Letters to the Editor.

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Heredity.

MAY I bring the following considerations before readers of NATURE interested in the study of heredity and evolution? I daresay I am wrong, but I should be glad to learn just how I am wrong.

The multicellular individual springs from a germ-cell. Presumably he inherits solely through that cell. In the germ are none of the characters which he afterwards develops—limbs, scars, instincts, knowledge, and the like. These are characters not of a cell, but of a cell-community—the soma. The germ contains nothing but potentialities (powers, capacities, diatheses, tendencies) for producing in its massed cell-descendants these communal characters in response to fitting influences (stimuli)—food, internal secretions, heat, light, moisture, functional activity (use), injury, and the like. Strictly speaking, therefore, nothing is inherited save potentialities—powers to develop in this way and that in response to this and that stimulus. Lacking the right influences, an individual may not reproduce all that he inherits, but he can reproduce nothing that he did not inherit. Reproduction is inheritance *plus* development. In the case of variations development occurs without inheritance; the individual does not then reproduce; he merely produces. Such colloquialisms as "The son has inherited his father's muscles" do no harm so long as the real truth be borne in mind; but if the truth be forgotten, endless loose thinking, confusion, and futile discussion may result, and often has resulted, as we shall see presently. Problems concerning potentialities are, of course, matters for the student of heredity. Problems concerning reproduction (as to what influences cause development) are equally, of course, matters not for the student of heredity, but for the student of physiology.

The sum of the potentialities in the germ whence the individual springs is his nature; the sum of the influences which play on him and cause, or prevent, or change his development is his nurture. Both nature and nurture are necessary and equal factors in the development of all characters. The query as to whether nature or nurture is the stronger is akin to a query as to whether the steam or the engine is the more potent in moving the train. Nature and nurture are never warring, but always co-operating, factors.

Individuals differ by nature and by nurture. They vary, and then their differences are *innate* or *germinal*. They are modified, and then their differences are *acquired* or *somatic*. Obviously, the words in italics are used intelligibly when employed to describe likenesses and differences between *individuals*. Thus we know what is meant when we are told that one man is by nature or by nurture darker than another. But, obviously again, they are used incorrectly and unintelligibly when employed to describe likenesses and differences between characters. How, for example, is a head more innate and germinal and less acquired and somatic than a scar? Can anyone tell us in precise language? The scar is as much founded on germinal potentiality as is the head; the head is as much a product of nurture and as much situated in the soma as is the scar. Evolution has so fashioned the race whence the individual sprang (has conferred

on it such a nature) that, given a certain kind of nurture, he produces a head, and given another kind of nurture, he produces a scar. Plainly, all characters are both innate and acquired, germinal and somatic, in precisely the same sense and degree. Plainly, also, inheritance (e.g. of latent ancestral traits) is one thing, while reproduction is another and quite a different thing.

Of course, we may, if we please, give arbitrary, limited, unusual meanings to our words. But we shall then, with the multiplicity of meanings, risk confused thinking. As Bacon said, "Men believe that their reason rules over words; but it is also the case that words react, and in their turn use their influence on the intellect." Thus we may limit the terms "acquired" and "somatic" to those characters which develop in response to use and injury, while reserving the terms "innate" and "germinal" for all other characters. This, indeed, is commonly done. Thus the abnormal musculature of the blacksmith is termed "acquired," while the normal development of the ordinary man is supposed to be innate. But the result is confusion worse confounded, for the muscles of the ordinary man also develop from birth forwards in response to use. Like most human structures, unused muscles, even in childhood, do not develop; they atrophy; they owe not only their development, but even their maintenance to use. If, then, we give these meanings to our words, we must apply the term "acquired" to vastly more than we do now, and we must go back to the infant, or beyond him, to find the natural man. Or, again, the word "innate" may be limited to the "normal," and "acquired" to the "uncommon." In that case we should have to term variations "acquirements," and call the English language germinal in England and acquired in France. In fact, no matter what arbitrary meanings we take, the moment we embark on them we are swamped in a sea of confusion.

Darwin founded his theory of natural selection on the supposition that innate likenesses and differences between individuals were transmissible. However he expressed himself at times, his meaning was usually clear. Lamarck founded his theory on the supposition that acquired likenesses and differences between individuals were transmissible; but he expressed himself in terms of characters, and his meaning, as we shall see immediately, was never clear. Gradually, especially after the advent of Weismann, discussion centred more and more on characters, some of which were termed "germinal" and others "somatic." At present most biologists hold that "acquired characters are not transmissible." But here again, can anyone explain precisely what he means? So far as I am able to judge, that pronouncement is neither true nor untrue; it is purely nonsensical.

Consider the following, which I think most biologists will consider true, and, I suppose, all will consider intelligible: "Heads, being germinal characters, are inheritable; but scars, being somatic, not germinal, are not inheritable." But since only potentialities are present in the germ, all we can mean by the statement that heads are transmissible is that offspring, inheriting like natures from their progenitors, reproduce, under like conditions, like heads. If we gave our words the same meanings, we should say that a scar is inherited when a child reproduces it under the same conditions as the parent did (i.e. in response to the nurture of injury). The child would then be like, both by nature and by nurture, to the parent. But no biologist regards a scar so reproduced as inherited. It would be regarded as inherited only if the child reproduced it

in a way in which the parent did not, and could not, have produced it, *i.e.* only if the child became profoundly different by nature from the parent, *only if it varied*. It follows that the word "inherit" (because often used as synonymous with "reproduce") is employed, commonly but quite unconsciously, with two directly opposite meanings. When applied to "germinal" characters it is given its ordinary meaning; it then means *inherit* (in the only sense in which anything can be said to be inherited). When applied to "acquired" characters it means *vary*. All this loose use and misuse of words—innate, germinal, acquired, somatic, inherit, reproduce—is a legacy from the days, before the discovery of cells, when students of heredity thought in terms, not of the germ-tract, but of the whole individual, the soma. "Germinal" and "somatic" are modern terms, but they reproduce ancient, inaccurate, popular ideas. The result has been half a century of futile labour, discussion, and confusion. If it be thought that I am mistaken as to all this, can anyone tell us in precise terms what in the world the Lamarckian controversy was *about*; or what is meant when it is said that some characters have "representatives in the germ-plasm" while others are merely due to "light, heat, moisture, and the like"; or what is intended when an inquirer seeks to ascertain to what categories (germinal or somatic) certain characters belong, and so on?

Is not the following universally and indisputably true? Does it not cover the whole Neo-Darwinian-Lamarckian field, and much besides? *The sole antecedent of non-inheritance is variation. Apart from variation, like exactly begets like when parent and child develop under like conditions.* But if this general statement be true, the study of heredity is relatively simple. Its difficulties have resulted not so much from the complexities and obscurities of reality as from those of language.

The natural inference from the discovery of cells and their mode of origin is that heritage travels down the germ-tract. The *necessary* inference from this, in turn, is that all the characters of the individual are innate, acquired, and inheritable in exactly the same sense and degree. The inference which Weismann, hypnotised by words, drew was that acquired characters are not transmissible. If we give our words their natural meanings (which is not the meaning the Lamarckians gave), there is sense in the statement that acquired characters are transmissible. *Of course*, acquired characters are transmissible in exactly the same sense and degree that any characters are transmissible. But there is absolutely no meaning in the Neo-Darwinian statement that acquired characters are not transmissible. It is like a declaration that five miles weigh five pounds.

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Squalodont Remains from the Tertiary Strata of Tasmania.

DURING a recent visit to the north-west coast of Tasmania I was fortunate enough to discover in the Tertiary beds at Wynyard—usually regarded as Miocene—the skull and a good proportion of the skeleton of a Squalodont whale. The fossil is in a particularly good state of preservation, and has been

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removed to the biological department of the University of Tasmania.

The remains so far discovered in Australia which can be assigned definitely either to the Archæoceti or to the primitive Odontoceti comprise in all some six or seven teeth, so that the present discovery is of more than passing interest. A detailed description of this specimen will be published later, but I have thought that a preliminary notice might be of interest to British naturalists.

The following is a short summary of the characters of the skull of this fossil:

Measurements.—Total length, 56 cm.; zygomatic breadth, 37.6 cm.; snout length (from bottom of antorbital notch), 25.5 cm. Whole skull, dolphin-like; snout shorter in proportion to skull than in Squalodon, longer than in Prosqualodon or Patriocetus; shape of snout triangular, but slightly concave on each side. Nasal bones similar to those of Prosqualodon. External nares not so far back as in Squalodon. Supra-orbital plate of frontal not entirely covered by the supra-orbital process of the maxilla. Supra-occipital strongly developed, meeting frontals anteriorly, and so preventing the parietals from entering into the formation of the skull-roof. Symphysis

FIG. 1.

of mandible extends to posterior edge of first molar.

Dental formula: $I \frac{3}{3}, C \frac{1}{1}, P \frac{4}{4}, M \frac{6}{6}$ (Van Beneden's notation).

Posterior molar in each jaw degenerate. All molars two-rooted, with indications of disappearing third root. Roots of molars connected by an isthmus as in Prosqualodon; roots of premolars coalesced, though separated by a groove in some cases. All teeth closely packed in jaw, sometimes overlapping. Molars with three cusps on each edge, making, with the primary cusp, seven cusps in all. Pattern of surface of molar teeth can be seen from Fig. 2, (B) and (C).

The arrangement of the bones of the skull-roof marks this skull as being that of a Squalodont, but there are features in which the specimen closely approaches the Archæoceti, *e.g.* in the form of nasals, the position of the external nares, and the shortness of the rostrum. The problems centring round the dentition need not be discussed here.

It is possible that these remains might be referred to one of the genera Parasqualodon and Meta-squalodon founded by Hall on an examination of the Australian teeth referred to above.

This is a point on which a definite opinion can be given only after a detailed examination of the teeth in the National Museum, Melbourne. I have refrained, therefore, from referring the specimen to any genus.

With regard to the figures accompanying this letter, Fig. 1 shows the skull from the right side, and Fig. 2 (A) the posterior premolar, (B) the fourth molar,