INTRODUCTION.

In 1922, while investigating the fauna of the New Hebrides under the Percy Sladen Trust, I found that many of the domestic pigs (Sus papuensis Less. and Garn.) kept by the natives were intersexual. These monstrosities had previously been noticed by anthropologists (Codrington, 1891). I dissected one of them and found that it differed from the great majority of the intersex pigs and goats occasionally found in Great Britain in the complete absence of uterus and vagina.

Returning to the New Hebrides in 1927, again under the Percy Sladen Trust, I made a much more thorough investigation of these pigs, of which this paper is the outcome. I dissected eight more specimens, and in none of them was there the smallest rudiment of uterus or vagina. I also investigated the natives' account of the genetics of the abnormality.

I wish to thank the Trustees of the Percy Sladen Memorial Fund and Mrs G. E. Baker and Mr S. J. Baker for providing part of the funds for my investigation of the fauna of the New Hebrides. I wish also to thank Prof. E. S. Goodrich for allowing me the leave of absence which has made my visits to the New Hebrides possible.

ANATOMY.

The internal organs are always essentially male, though some of the male organs are often poorly developed or absent. With the exception of the specimen obtained in 1922, no stages in spermatogenesis later than the pachyten stage occur in the testes, and usually no progress is made beyond spermatogonia even when the testes are extra-abdominal. Uterus and vagina are absent in every specimen.
A new type of Mammalian Intersexuality

The external genitalia vary from nearly the female condition to something approaching the male. The natives of the north-east peninsula of the island of Espiritu Santo, whose interest in intersex pigs is extreme, classify them into the following seven groups, which are sufficiently precise to be used in a scientific account of the abnormality. The meaning of the translation of each name will be explained later.

(1) ndré rasa = feminine intersex.
(2) ,, rüneth = sprouting coconut intersex.
(3) ,, narsög = sewn-up intersex.
(4) ,, ghara = fruit-bat ,,
(5) ,, nau = rat ,,
(6) ,, ghor-ghor = hidden ,,
(7) ,, selet = worm ,,

These grades run into each other, and often it is not possible to decide with certainty to which grade a pig should be assigned.

The natives have another grade called ndré thia, but despite lengthy discussions I am totally unable to see any difference between it and ndré rasa.

Fig. 1 to 5 show the anatomy of a normal male (Fig. 1), three types of intersex (selet, rüneth and rasa) (Figs. 2, 3 and 4), and a normal female (Fig. 5). The figures, which are semi-diagrammatic, represent vertical longitudinal sections through the posterior end of the body, seen from the left side.

The same conventions having been used throughout these figures, the name of any unlabelled part can be determined by referring to the figure of the normal male, the parts of which are labelled. The corpus cavernosum stands out in each picture from being marked with curved lines, while the urethra (including corpus spongiosum) is solid black and the bulbo-cavernosus muscle marked with parallel straight lines. Sexual organs of the right side (e.g. right testis and right vesicula seminalis) are represented as well as the median organs.

It is simplest to start by describing the ndré rasa (Fig. 4), in which the external appearance is very much that of a normal female, except for the presence (in adults) of tusks (see Pl. II, fig. 6). The testes, being abdominal, are not visible, and there is often a vulva hardly distinguishable externally from that of a female, though usually the corpus cavernosum is enlarged and the urinogenital aperture thus reduced to a slit. In its enlargement the corpus cavernosum often pushes the ventral labial commissure upwards or outwards. The extrapelvic part of the urethra is distinguished from the vestibule of the female by the presence of the essentially male bulbo-cavernosus muscles.

It is easy to derive the ndré rüneth (Fig. 3) from this condition. The testes are typically descended into a more or less well-formed scrotum, and the corpus cavernosum has enlarged so as to push the ventral labial commissure a considerable distance outwards. The phallus projects somewhat to the exterior, and the urinogenital aperture is very small. The name rüneth is derived from the resemblance of the projection formed by the corpus cavernosum and labial commissure to the sprout of a germinating coconut.
In the remaining grades, the corpus cavernosum is turned downwards as in the male and enlarged to different degrees. In its enlargement it carries the ventral labial commissure with it. The projection, consisting of the ventral labial commissure, the corpus cavernosum, and the terminal part of the urethra, may be situated anywhere from just below its position in the ndré rûneth to close behind the position of the urinogenital aperture in the male. In these intersexes the testes are usually descended.

When the projection is situated in the scrotal region, it commonly happens that the external urethral orifice is occluded, so that the ejection of urine is impossible and death would soon ensue. But in these cases the natives make a small incision through the skin into the urethra on the body-wall just above the base of the projection. These intersexes are called ndré narsôgã from their being “sewn-up.”

When the projection is long and situated near the anterior end of the scrotal region, the term ghara is applied, from the close resemblance of the external genitalia to those of a male fruit-bat.

When the corpus cavernosum has enlarged to about the same extent, but has done more of its enlargement inside the body, the projection is shorter, but further forward; and the name nau is applied from the resemblance to the condition in the male rat.

In the ndré ghor-ghor the externals are similar to those of a ndré nau, but the projection is further forward and hidden from view when the animal is seen from behind. The name is derived from the fact that the projection is hidden.

The ndré selet is similar to the ndré ghor-ghor, but the further enlargement of the corpus cavernosum has resulted in its extrusion from the end of the projection in worm-like form. The word selet means “a worm.” (Fig. 2.)
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The anatomy and testicular histology of the eight specimens brought home in 1927 is given in tabular form in the Appendix. I have described the 1922 specimen before (Baker, J. R. (1925, a) (Anatomy, etc.) and (1925, b) (Histology)).

Fig. 2. Selet intersex.

Fig. 3. Runeth intersex.

Fig. 4. Rasa intersex.

Fig. 5. Normal female.
GENETICS.

The natives of the north-east peninsula of Espiritu Santo maintain that a female pig which has produced one or more ηδρε usually produces one or more in every farrow, and further that females born in the same farrow as ηδρε are themselves ηδρε-producers. The natives of Gaua call an intersex-producing female wurupkwaval, while one which does not produce intersexes is called wurupowor. Female pigs which are born in the same farrow as intersexes are called wurupkwaval from birth onwards. They are confidently expected to produce intersexes later on, and cost twice as much as wurupowor. The male parent is not supposed to have any connection with the production of intersexes; but since males and females run loose together, and no controlled matings are made, the natives cannot be supposed to know much about the influence, if any, of the male parent.

I brought home two live intersexes and the brother and sister of one of them. Dr Crew is keeping these at the Animal Breeding Research Department of Edinburgh University, and the two normals will be bred from when they are old enough. It is hoped that sperms may be obtained from one or both of the intersexes. If female pigs could be fertilised with intersex-sperms, the resulting farrows should decide conclusively the chromosomal sex of the intersexes.

The natives' story of the genetics of the abnormality nearly fits in with the assumption that it is caused by a sex-linked factor, intersexes being males carrying this factor. Intersex-producing females would be heterozygous for the factor. Homozygous females can never occur in nature, for they could only arise by the mating of two pigs both of which carried the factor, and this could never be the case without artificial insemination; for the would-be males which carry the factor are of course intersexes, whose copulatory organs are never sufficiently well developed to function as such.

Of the 86 intersexes from Espiritu Santo on whose external genitalia I made notes, 11 were rasa, 40 rūneth, 11 narsōgh, 10 ghara, 5 nau, 8 ghor-ghor, and 1 selet. A most intelligent native of Gaua assured me that all the intersexes of Gaua have the projection close to the normal position of the female aperture, and my own observations confirmed this; for the ones on which I made notes were a rasa and 4 rūneth, and all the other intersexes I saw there were of these two grades. This seems a most significant fact in the genetics of intersexuality, for there is clearly an inherited tendency to certain grades of the abnormality.

PHYSIOLOGY.

There are two partial hypotheses to account for the intersexes in goats and pigs of European breeds. Crew (1923) suggested that there is a definite time in the development of each sexual organ during which it must either be stimulated by the appropriate gonad-hormone if it is to develop properly, or inhibited if it is to be stopped completely from developing. He supposes intersexes to be genetic males in which the testes were late in development, and therefore the testis-hormone was
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poured out too late to give full stimulus to the male organs and to prevent completely the development of the female ones. I pointed out, however (1925, a), that the differentiation of vagina and uterus in the complete absence of ovarian tissue was most unlikely. Lipschütz (1927) has shown also that the testis-hormone does not necessarily inhibit the development of female organs. I stated the hypothesis that all intersexes are true hermaphrodites in early stages of development, and that the uterus and vagina, which are nearly always present in intersexes of European breeds, differentiate under the stimulus of the ovarian hormone. It is a fact that not very rarely ovarian tissue as well as testicular persists (Baker, 1926).

Now although I am convinced that Crew's hypothesis will not account for intersexes of European breeds, which nearly always have some remnants at least of uterus and vagina and often have them quite well developed, yet I believe that his theory does account for the intersex pigs which I have described in this paper. One has only to assume that the typical female vulva will differentiate in the absence of the ovarian hormone (and there is no evidence at all that it will not), and that the end of the urethra thus normally forms itself into a vulva unless the testis-hormone is present to alter its development by stimulating the growth of the corpus cavernosum. The ndré rasa is then simply a male in which the testis had developed very late, after the vulva has been formed; the corpus cavernosum may enlarge a little and slightly modify the vulva, but essentially the externals remain female. Once the vulva has been properly formed, no amount of testis-hormone poured out too late can cause the corpus cavernosum to enlarge so as to push the end of the urethra and the ventral labial commissure round towards the ventral surface of the body. But if the testes are formed a little less late, the corpus cavernosum starts to enlarge a little before the vulva is complete, and a ndré rüneth results. Earlier development of the testis results in the ghará or nau; earlier still in the ghor-ghor or selet. But even in the selet the ventral labial commissure can be detected. In the normal male the testes are formed before the vulva is fashioned at all, and the early enlargement of the corpus cavernosum results in the end of the urethra being carried right round to the characteristic male position on the belly. Neither the uterus nor the vagina is formed simply because there is never any ovarian tissue.

DISTRIBUTION.

Intersex pigs only occur in the more northerly islands of the New Hebrides. The ones I examined were on Espiritu Santo and Gaua. They are said also to occur on Vanua Lava, Mota, Omba (= Aoba), Ambrim (not plentifully) and Tongoa. The natives say that there were no indigenous intersexes in Merelava and Merig, but that intersex-producing females were brought from other islands to provide them.

Intersexes are called rau or rauas in Gaua, ndré or nere in the north-east peninsula of Espiritu Santo, ra or ravé in south-east Espiritu Santo, teret in Ambrim, and pulpul in Tongoa.

1 Conceivably the vulva differentiates under the stimulus of the maternal ovarian hormone.
ABUNDANCE.

Nowhere in the world are mammalian intersexes so abundant as in the New Hebrides. In England one may at long intervals get an occasional intersex pig from a bacon-factory which kills perhaps a thousand pigs a week and is on the look-out for them. In Espiritu Santo and Gaua they occur in nearly every little native village. I tried to collect figures to indicate their abundance relative to normal pigs, but soon found it impossible, as it would have been necessary to get the co-operation of all the natives who owned pigs in several villages. I estimate that there are between ten and twenty intersexes per hundred normal males. (Most of the female pigs are killed young.) I once saw no fewer than 125 intersexes in one single day at Hog Harbour, when an exchange of many young intersexes for a few old ones brought from another island was taking place.

Their importance in the social life of the natives (except the Christian ones) is very great. Each time a chief ascends to a higher rank, a definite number of intersexes and males has to be killed. At the last change of rank, between 10 and 20 full-grown intersexes with large tusks have to be killed. Intersexes are regarded as of greater value than males. It is because of their social importance that the natives are at pains to produce them by breeding from sows which have already produced them and from females born in the same farrows as intersexes.

Some of the feral pigs of Espiritu Santo are said also to be intersexual.

TUSKS.

All adult intersexes possess tusks similar to those of boars, and this serves immediately to distinguish an adult ndrē rasa from a normal female without dissection, which is not always possible in the young.

The natives remove the upper canines of males and intersexes, in order to allow the lower canines to grow indefinitely. Their growth being circular, at the age of perhaps eight years the tip of the tusk often re-enters the mandible close to its own root. Sometimes it passes outside the mandible and considerably more than a complete circle of tusk may then be formed. When the tip of the tusk begins to come close to the mandible, a knob of bone arises on the mandible opposite to it. Later growth of the tusk commonly causes it to enter this knob. The formation of the knob seems to be a response to the irritating action of the tip of the tusk on the flesh of the lower jaw. (Figs. 6 and 7.)

The natives of Gaua (but not of Espiritu Santo) unhesitatingly designate one tusk as that of an intersex and another as that of a boar, but I have not been able to find out their criteria of distinction. They seem to judge by the colour of the tusk and the degree to which it has been worn down. Certainly the dentine of the tusks of some intersexes is partly yellowish or brownish, but this is by no means invariable.
Fig. 6.

BAKER—A NEW TYPE OF MAMMALIAN INTERSEXUALITY (pp. 56-64).
A new type of Mammalian Intersexuality

SUMMARY.

(1) In certain islands of the New Hebrides (in the Pacific Ocean) a considerable proportion of the pigs are intersexual. Nowhere in the world are intersexual mammals so abundant.

(2) These intersexes differ from the rare intersexes of European pigs in the invariable absence of any rudiment of uterus or vagina.

(3) A tendency to intersexuality is inherited.

(4) The intersexes are interpreted as genetic males in which the testicular hormone has been produced too late in development.

REFERENCES.


PLATE II.

FIG. 6. Lower jaws. The natives of Gaua designated the jaw represented in the upper figure as that of a male, the other as that of an intersex. (Photos by Mr W. Chesterman.)

FIG. 7. An intersex pig in Espiritu Santo, New Hebrides, to show the tusk. (Photo by Mr J. de H. Morel.)
### APPENDIX*

<table>
<thead>
<tr>
<th>No.</th>
<th>Length (head and body) (cm.)</th>
<th>Externals</th>
<th>Testes. Position</th>
<th>Length (as % of head and body)</th>
<th>Diam. tubes (μ)</th>
<th>Stage in spermatogenesis</th>
<th>Interstitial cells</th>
<th>Epididymes</th>
<th>Vasa deferentia</th>
<th>Vesiculae seminales</th>
<th>Bulbo-urethrales</th>
<th>Female internal organs</th>
</tr>
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<tbody>
<tr>
<td>106</td>
<td>181</td>
<td>Rasa</td>
<td>Rasa</td>
<td>—</td>
<td>R. 70</td>
<td>R. Quite degenerate</td>
<td>R. Not very abundant. Loaded with yellow pigment</td>
<td>Absent or vestigial</td>
<td>Absent</td>
<td>Quite large</td>
<td>Not recognised</td>
<td>Absent</td>
</tr>
<tr>
<td>181</td>
<td>121</td>
<td>Rasa</td>
<td>Rasa</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Absent or vestigial</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>147</td>
<td>148</td>
<td>Rüneath</td>
<td>Rüneath</td>
<td>L. Palpable</td>
<td>R. 70</td>
<td>R. Many Sertoli nuclei, a few spermatogonia</td>
<td>R. Very little interstitial tissue</td>
<td>Well formed</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>148</td>
<td>36</td>
<td>Runeth</td>
<td>Runeth</td>
<td>Both visible</td>
<td>L. 4·4, R. 4·2</td>
<td>Both 55</td>
<td>Very abundant in both testes</td>
<td>Absent or vestigial</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Length (head and body) (cm.)</th>
<th>Externals</th>
<th>Testes. Position</th>
<th>I.P.D. 8</th>
<th>I.P. 19</th>
<th>239</th>
<th>249</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>41</td>
<td>Runeth</td>
<td>Narsogh</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>106</td>
<td></td>
<td>Rüneath</td>
<td>Ghara</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87</td>
<td></td>
<td>Selet</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>Externals</th>
<th>Testes. Position</th>
<th>Length (as % of head and body)</th>
<th>Diam. tubes (μ)</th>
<th>Stage in spermatogenesis</th>
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<th>Bulbo-urethrales</th>
<th>Female internal organs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rüneath</td>
<td>L. Among scrotal hernia</td>
<td>Both 2·5</td>
<td>L. 90, R. 70</td>
<td>Spermatogonia and many Sertoli nuclei. Also indeterminate nuclei in L.</td>
<td>No interstitial cells in either testis</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Runeth</td>
<td>Both in scrotum</td>
<td>Both 4·9</td>
<td>L. 50, R. 60</td>
<td>Both normal young testes, Primary and secondary spermatogonia</td>
<td>Extremely abundant in both testes</td>
<td>Small</td>
<td>Absent</td>
<td>Both present</td>
<td>Quite large</td>
<td>Present</td>
</tr>
<tr>
<td>Narsogh</td>
<td></td>
<td>L. 3·8</td>
<td>L. 130</td>
<td>Absolutely degenerate, Single layer of nuclei round walls</td>
<td>L. Normal in amount</td>
<td>L. only</td>
<td>Absent</td>
<td>L. only</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Ghara</td>
<td></td>
<td>L. 5·3, R. 6·5</td>
<td>L. 120, R. 75</td>
<td>L. Up to pachytene</td>
<td>R. Normal in amount</td>
<td>Present</td>
<td>Present</td>
<td>Quite large</td>
<td>Quite large</td>
<td>Present</td>
</tr>
<tr>
<td>Selet</td>
<td></td>
<td>R. More than normal in amount</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* L. = left side.
R. = right side.