that is to say, of anabolism and katabolism. Were these steps made a new synthesis would be reached, and from this point it should even next be possible to retrace the progress of the science, and interpret the forms and the functions of tissues and organs, nay, even of the facts of aspect, habit, and temperament, so furnishing the deductive rationale of each hitherto merely empirical order of ob­served fact and connecting theory.

While this conception does not admit of development within the present limits, @@1 a brief abstract of such an interpretation of reproduction and of sex in terms of anabolism and katabolism may be of interest to the reader. The theory of reproduction, in general principle at least, is simple enough. A continued surplus of anabolism involves growth, and the setting in of reproduction when growth stops implies a relative katabolism. This in short is merely a more precise restatement of the familiar antithesis between nutrition and reproduction. At first this disintegration and reintegration entirely exhaust the organism and conclude its individual existence, but as we ascend the process becomes a more and more localized one. The origin of this localization of the reproductive function may best be understood if we figure to ourselves a fragment of the genealogical tree of the evolutionist in greater detail, and bear in mind that this is made up of a con­tinuous alternate series of sex-cell and organism, the organism, too, becoming less and less distinguished from its parent cell until the two practically coincide in the *Protozoa,* which should be defined not so much as “ organisms devoid of sexual reproduction ” but rather as undifferentiated reproductive cells (protosperms or protova, as they might in fact be called), which have not built up round them­selves a body. We should note, too, how the continuous immortal stream of Protozoan life (see Protozoa) is continued by that of ordinary reproductive cells among the higher animals, for the mor­tality of these does not affect this continuity any more than the fall of leaves does the continued life of the tree. The interpreta­tion of sex is thus less difficult than might at first sight appear. For anabolism and katabolism cannot and do not absolutely bal­ance, as all the facts of rest and motion, nutrition and reproduc­tion, variation and disease, in short of life and death, clearly show. During life neither process can completely stop, but their algebraic sum keeps varying within the widest limits. Let us note the result, starting from the undifferentiated amoeboid cell. A surplus of ana­bolism over katabolism involves not only a growth in size but a reduction in kinetic and a gain in potential energy, *i.e.,* a diminu­tion of movement. Irregularities thus tend to disappear ; surface tension too may aid ; and the cell acquires a spheroidal form. The large and quiescent ovum is thus intelligible enough. Again starting from the amoeboid cell, if katabolism be in increasing preponderance the increasing liberation of kinetic energy thus implied must find its outward expression in increased activity of movement and in diminished size ; the more active cell becomes modified in form by passage through its fluid environment, and the flagellate form of the spermatozoon is thus natural enough. It is noteworthy, too, that these physiologically normal results of the rhythm of cellular life, the resting, amoeboid, and ciliate forms, are precisely those which we empirically reach on morphological grounds alone (see Morphology, vol. xvi. p. 841).

Given, then, the conception of the cellular life rhythm as capable of thus passing into a distinctly anabolic or katabolic habit or diathesis, the explanation of the phenomena of reproduction becomes only a special field within a more general view of structure and function, nay even of variation, normal and pathological. Thus the generality, use, and nature of the process of fertilization become readily intelligible. The profound chemical difference surmised by so many authors becomes intelligible as the outcome of anabolism and katabolism respectively, and the union of their products as restoring the normal balance and rhythm of the renewed cellular life. Without discussing the details of this, farther than to note how it resumes the speculations of Rolph and others as to the origin of fertilization from mutual digestion, of the reproductive from the nutritive function, we may note how they illustrate on this view that origin of fertilization from conjugation which is the central problem of the ontogeny and phylogeny of sex. The formation of polar vesicles seems thus an extrusion of katabolic (or male) elements, and conversely its analogues in spermatogenesis (see Reproduc­tion). Passing over such tempting applications as that to the explanation of segmentation and even subsequent developmental changes, it must suffice to note that the constant insistance of embryologists upon the physiological importance of the embryonic layers bears essentially upon their respective predominance of ana­bolism and katabolism. The passage from ordinary growth to that discontinuous growth which we term asexual reproduction, and from this again to sexuality or the frequent reverse progress, is capable of rational interpretation in like manner: the “ alternation of gene­

rations” is but a rhythm between a relatively anabolic and katabolic preponderance ; a parthenogenetic ovum is an incompletely differ­entiated ovum which retains a measure of katabolic (male) products, and thus does not need fertilization ; while hermaphroditism is due to the local preponderances of anabolism or katabolism in one set of reproductive cells or in one period of their life. The reversion of unisexual forms to hermaphrodite ones, or of these to asexual ones, which we have seen in such constant association with high nutrition and low expenditure, @@2 is no longer inexplicable. The female sex being thus preponderatingly anabolic, the importance of good nutrition in determining it is explained : menstruation is seen to be the means of getting rid of the anabolic surplus in absence of its fœtal consumption, while the higher temperature and greater activities of the male sex express its katabolic diathesis. The phenomena of sex, then, are no isolated ones, but express the highest outcome of the whole activities of the organism—the literal blossoming of the individual life. (P. GE.)

SEXTANT, an instrument for measuring angles on the celestial sphere. The name (indicating that the instru­ment is furnished with a graduated arc equal to a sixth part of a circle) is now only used to designate an instru­ment employing reflexion to measure an angle ; but originally it was introduced by Tycho Brahe, who con­structed several sextants with two sights, one on a fixed, the other on a movable radius, which the observer pointed to the two objects of which the angular distance was to be measured.

In the article Navigation the instruments are described which were in use before the invention of the reflecting sextant. Their imperfections were so evident that the idea of employing reflexion to remove them occurred independently to several minds. Hooke contrived two reflecting instruments. The first is described in his *Pοst- humοus Works* (p. 503) ; it had only one mirror, which reflected the light from one object into a telescope which is pointed directly at the other. Hooke’s second plan employed two single reflexions, whereby an eye placed at the side of a quadrant could at the same time see the images formed in two telescopes, the axes of which were radii of the quadrant and which were pointed at the two objects to be measured. This plan is described in Hooke’s *Animadversions to the Machina Coelestis of Hevelius,* pub­lished in 1674, while the first one seems to have been communicated to the Royal Society in 1666. Newton had also his attention turned to this subject, but nothing was known about his ideas till 1742, when a description in his own handwriting of an instrument devised by him was found among Halley’s papers and printed in the *Philosophical Transactions* (No. 465). It consists of a sector of brass, the arc of which, though only equal to one-eighth part of a circle, is divided into 90°. A tele­scope is fixed along a radius of the sector, the object glass being close to the centre and having outside it a plane mirror inclined 45° to the axis of the telescope, and intercepting half the light which would otherwise fall on the object glass. One object is seen through the tele­scope, while a movable radius, carrying a second mirror close to the first, is turned round the centre until the second object by double reflexion is seen in the telescope to coincide with the first.

But long before this plan of Newton’s saw the light the sextant in its present form had been invented and had come into practical use. On May 13, 1731, John Hadley gave an account of an “ octant,” employing double re­flexion, and a fortnight later he exhibited the instrument. @@3

@@@1 See paper by Geddes already mentioned at p. 721, footnote.

@@@2 Thus Marshall Ward has lately drawn attention to the association of parasitism with the disappearance of sexual reproduction in *Fungi (Quart. Jour. Micr. Sci.,* xxiv.).

@@@3 Hadley described two different constructions : in one the telescope was fixed along a radius as in Newton’s form, in the other it was placed in the way afterwards universally adopted ; an octant of the first construction was made as early as the summer of 1730, according to a statement made to the Royal Society by Hadley’s brother George on Feb. 7, 1734.