appears, just below the surface, much smaller and quite lateral from the former group. The medial portion grows rapidly and stretches laterally in a point, thus following the frontal wall of the oblongata; the middle olive likewise becomes thicker, and the lateral portion remains relatively small. Very speedily a third small group appears laterally (II of fig. 10). The large medial portion is at first separated from the frontal wall by arc-fibres which issue from the raphé. This fibre system grows much stronger, and in it we see a new group appear, again independent of other groups.

The middle olive above-mentioned has disappeared, now however, in the ventral portion of the raphé, cells appear which rapidly increase in number right and left in the heavy arc-fibre system ventrally from the medial olive. This increase is so rapid that a dorsal and a ventral medial olive can soon be distinguished (III of fig. 10). The raphé cells have then disappeared. Now the lateral portions of the large complex diminish, the dorso-medial olive likewise grows poorer, while the ventro-medial portion, on the contrary, grows heavier and heavier. It bends dorsally in a strongly lateral curve, ventrally it follows, also in a curve, the frontal wall of the oblongata, so that the whole has the appearance at this place of a gigantic comma. The dorso-medial portion has then greatly decreased.

Meanwhile a new group has appeared laterally from the dorso-medial portion, and medially from the efferent hypoglossus root (IV of fig. 10), it becomes stronger and spreads ventro-laterally so that many XII bundles pass through it lengthwise; the dorso-medial portion, originally so heavy, has all but disappeared, the ventro-medial turns pronouncedly upwards and has so spread on the lateral side as to lose its comma-like shape (V of fig. 10). Likewise the portions situated laterally

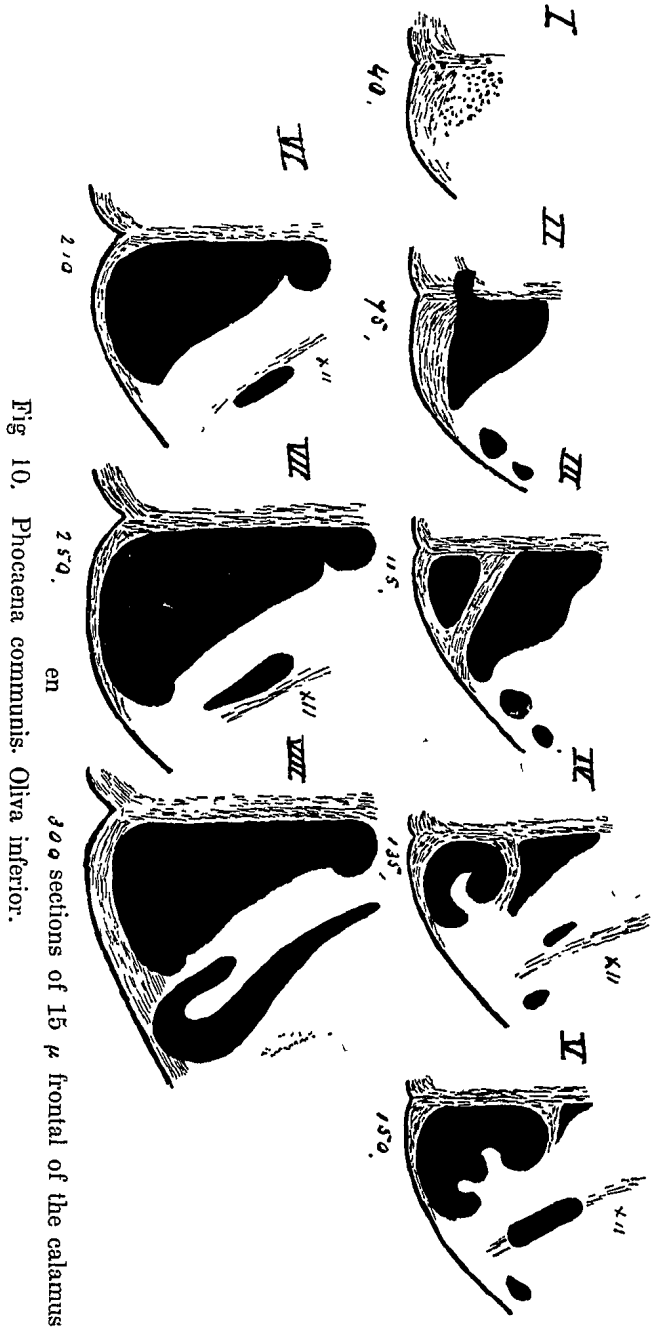


Fig 10. Phocaena communis. Oliva inferior. 300 sections of 15 μ frontal of the calamus en

have grown smaller and disappear by degrees. In the following stage the dorso-medial portion of the olive is entirely gone, the ventro-medial, on the contrary, is particularly powerfully developed and much turned upwards (VI of fig. 10). The portion through which the XII roots now make their way shrinks and also disappears. Soon after, however, while the ventro-medial portion is becoming heavier, we see a new group appear, also medially from the efferent hypoglossus root (VII of fig. 10). This group also develops rapidly, first in a ventro-lateral direction, after which it takes a hook-like bend near the frontal wall of the oblongata. The original lamella of this group grows up so high that its top reaches the level of the main mass lying medially. The latter is now particularly well developed, except that at the base it is not so broad as before (VIII of fig. 10). The medial lamella of the last group also grows upwards though not to such an extent as the lateral one. After this the whole complex diminishes. The medial main mass remains the largest and longest, till finally this also shrinks rapidly and disappears in a few sections. For reference I have given in Fig. 10 under each diagram the number of sections frontally from the calamus, with the indication of the place of which the diagram is made.

In several mammals a strong development of the oliva inferior is accompanied by a slight development of the nucleus reticularis inferior. As might be expected therefore, this reticular nucleus in the porpoise proves to be very poor considering the great size of the olive inferior. Simultaneously with the olive, and ventrally from the radix descendent V, a group of cells appears which for reticular elements are small. With the appearance of the ventro-medial olive, small raphé cells make their appearance in the dorsal portion of the raphé, and we also see directly dorsal from the dorso-medial olive a small-cellular nucleus. Further frontally several smaller groups of reticular cells occur very inconstantly in the substantia reticularis. Only the ventro-lateral portion extends in an upward direction towards the side wall of the oblongata, all the rest remains poorly developed and frequently inconstant. With the olive the elements of the reticularis group also disappear.

The considerable development in Phocaena communis of the dorsal motor vagus nucleus and its extension with the commissural nucleus has to do with the size and the construction of the stomach in this animal. (MAX WEBER, Studien uber Säugetiere. Ein Beitrag zur Frage nach dem Ursprung der Cetaceen; idem Anatomisches über Cetaceen,

morphologisches Jahrbuch. Bnd. XIII; S. A. ARENDSEN HEIN, Contributions to the anatomy of Monodon Monoceros, Verhandelingen van de Kon. Akad. v. Wetensch. te Amsterdam. 2de Sectie, Deel XVIII. N°. 3—4). Although Cetaceans do not ruminate, their stomach, like that of ruminant animals, consists of several divisions (in Phocaena four). In many, including Phocaena, the first only, like the oesophagus, has cutaneous, glandless mucous membrane, the other divisions are very rich in glands. The fact that in ruminants this nucleus is much better developed in comparison is undoubtedly to be ascribed to the fact that the musculature of some divisions of the stomach, e.g. that for the process of chewing the cud, is stronger than in Cetaceans.

As regards the absence of the nucleus ambiguus spinally from the calamus I wish firstly to remark that in general the bulbar motor centra in question stretch but slightly spinally from the calamus, and in the second place to point out that in Phocaena the nucleus crico-arytaenoideus lateralis, which is innervated by the nervus recurrens, is lacking (WEBER, see above). The strong pharynx musculature and the considerable development of the musculus thyroideus (see above works), explain the extensive development of the frontal part of the nucleus ambiguus, the motor IX nucleus. The continuation of this with nucleus VII, which in mammals has been demonstrated for a part in the dog, is otherwise a phenomenon also met with in reptiles and many fishes (KAPPERS).

In no mammal, so far as I know, has the tongue nucleus preserved such a pronounced bird-type as in porpoises. Whereas I was able to show the connection between nucleus XII and the cervical grey matter in Camelides and Camelopardalus giraffe spinally from the calamus, in the porpoise only the frontal half of the tongue nucleus is free, and only there is it at the place where we know it to be in other mammals, viz. laterally from the fasc. long. pos., directly below the ependyma. Its spinal half, which is joined to the cervical grey matter, thereby lies in a more ventral level than in other mammals. This phenomenon is explained by the fact that Cetaceans have no organ of taste, or at least a very poorly developed one. The sense of taste in mammals is largely localised in the taste buds of the tongue. RAWITZ has demonstrated that taste-buds are even entirely wanting on the tongue of Delphinus Delphis. (Beiträge zur mikroskopischen Anatomie der Cetaceans II, Ueber die Zunge von Delphinus Delphis, Internationale Monatschrift für Anatomie und Physiologie. Bnd. XX 1903). In most mammals it has worked itself quite free from the cervical grey matter neurobiotactically in a more fronto-

dorsal region thus reaching the sensory centra which control the taste. Where this tendency is not evinced, or but slightly, the XII nucleus has comparatively kept its original connection, and is still wholly or partially connected with the motor cervical grey matter of which it is the direct continuation. For this reason it lies in such animals more spinally and more ventrally than in animals with a finer sense of taste where, in obedience to neurobiotactic influences, it has had to separate from the cervical grey matter in order to shift in a fronto-dorsal direction. The connection of the frontal remnant of the cervical grey matter with the nucleus motorius dorsalis X, which in Phocaena occurs throughout a small extent but nevertheless very distinctly, is likewise a primitive phenomenon which has been described by KAPPERS in the Alligator and in Birds, and I have observed it to a slight degree and in a more caudal region in the giraffe.

After the extremely strong development of the oliva inferior, its late appearance, not until near the calamus in the porpoise, is remarkable.

CONCLUSIONS.

1. In Phocaena the dorsal motor vagus nucleus spreads out only through a small portion, not more than $^2/_7$, spinally from the calamus. In this portion the nucleus is poorly developed, at first it does not even occur constantly. In the same region an equally poorly developed commissural vagus nucleus occurs. As far as the immediate vicinity of the calamus its direct connection with nucleus XI can be repeatedly demonstrated. At the time of its greatest development it is club-shaped, the broadened portion is directed medially; the tail running under the ependyma may even nearly reach the side wall of the oblongata. This tail, frequently loosely built, often breaks up into different cell groups. The cells, to a maximum number in each section of 100, are of two types and different in size.

2. Of the nucleus ambiguus not a trace is to be seen spinally from the calamus, though in sections spinally and frontally from the calamus before its appearance distinct radiations can be seen from the dorsal motor vagus nucleus in a ventro-lateral direction, which in my opinion confirms KAPPERS' theory that in mammals at least the ambiguus is a splitting of the dorsal motor vagus nucleus. The frontal extremity of the ambiguus in Phocaena is very large, and begins at the frontal pole of the tongue nucleus; it passes directly over into the nucleus facialis.

3. The nucleus hypoglossi in Phocaena is throughout the half of its extent joined to the ventral cervical grey matter, and consequently lies as far as its spinal half is concerned, in a more ventral region than in other mammals. In the frontal portion of this connection a cell group appears, lateral from the anterior horn rest, which in several sections is very distinctly connected with the dorsal motor vagus nucleus. Likewise the connecting nucleus between this vagus nucleus and the tongue nucleus (nucleus intermedius?) is in many places well developed. The free tongue nucleus is grouped into three, and more frontally into as many as six, groups of cells.

4. As far as the immediate vicinity of the calamus, efferent accessorius roots can be observed. The XI nucleus in general is poorly developed, and only exceptionally does it contain 8—10 cells. The cells are of a small type. Until near the calamus it can be met with in the angle between the anterior and posterior horns; spinally it may radiate from here in a medial direction (connection with X dorsalis), along the dorso-lateral edge of the frontal horn, i. e. in a ventro-lateral direction and upwards along the lower edge of the posterior horn. A separate cell group of it is repeatedly to be observed at the caudo-ventral angle of the posterior horn.

5. The oliva inferior appears very late, viz. near the calamus; it spreads very far frontally however into the facialis region. It is extraordinarily developed. In its development several groups appear quite independently of each other. First next the raphé a portion develops ventrally, which grows out rapidly and is connected at first for a small distance through the raphé with the corresponding portion of the other side. After this a second portion appears ventrally from the first, and is also at first connected with that of the other side by an intermediate olive. This second portion develops very strongly, and pushes the first-mentioned upwards, whereby the latter gradually shrinks, and finally disappears before the part lying distally has attained its greatest development. These parts form together the *medial* olive. As a third group of cells there appears in the frontal third portion of the last-mentioned, and laterally from it, a complex consisting of two lamella, a short medial one and a long lateral one. This corresponds with the *principal* olive. Besides these three main groups, several smaller ones appear from the beginning, but also later, invariably in the lateral regions, and remain a longer or shorter time. Their identification is not sure.

6. The nucleus reticularis inferior contains small cells and is poorly developed.