Rana agilis. His assertion that the pads of *Alytes obstetricans* are not pads because they have a different appearance from those of *Rana agilis* is as unreasonable as it would be to maintain that *Alytes obstetricans* is not a Batrachian because it does not look like *Rana agilis*.

Lastly, a few words on the question of adaptation. In my lecture I avoided speaking of adaptation because this term involves a hypothetical and teleological element: I feared that to use it might lead to endless unfruitful discussion. Unfortunately, I was unable to prevent this; Mr. Cunningham discussed his own theory of adaptation in a way that had little to do with the facts which I had cited. I definitely declined to enter into this subject in my reply, simply because it is not usual for the discussion to wander so far from the subject of the lecture. So far as the nuptial pads are concerned, may I refresh Mr. Bateson's memory so far as to remind him that not only my Alytes but also other Batrachians, and especially the Discoglossidæ (to which Alytes belongs), have pads on places which never come into contact with the female? *Bombinator pachypus*, for example, develops pads on two or three toes of the *hind* foot (cf. Schreiber, "Herpetologia Europæa," 1912, p. 175). Are these "in the wrong place" or "retouched" by Nature?

I willingly admit that the traditional explanation of the pads, namely, that they are produced by friction with the skin of the female, may possibly be a fable: for that reason I have referred to this view with reserve and scepticism in my paper (1919, pp. 331, 339, 353). It is true that the spread of the thickening to regions of the skin which in the copulatory act do not undergo friction, is no valid ground for rejecting the theory. Mr. Bateson has doubtless himself observed that pressure thickenings and blisters often extend beyond the original zone of irritation. But it is by no means impossible, although of course not proved (Kammerer, 1919, p. 340), that life in water produces the pads; if this were so we should have a case of direct passive production but not of active adaptation. The correctness of my observations and their relevance to the theory of heredity, is not affected whichever of the explanations is adopted.

PAUL KAMMERER.

DR. BATESON, in a letter to NATURE of June 2, raises the very interesting point as to whether the appearances alleged to be "nuptial pads" in *Alytes obstetricans* are really such. Whatever their nature, they are undoubtedly organised structures; and if they should prove not to be "nuptial pads," they will have to be regarded as a new and arbitrary feature which has appeared after subjection to an experimentally altered environment for two or three generations, and which persists for at least a few generations after a return to normal conditions. In other words, it would seem that Dr. Kammerer has had success in an experiment which is almost analogous to those ancient researches in which was attempted the reproduction by hereditary means of a surgically impressed modification.

However, Dr. Kammerer has clearly stated that in his opinion the only feature of the experiment which in any way justifies such a view is that the excrescences in question are not dependent for their development on the presence of a testis, and in this differ from the nuptial pads of the better known Amphibia Anura.

Dr. Bateson points to two details which make "the appearance quite unlike that of any natural *Brunftschwielen*": first, that in Alytes there is a "dark uniform surface . . . without the dotting or stippling so obvious in true *Brunftschwielen*"; secondly, that their position does not correspond to that of the nuptial pads in *Rana agilis*.

Lataste's excellent drawings (*Ann. Sci. Nat.* (6), tom. 3, pl. 11, 1876) show that a uniform blackness of the outer layer of the pad is a characteristic feature of the Discoglossidæ (to which Alytes belongs) and distinguishes them from other Anura. The fully developed pads of *Bufo vulgaris* are also uniformly black, and I have recently found that when such full hypertrophy of the outer epithelium is inhibited, as occasionally happens from obscure causes, it may be induced by making the male maintain a sexual embrace for a week or two. The same effect may be produced in the summer condition of the pad, and I have found that the hypertrophy takes place even when the male maintains his tonic embrace on thin air.[1]

The pad of the Alytes "water-breed" also resembles that of the Discoglossid Bombinator in having a complete layer of black pigment in the cutis vera which would further contribute to the uniform dark appearance which Alytes so well and characteristically shows. Photographs show another interesting point. Very distinct connective-tissue papillæ are developed from the cutis vera in association with the epidermal spines. Such papillæ are but very slightly developed in the Discoglossidæ, though Lataste's picture of Discoglossus shows traces, whilst they are a characteristic feature of the pads of many other Batrachians.

The epidermal spines are very obvious in the intact specimen, as I have repeatedly seen both with lens and binocular microscope, and as many others have witnessed in my presence. Of course, they are practically impossible to photograph on account of the glistening of a wet specimen, but a photograph at least makes clear what areas of skin are affected. These include nearly the whole of the palm, the radial surface of the inner metacarpal and part of the first phalangeal joint of the thumb, and more or less of the ventral and radial surfaces of the forearm, passing over the dorso-radial margin of the inner carpal tubercle. The Discoglossidæ are remarkable for the very various positions in which the histological features of *Brunftschwielen* may manifest themselves, on the chin, belly, thighs, toes of the feet even; in other words, they are not necessarily dependent on contact with the female for their development. Dr. H. Gadow has shown me his sketch of the nuptial pad in *Alytes cisternasii*, Bosca., where it is developed on the tip of the thumb, extending on the palmar surface. Even in the common toad I have frequently observed the nuptial rugosity extending on to the palmar surface of the inner carpal tubercle.

Questionable as it is to draw conclusions on anatomical points by analogy from other animals, it is even more unsafe to do so as regards their habits and postures; Alytes does not belong even to the same suborder as *Rana agilis*. De l'Isle (*Ann. Sci. Nat.* (6), tom. 3, p. 18), in his account of the cervical clasp of Alytes, says with regard to "les paumes," "les applique contre le cou de la femelle." Moreover, although he gives no definite description of the attitude of the hands during the inguinal clasp, he describes how, with the fingers interlaced, the two backwardly directed internal digits participate in the well-known chafing of the cloaca, which seems to me anatomically impossible if the hands are so much everted that the palms do not come in contact with the pubic region, the groins, or at least the thighs of the female.

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June 16.

[1] The surgical details of this experiment are of no importance in the present connexion.