

XXII. *On the Mammary Glands of the Ornithorhynchus paradoxus.* By
 Mr. RICHARD OWEN. Communicated by J. H. GREEN, Esq. F.R.S.

Read June 21, 1832.

THE extraordinary nature of the monotrematous quadrupeds of Australia cannot be illustrated more forcibly than by observing that it is still doubtful to what class of animals they properly belong. In the confines of the animal kingdom, it is less surprising that a species should occasionally be discovered, either so devoid of external character, or of a form so strange, as to occasion a difficulty in ascertaining its class; and an Entozoon, a Lernæa, or an aggregate species of Salpa may require very minute investigation in order to determine its relation even to the most comprehensive division of a methodical arrangement. But the same difficulty occurring with respect to a hairy quadruped, affords one of the most unexpected, as well as interesting problems in natural history, and renders acceptable the smallest addition to the series of facts already ascertained respecting so anomalous a creature.

In this country we can hardly hope to throw light upon the economy of Ornithorhynchus and Echidna, except by the way of anatomy; at least, the aquatic habits of the former species render it improbable that it will ever be brought alive to our menageries. But the same objection does not apply to the spiny ant-eater, and it is to this animal therefore that the attention of voyagers from New South Wales should be more especially directed with a view of importation.

It is well known that one of the points now at issue with respect to these animals, is the nature of certain glandular organs which they possess, which are supposed to appertain to the mammary system: and it is obvious that our knowledge of the true affinities of the Monotremata greatly depends on a complete elucidation of this subject. To it, therefore, my attention has been particularly directed whenever an opportunity has occurred of examining the *Ornithorhynchus paradoxus*; and I have invariably noted the condition of

MDCCCXXXII.

3 x

the uterine organs with reference to that of the glands in question. In this way a series of facts has been ascertained, which I have ventured, from the interest of the subject to which they relate, to submit to this learned Society. But as the value of these observations, in a great measure, arises out of the state of doubt in which the question was left by previous researches, I have premised a short abstract of the anatomical history of the Monotremata.

Echidna Hystrix and *Ornithorhynchus paradoxus* were first described and figured by Dr. SHAW; the former, as early as the year 1792, in the third volume of the "Naturalist's Miscellany," under the denomination of *Myrmecophaga aculeata*; the latter, in the tenth volume of the same work, in 1799, by the name of *Platypus anatinus*. In the following year this extraordinary animal received a further description, together with its present generally adopted appellation, from Professor BLUMENBACH; and about the same time, Sir EVERARD (then Mr.) HOME gave an account of some of its anatomical peculiarities, which appeared in the Philosophical Transactions for the year 1800. As these observations however were limited to the head and beak of the *Ornithorhynchus*, they threw but little additional light on the situation of that animal in the natural series. In the meanwhile, Professor BLUMENBACH placed the *Ornithorhynchus* among the Palmata of his system of natural history, intermediate to the otter and the walruss; while Dr. SHAW more correctly referred it to the Bruta of LINNÆUS; and, although limited to such traces of affinity as the outward form alone presented, he announced the alliance of this species, as well as of the *Echidna*, to the *Myrmecophagæ*.

The important memoirs on the anatomical structure of both these animals by Sir EVERARD HOME, which were read before the Royal Society, and published in the Philosophical Transactions for 1802, drew the attention of the scientific world more strongly towards their remarkable peculiarities and deviations from the normal type of the Mammalia. In these investigations, the author, having brought to light numerous instances of mutual affinities before concealed beneath very dissimilar exteriors, grouped the two animals together under the same generic appellation. He also announced his opinion that they differed considerably in their mode of generation from the true Mammalia, grounding his belief on the peculiarities of the organs themselves, and on the absence of nipples in both species, and especially in the female of the *Ornithorhynchus paradoxus*.

The opinion of Sir EVERARD HOME was soon after adopted by Professor GEOFFROY ST. HILAIRE, who, in the *Bulletin de la Société Philomathique*, tom. iii. p. 225, constituted a new order for these animals under the term "Monotrêmes," being induced to believe, from an imperfect dissection, that the genital products of both sexes, as well as the urine and excrement, were voided by a common outlet*. Concluding also by inference that the mammary glands as well as nipples were wanting, and strengthened in his belief of the oviparous nature of the Monotremata, by some accounts from New South Wales of the discovery of the eggs of the Ornithorhynchus†, he subsequently separated the monotrematous animals altogether from the Mammalia, and characterized them as a class intermediate to Quadrupeds and Birds. (*Bulletin de la Société Philomathique*, tom. viii. p. 95.—*Annales des Sciences Nat.* xviii. p. 164.) The same idea had previously been entertained by LAMARCK, (*Philosophie Anatomique*, 8vo, tom. i. pp. 145, 342); and by VAN DER HOEVEN, (*Nova Acta Physico-medica Acad. Nat. Cur.* tom. xi. Part. II. p. 368). But with these naturalists also the proposed dismemberment was founded principally on the presumed absence of mammary organs, unsupported by any additional facts relative to the internal anatomy of the species in question.

This mode of viewing the Monotremata was not, therefore, generally assented to. Possessing so many peculiarities of structure, these animals could not fail of attracting due attention from the immortal CUVIER. With his usual sagacity, he had very early perceived the true nature of the relation in which the *Myrmecophaga aculeata* of SHAW stood to the genus it was then placed in, and accordingly in the "Tableau Elementaire de l'Histoire Naturelle," (1797,) he separated it from the true ant-eaters, under the denomination of Echidna. He subsequently made considerable additions to the anatomical history of this species as well as to that of the Ornithorhynchus, acknowledged their mutual relations, and adopted the collective term pro-

* See on the contrary the description of the male organs of the Ornithorhynchus, by Dr. KNOX, in the fifth volume of the *Wernerian Transactions*, p. 152, where Sir EVERARD HOME's account of the passage of the seminal fluid by a distinct channel through the penis is confirmed.

† See Mr. HILL's Letter in the thirteenth volume of the *Linnean Transactions*, inserted in the *Mém. du Museum*, tom. xv. p. 622: and that of Professor GRANT in the eighteenth volume of the *Annales des Sciences Naturelles*, p. 161.

posed by Professor GEOFFROY, but admitted it in the Règne Animal, as indicative of a tribe or family only, in his order Edentata.

OKEN and DE BLAINVILLE more decidedly opposed the opinion of GEOFFROY. The former naturalist even went so far as to hazard a conjecture respecting the mammary glands, and suspects that they will be found in the Cloaca, (Zoologie, tom. ii. p. 957); and M. DE BLAINVILLE, in a dissertation on the place which the Ornithorhynchus and Echidna ought to hold in the natural series, after adducing the numerous instances in which the structure of the Monotremata agrees with that of the Mammalia, also expresses his belief that the mammary organs will ultimately be detected, and is of opinion that the animals themselves are most closely allied to the Marsupial order. Lastly, Professor MECKEL, of Halle, announced in FRORIEP's Notizen, (Band vi. p. 144. 1824.) and subsequently in his excellent monograph on *Ornithorhynchus paradoxus*, (folio, Lipsiæ, 1826,) the existence of mammary glands largely developed in the female of that species*. In the latter work he accurately describes their situation, magnitude, form, and lobular composition. The tissue of the lobules he regards as consisting of closely aggregated tubes. Being unable to inject the gland, he is uncertain as to the precise mode in which the ducts terminate; but describes some small eminences, situated in the middle of the areola, as being undoubtedly orifices of the ducts.

From this most important example of the affinity of the Ornithorhynchus to the ordinary Mammalia, Professor MECKEL is, however, far from drawing conclusions as to the identity of their mode of generation. For observing, "that the difference between the bringing forth of living young and of eggs is really very small, and by no means of an essential nature,—that birds have accidentally hatched the egg within the abdomen, and so produced a living foetus,—an occurrence which has also been induced by direct experiment†,—and that, lastly, the generation of the marsupial animals is very similar to the oviparous mode," he deems it "very probable that, as the Ornithorhynchus

* This description has been translated into the French language and published by DE BLAINVILLE in the Bulletin de la Société Philomathique, tom. ix. p. 138: and into our own language by the Editor of the second edition of LAWRENCE's translation of BLUMENBACH's Comparative Anatomy.

† Probably in allusion to the Experiences sur la Génération des Animaux Ovipares, par M. ROSSI, Mém. de l'Acad. de Turin, 1779, p. 266.

approaches still nearer than the Marsupiatæ to Birds and Reptiles, its mode of generation may be in a proportionate degree analogous*.”

For an animal possessing mammary glands he claims, however, the right to rank with the Mammalia ; and accords with Professor GEOFFROY only so far as to consider the Monotremata a distinct order of quadrupeds, which he places, as in the system of CUVIER, next to the Edentata.

Notwithstanding the authentic and circumstantial manner in which this discovery was given to the world, it has been by no means universally regarded as conclusive with respect to the mammiferous nature of the Monotremata. Professor GEOFFROY, having subsequently had an opportunity of dissecting a female Ornithorhynchus, and of verifying in some measure the description above quoted, has more especially endeavoured to invalidate the inferences drawn from it. He urges †, that the subcutaneous abdominal glands considered by MECKEL as mammary, possess none of the characters of a true mammary gland;—that he examined them with the greatest attention, comparing them with the human mammary glands, and especially with those of marsupial animals, and that they were of a totally different texture (*tissu*), consisting of a vast number of cæcums placed side by side, all directed to the same point of the skin, where only two excretory orifices were to be perceived, and these orifices so small, that the head of the smallest pin could not be made to enter them ;—that, above all, there was no trace of nipples ;—that in the specimen he examined, which had the size and appearance of an adult female Ornithorhynchus, the apparatus in question was not more than a fourth part of the size of that observed by MECKEL. But a mammary gland, he further observes, when arrived at its full development, occasions an enlargement of all its constituent parts, the nipple acquiring additional bulk even before lactation commences, while nothing of the kind has been noticed in the Ornithorhynchus. He considers them, therefore, as being analogous rather to those glands for the secretion of a lubricating fluid, that are disposed along the flanks of the aquatic reptiles and fishes ; or to the odoriferous follicles of quadrupeds, and especially to those which are found on the sides of the abdomen in shrews. To these objections Professor MECKEL has re-

* Ornithorhynchi paradoxi Anatome, fol. p. 58.

† Annales des Sciences Naturelles, tom. ix. p. 457.

plied in his *Archiv für Anatomie und Physiologie*, B. x. p. 23; where, after combating the arguments drawn by Professor GEOFFROY from the supposed follicular structure of the glands and the absence of a nipple, he particularly urges the great difference of size which the glands presented in the two females examined, and also their total absence in the male,—both which circumstances he considers as strongly corroborative of his original opinion. In the same work (B. x. p. 568,) Professor V. BAER, in support of the opinion of MECKEL, adduces the example of a mammary gland analogous in simplicity of structure to that of the *Ornithorhynchus*, viz. in the *Cetacea*, where its function has never been questioned. But as no additional particulars relative to the structure of the glands in the *Ornithorhynchus* have arisen out of this discussion, I shall not dwell further on the arguments used by these celebrated anatomists, but proceed to give the results of my own investigations relative to this subject.

In five apparently adult and full-grown *Ornithorhynchi* examined by me, the mammary glands presented as many different degrees of development. In one of the specimens they were even larger than in that dissected by MECKEL, measuring in length respectively five inches and a half, in breadth two inches, and in thickness from four to five lines. In another specimen they did not exceed one inch and a half in length, and were only five lines in breadth, and half a line in thickness. In the remainder the mammary glands were of intermediate sizes to the two above mentioned.

In each specimen the gland was composed of from one hundred and fifty to two hundred elongated subcylindrical lobes, disposed in an oblong flattened mass, and converging to a small oval areola in the abdominal integument, which areola is situated between three and four inches anterior to the cloaca, and about one inch from the mesial line. The lobes in the smaller glands preserve the same breadth to near their points of insertion, but in the larger ones they are broadest at the free extremity, measuring three or four lines across, and become narrower to about one third from the point of insertion, where they end in slender ducts. The lobes are almost all situated to the outer side of the areola, and consequently converge towards the mesial line of the body.

Between the glands and the integument the panniculus carnosus is interposed, closely adhering to the latter, but connected with the glands by loose

cellular membrane. This muscle is here nearly a line in thickness; its fibres are longitudinal, and, separating, leave an elliptical space for the passage of the ducts of the gland to the areola. (Pl. XVIII. fig. 1.)

On the external surface of the skin the areola (when the hair with which it is covered has been removed,) can only be distinguished by the larger size of the orifices of the ducts as compared with those for the transmission of the hairs, and occasionally by being of a deeper colour than the surrounding integument. The orifices of the ducts thus grouped together form an oval spot, which in the specimen which had the largest glands measured five lines in the long, and three in the short diameter. In that in which the glands exhibited the smallest size, the areola could be traced by the aid of a lens to nearly the same extent in the long diameter, but it was much narrower. From the minuteness of the orifices of the ducts in the specimens with the small glands, the situation of the areola can hardly be detected without previously dissecting the gland; whilst in those in which the glands are fully developed, the practised eye readily discovers the areola on removing the hair. In none of the specimens was the surface on which the ducts terminated in the slightest degree raised beyond the level of the surrounding integument; the elevation like a millet-seed in Professor MECKEL's specimen I conceive to have been accidental, and not essential to the structure of the part, having observed similar risings in the integument at different distances from the areola, but not in the areola itself. The orifices, moreover, appear of nearly equal sizes, not any of them at least being calculated to suggest the idea of its being common to many ducts or lobules, as might be inferred from the description of Professor GEOFFROY. (The appearance which one of the areolæ presented under the microscope is represented at Pl. XVIII. fig. 2.) On compressing the glands in a specimen in the Museum of the Zoological Society, where they had arrived at the maximum of development, there escaped from these orifices minute drops of a yellowish oil, which afforded neither perceptible taste nor smell, except such as was derived from the preserving liquor.

Having in vain attempted to insert the smallest absorbent pipe into these orifices, I thrust it into the extremity of a lobule, and after a few unsuccessful efforts at length perceived the mercury gradually diffusing itself in minute globules through the parenchyma of the lobule; and at the distance of an

inch from the place of insertion it had evidently entered a central duct, down which it freely ran to the areola, where it escaped externally from one of the minute orifices just described. This process was repeated on most of the lobes with similar results; the greater part of them terminated by a single duct opening exteriorly, distinct from the rest; but in a few instances the ducts of two contiguous lobules united into one, and in these cases the mercury returned by the anastomosing duct, when the common one was tied up, and penetrated the substance of the other lobule as freely as that into which the pipe had been inserted.

Some of the lobules injected by the reflux of the mercury through the anastomosing duct were dried, and various sections were submitted to microscopical examination. At the greater end the lobules are minutely cellular; these cells become elongated towards the centre of the lobule, and as it grows narrower, form minute tubes which tend towards, and terminate in a larger central canal, or receptacle, from which the excretory duct is continued. When uninjected, the entire lobule might be readily supposed to be composed of minute tubes; but it is difficult to imagine how the lobules can have been considered as hollow cæcums or elongated follicles. On making a section of the corium through the middle of the areola, the ducts were seen to converge in a slight degree towards the external surface; but there was no trace of an inverted or concealed nipple, as has been observed in the kangaroo. (Fig. 5. Pl. XVIII. represents a magnified view of this section, with a section of one of the dried and injected lobules.)

The next stage of the inquiry was the examination of the ovary and other organs of generation in the specimens which had presented such a diversity of size in the mammary glands; and as they exhibited in these dissections corresponding differences of development, the following account of the structure of the uterine organs may not be wholly unacceptable, notwithstanding the extended memoir on the subject inserted by Professor GEOFFROY in the *Mémoires du Muséum*, tom. xv. p. 1.

There is no part in the female *Ornithorhynchus* that can be properly termed vagina; but the canal which leads from the orifices of the uteri to the external outlet may be divided into two portions: of these the first and most internal is termed by Professor GEOFFROY the *urethro-sexual canal*, as it con-

veys the urine and the genital products into the second or external cavity : for this part he retains the name, originally given to it by Sir EVERARD HOME, of *vestibule*, as it affords a common outlet to the preceding substances and the contents of the rectum.

The common vestibule is about one inch four lines in length, and varies from half an inch to an inch in diameter. The muscular fibres immediately investing it are disposed as follows. A thin circular muscle arises from a dorsal raphé which extends the whole length of the canal. Of this muscle the sacral fibres, or those nearest the outlet, surround the whole vestibule ; but the atlantal or more internal fibres pass obliquely upwards and surround the termination of the rectum only, serving as a sphincter to it. On the sternal aspect of the vestibule there are a series of longitudinal fibres, which extend from its external orifice to that of the urethro-sexual cavity, the office of which is to approximate these orifices, and in this action the oblique fibres above described would assist, while at the same time they closed the rectum.

On the sternal aspect of the urethro-sexual cavity, and close to where it joins the vestibule, the clitoris is situated, which is consequently about an inch and a half distant from the external orifice of the vestibule. It is inclosed in a sheath upwards of an inch in length, and about two lines in diameter, of a white fibrous texture, and with a smooth internal surface, and this sheath communicates with the vestibule about a line from the external aperture. The clitoris itself is a little flattened body shaped like a heart on playing-cards ; it is about three lines long, and two lines in diameter at its dilated extremity, where the mesial notch indicates the correspondence with the bifurcated penis of the male. From the shortness of the clitoris, and the length of its sheath, it is obvious that no part of it can project into the vestibule in the ordinary state of the parts, as stated by Sir EVERARD HOME, its extremity being situated at least an inch distant from where its sheath communicates with that cavity. At the base of the clitoris are two small round flattened glands which open into the sheath or preputium clitoridis. These glands were largest in the specimen whose uterine organs were most developed. The vestibule is lined by a dark-coloured cuticular membrane, and has a tolerably uniform surface. The rectum opens freely into it posteriorly, the line of distinction in the relaxed state of the sphincter

above mentioned being little more than a change in the character of the lining membrane. The urethro-sexual canal, on the contrary, opens into the vestibule by a contracted orifice, and in one of the specimens examined, made a small circular and valvular projection into that cavity. On either side the termination of the rectum there are from six to eight small apertures of dark-coloured glands or follicles, about the size of a pin's head, situated immediately behind the proper membrane of the vestibule.

The urethro-sexual canal is one inch and a half long, and three or four lines in diameter, but capable of being dilated to as great an extent probably as the pelvis will admit of, the diameter of that passage being seven tenths of an inch. It is also invested with a muscular coat, the external fibres of which are longitudinal; the internal, circular. The inner membrane of this part was disposed in longitudinal rugæ more or less marked, but presented as little the character of a secreting membrane as that of the vestibule, being smooth and shining; after a careful examination with the lens, the orifices of a few minute follicles were discovered in the interstices of the rugæ near the orifice of the urinary bladder.

It is this division only of the passage from the uterus which is situated within the pelvis, the vestibule being produced beyond it, and the common outlet being in consequence situated at a considerable distance from the outlet of the pelvis, as in the beaver, which besides its analogy in habits to the *Ornithorhynchus* is also in the literal sense of the word monotrematous. If, then, the *Ornithorhynchus* be really oviparous, its eggs must be disproportionately small compared with those of birds, in order to pass through the pelvis. For on the supposition that they are of "the size, shape, and colour of those of a hen *," the yolk at least must be much smaller; for it is obvious that this part only of such an egg could pass through the pelvis, and the albumen and shell must necessarily be laid on in the vestibule. But, as has been before observed, neither the lining membrane of the vestibule nor that of the genito-urinary passage presents the characters of a secreting membrane; and great alterations at least must take place in them, if they exercise any share in contributing to the nutrient store of the embryo.

At the atlantal extremity of the urethro-sexual canal there are five distinct

* Linn. Trans. vol. xiii. p. 624.

orifices: the largest is in the middle and conducts into the urinary bladder; about three lines below this orifice are those of the uteri, situated, each on a small nipple-like prominence, or *os tincae*; and just below these, but on the same prominence, are the terminations of the ureters. These prominences were most marked in the specimens with the largest ovary and uteri, and the one on the left side projects further than that on the right.

The uteri are two distinct tubes, not arising, like the horns of the uterus in ordinary quadrupeds, from a cavity peculiar to them, or *corpus uteri*; but continued, as in tortoises, from a cavity into which the urinary bladder and ureters separately enter. Neither is this the sole resemblance they bear to the oviducts of reptiles; for, compared with ordinary quadrupeds, the distinction between the true uterus and Fallopian tube is but slightly marked, and the entire canal is thrown into many convolutions, partly by the process of peritoneum, or *ligamentum latum*, which attaches them to the pelvic region, and partly by means of a ligamentous chord upon which the convolutions are, as it were, strung. In their natural state the uteri measure about three inches in length; but when the convolutions are unfolded they extend to more than double that length; the right uterus, however, being always the shortest. The ligament above mentioned arises from the posterior parietes of the abdomen in the situation analogous to that of the testes in the male, viz. below, and a little to the outer side of the kidneys, and passes along the edge of the broad ligament to the Fallopian extremity of the uterine tube, where it divides; one portion is continued along the posterior margin of the orifice of the uterine tube, the other along the corresponding edge of the ovary; and after a course of an inch they again unite, and the ligament is continued along the anterior part of the uterus to the neck of the tube, where it is insensibly lost. The two separated portions of the ligament support a large pouch of peritoneum, which forms the ovarian capsule; the wide anterior orifice of the uterus is also by means of this ligament prevented from being displaced or drawn away from the ovary, during the actions of the rest of the tube.

The structure of the uterine tube is the same on both sides of the body. It is enveloped in a loose external serous coat, connected to the muscular coat by filamentary processes of cellular membrane, among which, numerous tortuous vessels ramify. The second tunic is a thin compact membrane, which I conclude to be muscular from analogy only, having been unable, even with a

high magnifying power, to detect a distinct arrangement of fibres in it. It is most easily demonstrated as a distinct coat in the dilated uterine portion of the tube. The innermost coat is a soft pulpy membrane with a slightly granular surface in the uterine portion of the tube, but thin and smooth in the Fallopian division. The difference was most considerable in the specimen with the largest ovary, in the uterine portion of which this membrane was thickened and of a dark colour, but no villi were perceptible on it when examined with the lens.

The left uterus, in the specimen with the large ovary, (Fig. 1. Pl. XVI. & fig. 3. Pl. XVII.) was for the first two inches of its extent from four to five lines in diameter, and about a line thick in its parietes; it then became suddenly contracted, and thinner in its coats, diminishing in diameter to about two lines, and afterwards slightly enlarging to within an inch of the extremity which forms a wide membranous pouch opening into the capsule of the ovary by an oblong orifice or slit of eight lines in extent. The edges of this orifice were entire, as in the oviducts of reptiles; not jagged as in the fimbriated extremity of the Fallopian tube in ordinary quadrupeds: nevertheless the dilated and muscular part of the tube at its commencement may be considered as the true uterus, and the contracted portion beyond as the Fallopian tube. The entire length of this uterus when detached from its connexions was nine inches. The right uterus in the same specimen exhibited similar differences in diameter and structure; but the contracted part representing the Fallopian tube was shorter in proportion to the true uterine division. This uterus measured six inches in length.

In the specimen with the smallest developed ovary, (Pl. XV. fig. 1.) the first portion of the uterine tubes was very little wider than the second, and not thicker in its coats; the entire tubes were much less in all their dimensions than those just described, and the terminal cavity, though more dilated than the rest of the tube, was also smaller.

In another specimen, in which the ovary (Pl. XVIII. fig. 4.) appeared to have shed its contents, the uteri presented the same variations of diameter as in the specimen with the largely developed ovary; but the parietes of the uterine portion were not so thick.

In the specimen above described with the large ovary, the thickened parietes of the first portion of the uterine tube depended chiefly on an increase of the

inner membrane, which possesses in a high degree the character of a secreting membrane. This membrane at the cervix uteri presented in all the specimens many deep and close-set furrows, which as the canal grew wider were gradually lost, and the surface became more or less smooth in the different specimens, being most irregular in the specimen with the largest ovary: in the contracted part of the tube, the inner surface is at first smooth, but beyond that becomes finely reticulate, and in the terminal dilated part is again smooth. The laminæ at the cervix uteri, when seen from the urethro-sexual cavity projecting across the terminal orifice, give the appearance of that orifice being divided by a septum. But in whatever way I have examined this part, I have never been able to detect such a division; the uterine tubes have invariably presented only a single aperture of communication with the urethro-sexual cavity. Such a septum may, however, exist in the virgin state of the parts; and on their assuming the natural functions, it may, like the hymen, be obliterated. Professor GEOFFROY, who has described and represented this structure, (*Mém. du Muséum*, xv. p. 32. Pl. I.) regards it as a rudimentary indication of the form of uterus peculiar to the Marsupiata.

In all the specimens but one, the ovary existed only on the left side; it is appended to the portion of ligament* before mentioned, and is of a flattened oblong form. In the specimen in which the mammary glands presented the smallest size (Plate XV.), the left ovary consisted of a thin, smooth, and soft substance, measuring half an inch in length, three lines in breadth, and half a line in thickness; the external covering was a tough membrane, beneath which were two black specks, but there was no appearance of ova; the rest of the substance being cellular membrane only. In the specimen (Pl. XVI.) in which the mammary gland was a little more advanced than the preceding, the left ovary presented the highest observed degree of development; and the right ovary was more distinct than in any of the other specimens. The left ovary was nine lines in length, five in breadth, and from two to three in thickness, having numerous ova distinctly developed in it, two of which were two lines and a half in diameter; and therefore, probably, not less than those which Mr. HILL has described† as being the size of small peas. These consisted of

* This ligament is represented in Mr. BAUER's magnified drawing of the posterior view of the ovary of the Ornithorhynchus, *Phil. Trans.* 1819, Pl. XVIII. p. 240.

† *Linn. Trans.* vol. xiii. p. 623.

a tough capsule filled with a soft substance of a dark brown colour. The remaining ova varied in diameter from a line to the fiftieth part of an inch, giving an irregular tuberculate surface to the ovary, and a superficial resemblance to the ovary or clutch in the bird: but in the *Ornithorhynchus* the ova are enveloped in a tough fibrous membrane, in which the traces of vascularity (at least after having been preserved in spirits,) are not perceptible, whilst in the fowl the ova are attached by narrow pedicles, and are covered by a thin and highly vascular membrane. The right ovary in this specimen was of an elongated form, attached to, and apparently developed from the ligament above mentioned; it was a thin substance about half an inch in length, and nearly two lines in breadth, with the surface studded over with incipient ova. This appearance renders probable the supposition of Sir EVERARD HOME that it may come into action at some period of the animal's existence; but the traces of it in all the other specimens could only be recognised in a slight thickening of the ligament. The mammary glands in this specimen were each two inches four lines in length, eight lines in breadth, and nearly a line in thickness. The lobules of the gland had increased more in length than breadth, being almost as narrow as in the smallest gland. In both instances they were of the same colour and texture as in the largest glands.

In the specimens in which the mammary glands had arrived at their full size, the ovary presented the following appearance. It was nearly as large, as respects length and breadth, as in the preceding case, but was much thinner, and its surface was rendered irregular by furrows and wrinkles. There were also minute granules of a black colour immediately beneath the outer covering, but the body of the ovary was composed of a loose cellular texture only. It may reasonably be concluded, therefore, on a comparison of these appearances with those exhibited in the ovaries previously described, that they indicated the condition of the ovary shortly subsequent to the performance of its peculiar functions, and that at this period, the circulation having been diverted to the neighbouring mammary organs, had contributed to their excessive development.

In the female wherein the ovary and the uteri were in apparently the lowest stage of adult development, and exhibited no traces of recent action, the mammary glands presented a volume indicative of a corresponding degree of inactivity. Where the ovary had made a considerable advance towards per-

fection, the glands did not exhibit a corresponding degree of development ; they had only begun to enlarge and to manifest their obedience to the law of the sexual impulse. But had their office been to secrete, as Professor GEOFFROY supposes, an odorous substance attractive of the male, their maximum of development ought to have been exhibited in this specimen, in which the uteri evinced, by their size and vascularity, traces of high excitement, and the ova appeared ripe for impregnation. The greatest development of the abdominal glands, on the contrary, was observed where the ovary appeared to have recently executed its function.

The variation in size of these glands, in individuals of the same bulk, evidently points out that they are not adapted for the performance of any constant office in the economy of the individual, but relate to a temporary function. Otherwise, the circumstance of their yielding oil on pressure, as in the instance above mentioned, might have led to the supposition that they furnished a lubricating fluid useful to an animal of the aquatic habits of the *Ornithorhynchus* *.

That this temporary function, moreover, is peculiar to the economy of the female, cannot be doubted. For in the male, both Dr. KNOX and Professor MECKEL have been unable to detect these glands ; and after a careful scrutiny, with the same view, in a well preserved specimen of that sex, I have not succeeded in detecting more than a few minute lobules occupying a space of about four lines in situations corresponding to those in the female ; but the nature of which, from the total absence of corresponding foramina on the external surface of the integument, may still be doubted.

Lastly, from the evidence derived from the uterine system in the present inquiry, the period when these glands exhibit the greatest activity, appears to be *after* gestation. It therefore comes to be considered whether their structure is so widely different from the ordinary mammary gland as it has been represented to be.

Now, whether the secretion of these glands be milk or not, it is highly probable, from its being conveyed externally by long and narrow ducts, that it is of a liquid nature ; and this mode of being carried off is much more analogous to that exhibited in the ordinary lacteal apparatus than in the odoriferous

* Since writing the above, I have ascertained that the mammary glands exist in a similar situation, and under a similar form, in the *Echidna hystrix* ; an animal which burrows in dry sandy situations.

glands, which more commonly open externally by one large and wide orifice. The excretory orifices of the glands in the *Ornithorhynchus*, moreover, are not extended over a wide surface, but are collected into a point, in all probability, not disproportionate to the size of the mouth in the young animal, and these points are situated in parts of the body most convenient for the transmission of a lacteal secretion from the mother to her offspring.

Compared with an ordinary mammary gland, that of the *Ornithorhynchus* differs chiefly in being of a cellular and not of an acinous or conglomerate structure; as well as in the absence of the nipple and of the surrounding vascular structure necessary for its erection. But the inconclusiveness of arguments drawn from these circumstances has been sufficiently demonstrated by Professors MECKEL and V. BAER in the work above quoted. The question then arises, how the secretion of this gland, if mammary, is conveyed to the young? And with respect to the absence of a nipple, Professor GEOFFROY observes, "*C'est ainsi chez un animal dont le museau est fait de façon que même y aurait il une long tétine un tel animal serait privé de la saisir et de la sucer.*"

But with a form of mouth so extraordinary and unlike that of other quadrupeds, might we not expect some corresponding deviation from the normal structure in the efferent portion of the mammary apparatus? And if a nipple would indeed have been useless or unavailable in this case, have we not then the best reason for its absence? Unless, however, we limit nature to one mode only of conveying the lactiferous secretion from the parent to the offspring, I apprehend the evidence afforded by the preceding details will hardly render tenable any other theory than that which upholds the mammary nature of the glands in question.

Fortunately, an instance has already been afforded, and that too in the *Macropodidae*, of a structure superadded to the mammary gland apparently to compensate for a want of sufficient power of suction in the young animal*. So also in the *Ornithorhynchus* the strong panniculus carnosus which is every where interposed between the glands and the skin, may compress the glands

* See Professor GEOFFROY's account of this apparatus in *Mem. du Muséum*, tom. xv. p. 48; and *Description of the Mammary Organs of the Kangaroo*, by JOHN MORGAN, Esq. *Linn. Trans.* vol. xvi. p. 61.

against the flattened cartilages of the ribs and the marsupial bones, and occasion the expulsion of the secreted fluid; while the great extent and the yielding texture of the gland seem peculiarly to adapt it to be so influenced. In this case the mouth of the young animal need only be applied to the areola to receive the secretion; and it is particularly worthy of remark, that the great distinction between the mandibles of the Ornithorhynchus and those of the Bird consists in the former being, even in the adult state, surpassed by thick, soft, muscular, extremely sensible and flexible lips.

APPENDIX.

Whilst the preceding account was going through the press, the following interesting communication was made by Dr. WEATHERHEAD to the Committee of Science of the Zoological Society.

After stating that he had received a letter from his friend Lieutenant the Hon. LAUDERDALE MAULE of the 39th Regiment, at present in New South Wales, informing him of his having forwarded, among other curious objects of natural history, the carcasses of the female Ornithorhynchus and her young, he proceeds to give the following extracts from Lieutenant MAULE's letter:—
“ ‘Several of their (the Ornithorhynchuses') nests were with considerable labour and difficulty discovered. No eggs were found in a perfect state, but pieces of substance resembling egg-shell were picked out of the *debris* of the nest. In the insides of several female Platypi which were shot, eggs were found of the size of a large musket-ball and downwards, imperfectly formed however, i. e. without the hard outer shell, which prevented their preservation. Several young Platypi were obtained and put into spirits, in which state they are forwarded.’

“ In another part of his letter Mr. MAULE states, that in one of the nests he was fortunate enough to secure an old female and two young. The female lived for about two weeks on worms and bread and milk, being abundantly supplied with water, and supported her young, *as it was supposed*, by similar means. She was killed by an accident on the fourteenth day after her cap-

ture, and on skinning her while yet warm, it was observed *that milk oozed through the fur on the stomach*, although no teats were visible on the most minute inspection; but on proceeding with the operation *two teats or canals* were discovered, both of which contained milk. The carcase also of this female Mr. MAULE has kindly forwarded."

In the preceding account, therefore, two important facts are distinctly stated; the one, that the ova of the Ornithorhynchus attain the size of a large musket-ball, and, like the eggs of the ovo-viviparous reptiles, have a soft outer covering; the other, that the fluid secreted by the abdominal glands is milk. The first of these statements would of course derive additional value if the period of the year were stated when the eggs so developed were observed; and the precise part of the body in which they were situated, whether in the ovary, the oviduct, or the cloaca: also, whether they were observed at the same time that the female with her young was captured, or at what distance of time from that event.

With respect to the supposed portions of egg-shell found in the nest, it is obviously far from being conclusive as to the oviparous character of the Ornithorhynchus; since, when it is considered that the excrement and urine are expelled by the same orifice, we may readily suppose the former to be coated, as in birds, with the salts of the urine, and to have given rise to the above appearances.

The information respecting the mammary glands is much more satisfactory, and must be regarded as decisive of the question relative to their function. The mode of suckling appears, indeed, not to have been observed; but the ready escape of the secreted fluid after death, during the process of skinning, is corroborative of the opinion previously advanced as to the manner in which the milk is expelled. Among the other points of interest for which the scientific world is so highly indebted to the exertions of Lieutenant MAULE, that of discovering the number of young produced by the Ornithorhynchus may in all probability be reckoned; and it would appear, that, as in other Mammalia, it corresponds with the number of nipples, or outlets for the mammary secretion.

Fig. 1.

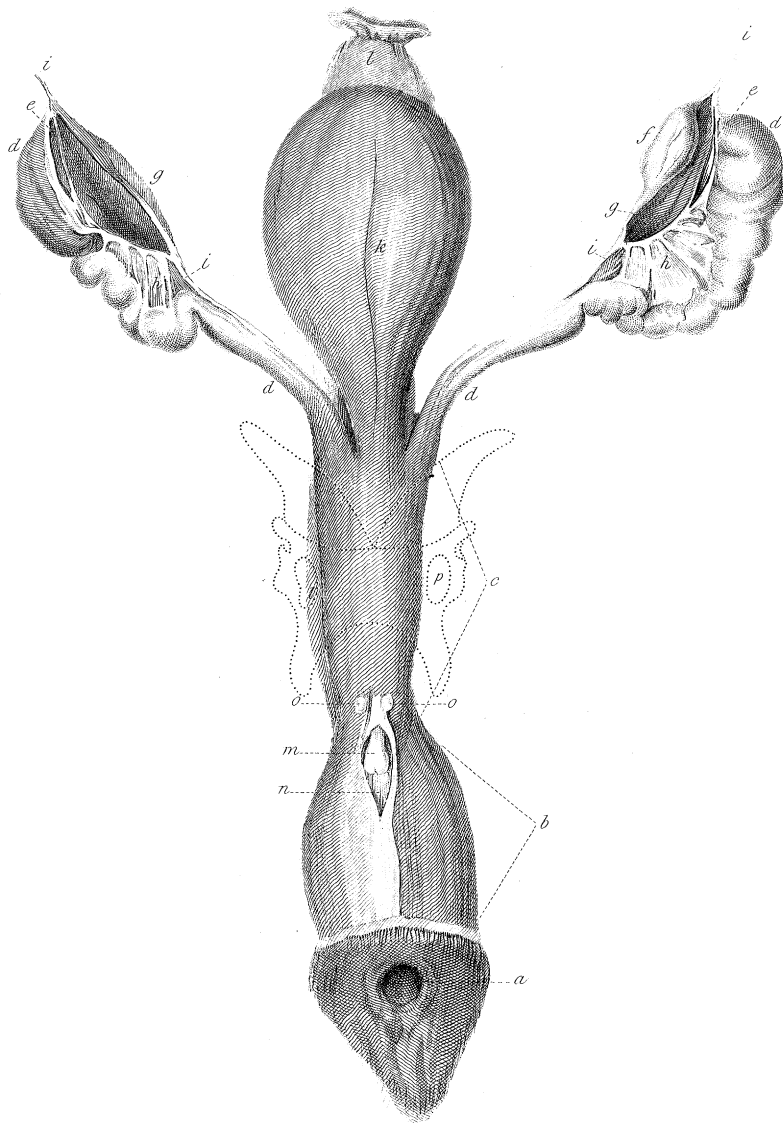


Fig. 2.

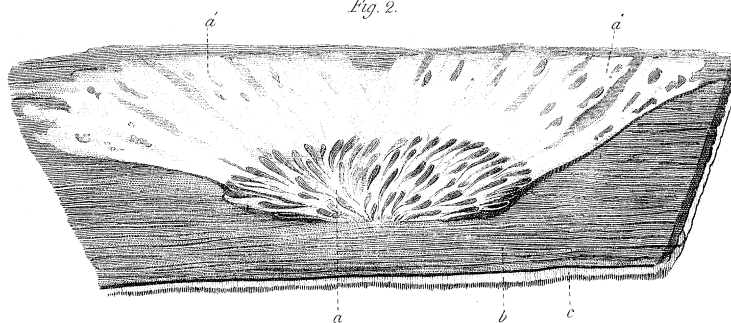


Fig. 1.

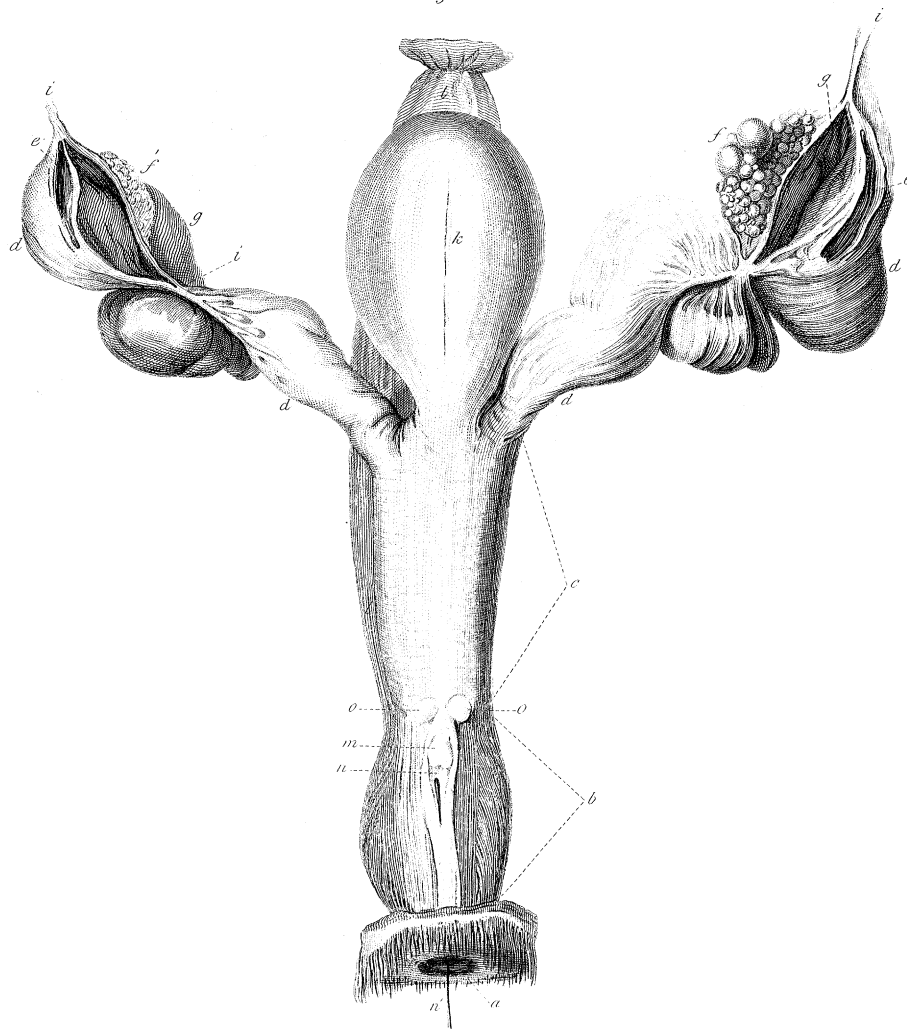
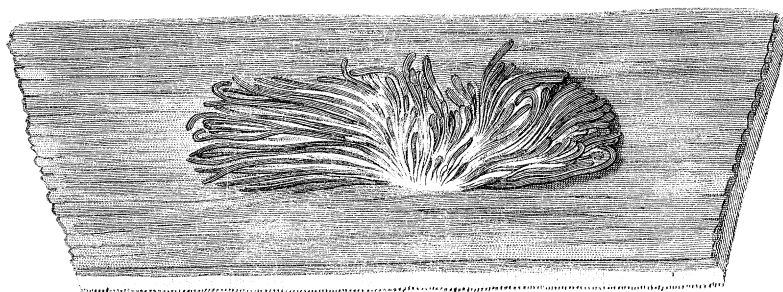


Fig. 2.



Description of the PLATES.

PLATE XV.

Fig. 1. The organs of generation in the unexcited state, with the urinary bladder and rectum of a full-grown female Ornithorhynchus.

- a.* The external outlet or orifice of the vestibule.
- b.* The vestibule.
- c.* The urethro-sexual canal.
- d, d.* The uterine tubes or oviducts.
- e, e.* Their anterior or Fallopian orifices.
- f.* The ovary, developed only on the left side.
- g, g.* The ovarian capsules or peritoneal bags connecting the ovarian ligaments with the Fallopian extremities of the uterine tubes.
- h, h.* The processes of peritoneum connecting the oviducts to the ligaments *i, i*.
- k.* The urinary bladder.
- l.* The rectum.
- m.* The clitoris.
- n.* The sheath or preputium clitoridis. *n'*. Plate XVI. A bristle passed into the sheath through the orifice in the vestibule.
- o, o.* Two small glands which open into the sheath of the clitoris.
- p.* Outline of the pelvis, showing its relation to the urethro-sexual canal.

Fig. 2. One of the mammary glands from the same individual, exhibiting the lowest observed degree of development.

- a.* The gland. *a', a'*. Sheaths of cellular membrane which could be inflated, and had been occupied probably with the glandular lobules at a previous period of enlargement.
- b.* The panniculus carnosus.
- c.* The integument.

PLATE XVI.

Fig. 1. The organs of generation of another adult female, which were pro-

bably prepared for impregnation. The letters indicate the same parts as in the preceding plate: *f'* is the ovary, slightly developed on the right side.

Fig. 2. One of the mammary glands, from the same individual, beginning to enlarge.

PLATE XVII.

Fig. 1. The same parts as are represented in fig. 1. of the preceding plate, but further dissected and laid open.

- a.* The common outlet or orifice of the vestibule.
- b.* The vestibule, with its anterior or sternal parietes removed.
- b'*. A probe passed through the rectum into the vestibule.
- c.* The urethro-sexual canal laid open.
- c'*. The orifice by which the urethro-sexual canal communicates with the vestibule.
- d, d.* The dilated or uterine portions of the oviducts laid open.
- d', d'*. The contracted or Fallopian portions: that on the left side is laid open through its whole extent, showing the dilated cavity at *d''*.
- e, e.* The wide slits which form the orifices of the oviducts.
- f, f'*. The ovaries. *i, i.* The ligaments which attach the oviducts and ovaries to the back of the abdomen.
- k.* The urinary bladder opening into the atlantal extremity of the urethro-sexual canal.
- l, l.* The ureters, through which bristles are passed to show their terminations in the urethro-sexual canal.
- m.* The orifices of the uterine tubes; that on the left side is laid open. They were each situated in this instance on a prominence resembling an *os tincæ*.

This figure is in some measure a repetition of the preceding; but is here added, as it supplies some of the deficiencies in the figures previously given of these remarkable organs. The figure in the ninety-second volume of the Philosophical Transactions, Pl. IV. represents both the uterine tubes of the same size; and neither the Fallopian orifices, the ovaries, nor the terminations of the ureters are shown. In the more recent figure by Professor

Fig. 2.

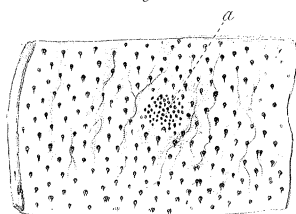


Fig 3.

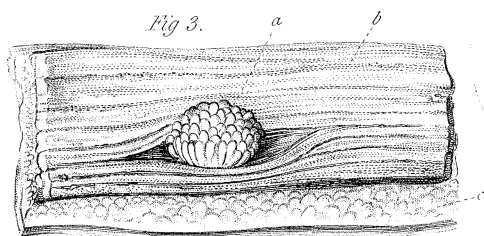


Fig. 1.

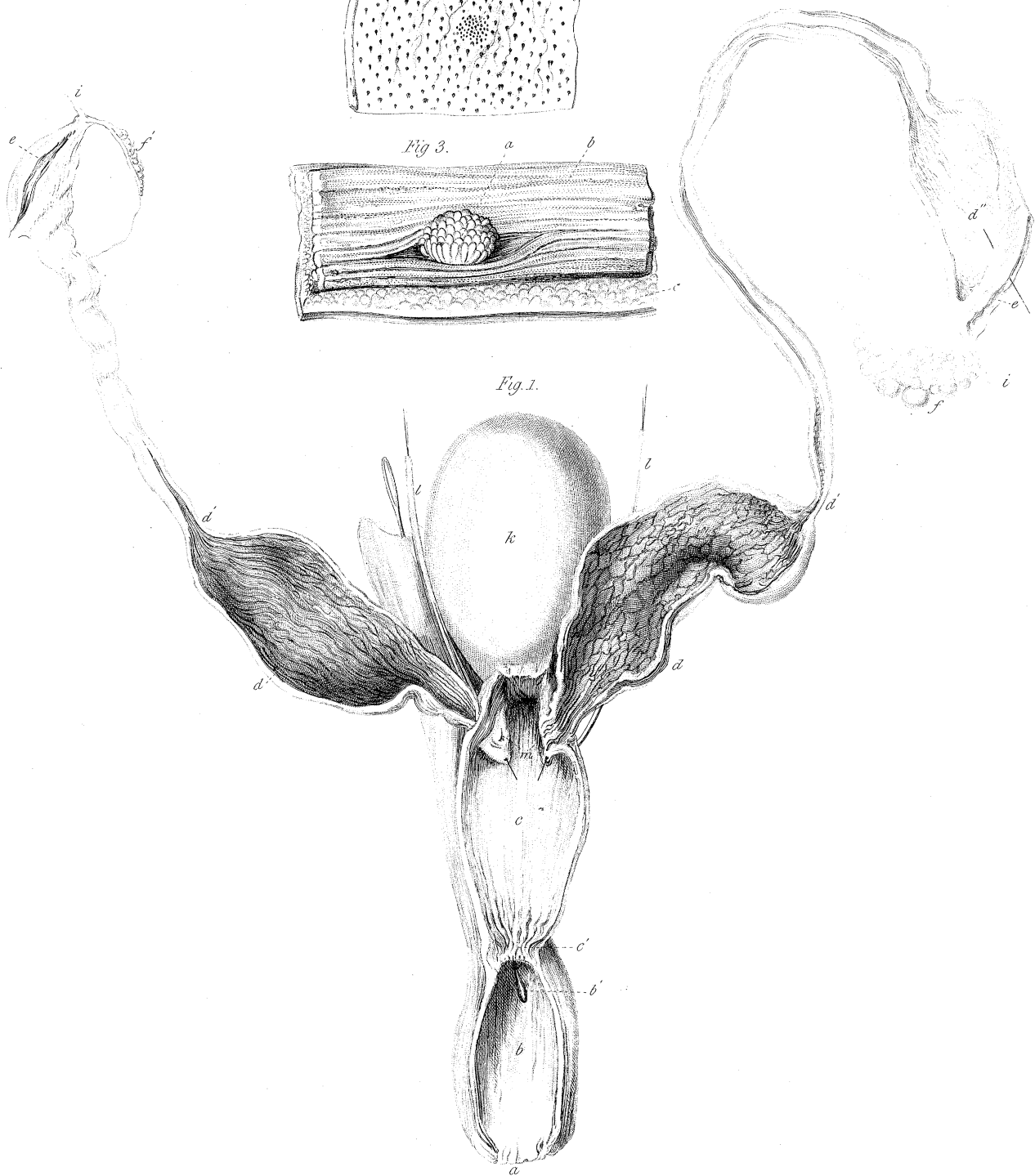


Fig. 1.

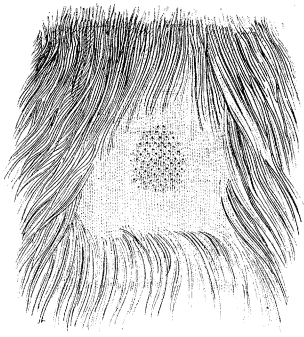


Fig. 2.

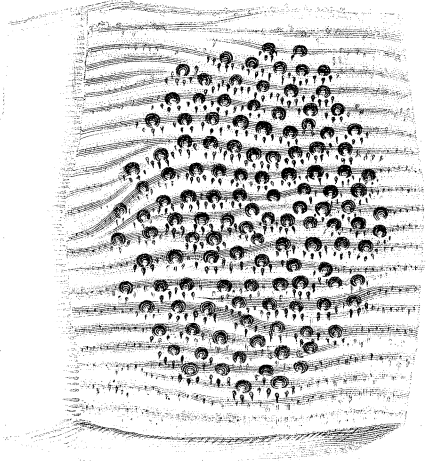


Fig. 5.



Fig. 4.

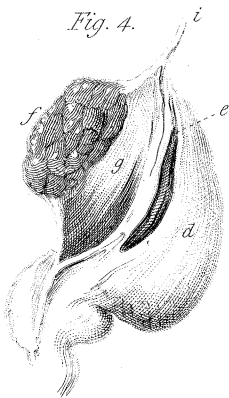
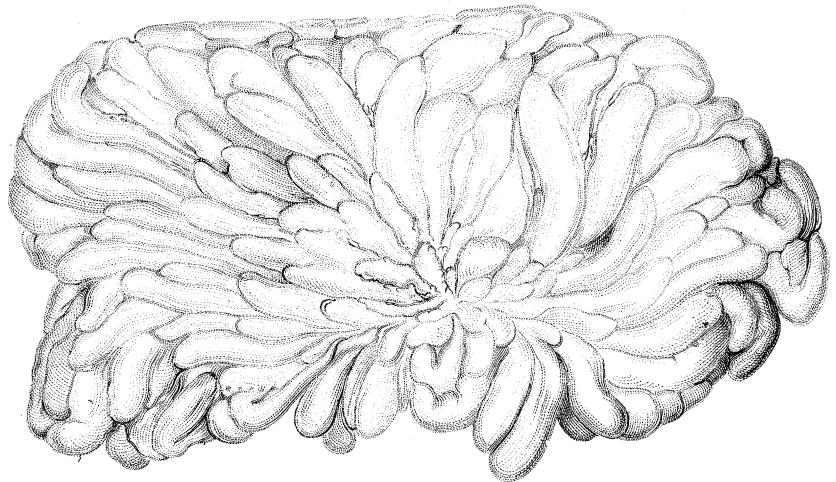


Fig. 3.



GEOFFROY (Mém. du Muséum, Pl. I. fig. 6.) the right uterine tube is omitted, and the left is made to terminate in a point without any indication of the Fallopian orifice or of the ovarian capsule.

Fig. 2. A portion of the integument from the abdomen of the Spiny Ant-eater (*Echidna hystrix*, Cuv.) showing at *a*, the mammary areola.

Fig. 3. *a*. The mammary gland of the *Echidna hystrix*.

b. The panniculus carnosus.

c. The integument.

This specimen was taken from a young female nearly arrived at maturity, but which had probably never been impregnated; it consequently exhibits the gland in a low stage of development. The glands are two in number as in the Ornithorhynchus, and are situated about half an inch from the mesial line of the abdomen, and three inches and a half anterior to the cloaca. They are each composed, as in the Ornithorhynchus, of numerous elongated lobes, which converge towards the mesial line, their ducts penetrating the integument, and forming by the aggregation of their orifices a small areola externally. This areola is more easily distinguished in the Echidna, from the hairs on the abdomen being more scattered; it is not situated on an eminence, nor surrounded by any erectile tissue: it is made up of about sixty orifices. The lobes of the gland are proportionally broader and shorter than in the Ornithorhynchus. A strong panniculus carnosus is similarly interposed between them and the integument, and the fibres of this muscle separate to allow the ducts to pass through, as represented in the Plate. The lobes are not mere cæcums, but present under the lens a similar texture to those in the Ornithorhynchus.

PLATE XVIII.

Fig. 1. A portion of integument from the abdomen of the *Ornithorhynchus paradoxus*, with the hairs removed so as to exhibit the mammary areola.

Fig. 2. A magnified view of the mammary areola, showing the orifices of the ducts of the glandular lobules.

Fig. 3. The mammary gland of the *Ornithorhynchus paradoxus* in a state of full development ; the exact dimensions of the gland are preserved.

Fig. 4. The left ovary and Fallopian extremity of the oviduct of the same specimen. (The letters indicate the same parts as in Pl. XV.)

Fig. 5. *a.* A magnified view of a section of one of the lobules of the mammary gland, after having been injected with quicksilver, and dried.

b, b. The extremities of the ducts of the other lobules converging as they pass through the integument to the mammary areola.

c. The fibres of the panniculus carnosus.

d. The integument.

The preparations described in the preceding paper have been deposited in the Museum of the Royal College of Surgeons.