shuttle and rotary-hook machines work with great smoothness and rapidity.

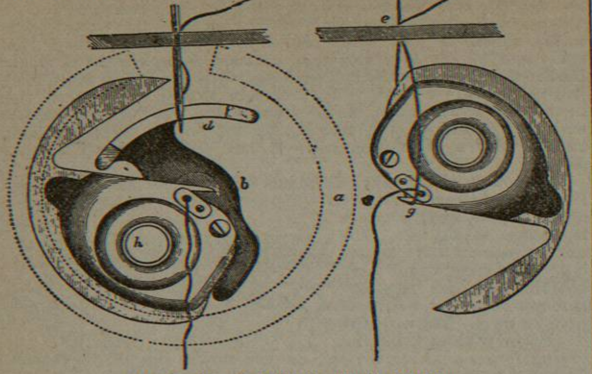


FIG. 7.—Singer's Oscillating-Shuttle Machine.

There are numerous special sewing machines adapted for leather work, glove-sewing, &c., some of which will be alluded to under SHOES. (J. PA.)

SEX. Since the article REPRODUCTION (*q.v.*) includes not only some account of the reproductive processes but an outline of the comparative anatomy of the reproductive organs, and even a somewhat detailed description of the essential sexual elements, it only remains here to make a brief survey of the more important groups with respect to the absence, union, or distinction of the sexes and to the associated "secondary sexual characters" which distinctly male and female organisms so frequently and strikingly present, and to follow up that outline of the morphological facts with a brief discussion of the nature and origin of the sexes and of the theory of reproduction.

Characters of the Sexes.—Starting with the *Protozoa*, we find indeed that union or conjugation of two or more individuals is of frequent if not universal occurrence; yet, since, at any rate with rare and slight exceptions, no permanent morphological difference can be made out which would entitle us to speak of males or females, the group is generally defined as characterized by the absence of sexual reproduction. Without at present accepting or rejecting this view, it is convenient to postpone its discussion until the origin of sex comes to be considered.

Passing to the *Cœlentera*, we find among the *Hydromedusæ* the sexes usually distinct, and this distinction of the sexes has lately been traced back to the apparently asexual colonies from which the gonophores arise. Exceptions, however, occur,—*e.g.*, *Tubularia*, which is monœcious. The higher *Medusæ* are also usually unisexual, and occasionally even show secondary sexual differences, as in the form and length of the prehensile filaments (*Aurelia*). *Chrysaora*, however, is hermaphrodite. The *Siphonophora* usually present both sexes within a single colony,—the gonophores themselves being, however, unisexual. In a few cases (*Apolemia uvaria*, *Diphyes acuminata*) the colony itself is entirely male or female. The *Ctenophora* are invariably hermaphrodite; and among the *Hexactinia* this is frequently though not generally the case, completely diœcious colonies even occurring (*Gerardia*). Among the *Octactinia* the sexes are usually distinct, even so far as the colonies are concerned, yet there are many exceptions, *e.g.*, *Corallium*, which has male, female, and hermaphrodite polyps on the same stock. See HYDROZOA, CORALS, &c.

The *Echinodermata* are very rarely hermaphrodite (*Synapta*, *Amphiura squamata*), but secondary sexual characters are almost unknown. *Thyone*, however, has the male orifice on a small protuberance. See ECHINODERMATA.

Probably no invertebrate group presents so varied and interesting a series of sexual phenomena as the *Vermes*. Thus the *Polyzoa* exhibit that remarkable association of hermaphroditism with asexual reproduction which so frequently recurs in organisms of vegetative habit. The Brachiopods also are hermaphrodite, as also are the Oligochætes; the *Polychæta* only exceptionally so; some (*Nereidæ*) exhibit secondary sexual characters so well marked as to have been mistaken for specific or even generic ones. The *Platyhelminthes* with few exceptions are hermaphrodite; the Nemerteans (except *Borlasia*) are unisexual and occasionally exhibit secondary sexual differences. The Nematodes are very rarely hermaphrodite (*Ascaris*, *Pelodytes*), but present very marked sexual differences, the male being usually recognizable by smaller size and caudal curvature. Spicules or claspers for copulation are also present. In *Strongylus* the female is carried by the male in a ventral furrow. The aberrant nematoid *Echinorhynchus* is also diœcious. *Sagitta* is hermaphrodite; *Balanoglossus* unisexual, but without secondary sexual difference. Some of the most striking cases of sexual dimorphism are presented by the *Rotifera*, where the male is often a fallen representative of the specific type presented by the female, having not only greatly diminished in size but having undergone thorough degeneration in structure, the alimentary canal especially becoming represented by a mere imperforate thread of cells. Nor are such cases of male degeneration by any means confined to this group: a yet more striking instance is presented by the Gephyrean *Bonellia*, in which the oviduct of the large and well-grown female contains a number of almost microscopic ciliated Turbellarian-looking parasites, which have been shown to be the degenerate males. The other *Gephyrea* present no such extraordinary dimorphism, while the *Discophora* are hermaphrodite. See POLYZOA, BRACHIOPODA, ANNELIDA, NEMERTEANS, PLANARIANS, TAPEWORM, SAGITTA, LEECH, &c.

Among Crustaceans the males are frequently smaller or relatively dwarfish, sometimes attached parasitically to the female, and the sexes are generally distinguishable at least by differences in the structure of some of the appendages,—generally, however, in evident relation to their respective functions. Among the Copepods the sexes are separate, and a marked tendency to dimorphism is manifested, even among the free-living forms. This is sometimes manifested in a way which suggests the sexual magnificence of the highest animals; thus, for instance, the male *Sapphirina* has the brilliance of a gem. With the appearance of parasitism in the group the reproductive relations become profoundly modified; thus it is the always less active female which first becomes sessile and parasitic; the male occasionally permanently retains freedom, as in the common *Nicothoe* of the lobster's gill; more usually, however, he settles down beside or even upon the female and becomes more or less completely epi-parasitic, undergoing a more thorough degeneration than the female herself. The analogous series from free to parasitic forms furnished by the *Ostracoda* and *Cirripedia* are yet more remarkable in their sexual degeneration, since not only does hermaphroditism become the rule, but "complementary males" (most frequently two to one female) appear. These are utterly degenerate in size and structure, in fact often quite unrecognizable as Cirripedes at all, much less as members of the same species, save for their developmental history and the existence of a few intermediate degrees of degeneration between the normal and the lost Cirripede organization, *e.g.*, *Ibla* or *Scalpellum*, where the males of some species still retain cirri and buccal pieces. In some cases at least their male reproductive function seems to be discharged early in larval life, before the exchange of free for sessile habits, their subsequent life apparently even sinking below the level of reproductive activity. A reversal of sex has actually been alleged in some cases, the males having been said to become female. In the Phyllopods the sexes are separate, but parthenogenesis very frequently occurs, as in *Daphnia*, *Apus*, &c., and even in *Apus* tends to replace sexual reproduction very completely. Von Siebold examined thousands of specimens during twelve years without finding a single male; in other years, however, from 10 to 45 per cent. of males have since been found. Besides the usual copulatory modifications of appendages the males of some Phyllopods have more olfactory filaments on the antennæ. In Amphipods similar differences have been noted; in Isopods these often become much more marked,—sometimes, as in the classical case of *Praniza* and *Anceus*, reaching a degree of dimorphism without degeneration which is hardly exceeded in the animal kingdom, and which quite naturally led to the separation of the sexes into distinct genera. In the parasitic forms (*Bopyridæ*) the females degenerate much more thoroughly than the small and active males. The Schizopods exhibit considerable sexual differences. Thus among the males the antennæ bear larger olfactory comb-like structures and larger abdominal members; copulatory appendages may also be specialized; while the females, as in many Isopods, &c., have a brood-pouch formed of overlapping ventral lamellæ. The different position of the sex-openings and the characteristic forms of the limbs render the sexes easily distinguishable among the Decapods; the crabs have an obviously broader abdomen in the female (see CRUSTACEA). Among the *Arachnida*, the archaic king-crabs already show slight external sex-differences; among the spiders the males have a maxillary palp specially modified for a copulatory organ, an adaptation which, associated with their often extremely small size, is of great importance in aiding their escape from their larger and ferocious mates. Some species of *Theridium* have a stridulating apparatus. The male scorpions on the other hand seem to possess a rather stronger development; in the *Acarinæ* the smaller males are more distinctly segmented, possess appendages modified for attachment, and sometimes retain a free habit of life as distinguished from the parasitic females. See ARACHNIDA.

Among Insects the sexes are distinguished by varying modifications of different parts of the body, and differences in general form and in colour are frequent. The males are generally active and more beautiful, and seem better endowed with sense organs, though usually smaller than the females. The males have also a pre-eminence or even monopoly in producing sounds, and it is perhaps in relation to this that the psychology of sex can first be said to come within the range of observation. Thus the field-cricket is said to lower the tone of his song while caressing the female with his antennæ. In the parasitic forms dimorphism, as might be expected, becomes very marked; in *Strepsiptera* the males are free and winged, while the females are blind and wingless, in fact, permanently larval. Similar cases occur in other orders, the glow-worm being probably the most familiar instance. In parasitic or abundantly nourished forms parthenogenesis very frequently appears, the extreme case being presented by *Cecidomyia*, a fly which exhibits rapid parthenogenetic reproduction in the larval state. The dimorphism of many beetles, in which the male frequently acquires the most extraordinary specializations of external form, has received especial attention from Darwin, whose *Descent of Man* includes the fullest details. Here it is enough to mention that Reichenau has recently pointed out the coexistence of the larger size and relative inactivity of the male with the presence of these functionless outgrowths. The beautiful sexual dimorphism so common among the Lepidoptera need not be more than mentioned at present; while the very remarkable sexual differentiation of *Hymenoptera* (bees, ants, sawflies, &c.) may also be assumed to be sufficiently familiar. See INSECTS, ANTS, BEES. In several orders (*Diptera*, *Lepidoptera*, *Coleoptera*) cases of dimorphism occur among the females themselves, or even among the males; as many as three forms of females have been described in certain butterflies.

The Molluscan series opens with the normally diœcious Lamellibranchs, of which some genera (most species of *Ostrea*, *Pecten*, &c.) are, however, hermaphrodite. The Pteropods, Pulmonates, and Opisthobranchs are hermaphrodite; the Prosobranchs, Heteropods, and Cephalopods unisexual. Though slight differences have been described even in Lamellibranch shells (*Unio*), and though the internal anatomy of the essential and accessory organs is of very high complexity, the extraordinary phenomena associated with "hectocotylization" among the Cephalopod are the only marked outward manifestations of that sexual dimorphism which reaches its climax in the Argonaut. (See MOLLUSCA, CUTTLE-FISH.) The Tunicates are usually hermaphrodite; *Amphioxus*, however, is unisexual (see TUNICATA).

Among Fishes hermaphroditism is extremely rare (*Serranus*). The males are sometimes characterized by the modification of the pelvic limbs as claspers, &c., and are at the reproductive period often readily distinguishable from the females by their brighter colour or other cutaneous changes, such as ruffling of the skin. Male and female rays are readily also distinguishable by their teeth and dermal defences. The hooked jaw of the male salmon gives him a characteristic physiognomy during the breeding season. The carp undergoes a sort of epidermic eruption at the same period; male and female eels, too, are said often to become distinguishable both in colour and shape. Stridulating apparatus may be present, notably in the Siluroids. (See ICHTHYOLOGY.) Among Amphibians the bright dorsal crest of the male newt is perhaps the most striking of sex distinctions, but many male frogs and toads have vocal air sacs, epidermal callosities, and some (*Cultripes*, *Pelobates*) possess a gland under the fore-limb. (See AMPHIBIA.)

Among the Ophidians the males are smaller, and have longer and more slender tails; the sexes, too, differ sometimes in colour and markings. Male Chelonians, too, have sometimes longer tails and claws and may even give voice. The submaxillary musk-gland of the crocodile is especially active in the breeding season; the lizards have remarkable throat-pouches and crests, which may be epidermic or even correspond to cranial outgrowths, as in the chameleon.

But it is among Birds and Mammals that the observer of sexual characters finds abundant and remarkable differences extending to the minutest details, and showing how the higher evolution of parental care which the inevitably prolonged embryonic life involves and the wider range of sexual selection have co-operated in modifying the whole organism. As might be expected, the lower mammals show least of this; but as we ascend the adult males become differentiated from the females by the acquirement of secondary sexual characters which are mainly either offensive and defensive aids for battle with each other, or which assist in gaining the admiration of the females; and these may coexist or coincide in very various degrees. Thus scent-glands are of common occurrence from the *Insectivora* (perhaps even from *Ornithorhynchus*) upwards. Greater beauty of markings or more vivid colours are acquired,—in many *Anthropidæ* (baboons, &c.) the latter being of peculiarly crude magnificence. Abundant local growths of hair often appear, most notably in the lion and in many *Anthropidæ*. The development of tusks and horns is also too familiar to need more than passing mention.

But it is unquestionable that in this as in not a few other respects the birds, rather than the mammals, have reached the highest stages of evolution. For here sexual characters no longer seem merely superadded or supplementary to the apparatus of individual life, but habits and organization alike become thoroughly adapted to these—the sex-differences and the reproductive functions as it were saturating the whole life, and producing so many and marvellous results, in habits and character, in beauty and song, that it is not to be wondered at that the descriptive labours of the professed ornithologist have constantly risen into those of the artist and even the poet. See BIRDS, and Darwin's *Descent of Man*.

Nature and Determination of Sex.—It is not here proposed to enter upon the task of historical review and criticism of the various theories of sex—which were estimated at so many as five hundred at the beginning of the last century, or even to attempt any sketch of the present very conflicting state of opinion on the subject.[1]

Although our theories of sex may be still vague enough, the greatest step to the solution has been made in the general abandonment by scientific men of the doubtless still popular explanation—in terms of a "natural tendency" for the production of an excess of males or the like. It is now held that "quality and quantity of food, elevation of abode, conditions of temperature, relative age of parents, their mode of life, habits, rank, &c., are all factors which have to be considered." The idea that the problem of the nature of sex is capable of being approached by empirical observation of the numbers of different sexes produced under known sets of conditions, and the obvious practical corollary of this, viz., that the proportion of the sexes must therefore be capable of being experimentally modified and regulated, are conceptions which have steadily been acquiring prominence, especially of late. In short, if we can find how sex is determined, we shall have gone far to investigate sex itself.

One of the most crude attempts has been that of Canestrini, who ascribes the determination of sex to the number of sperms entering the ovum, but this view has been already demolished by Fol and Pflüger. The time of fertilization has also and apparently with greater weight been insisted upon; thus Thury, followed by Düsing, holds that the sex of the offspring depends on the period of fertilization: an ovum fertilized soon after liberation produces a female, while the fertilization of an older ovum produces a male. This view has been carried a step farther by Hensen, who suggests that the same should probably hold true of the spermatozoa, and thus the fertilization of a young ovum by a fresh sperm would have a double likelihood of resulting in a female. There are some observations which support this: thus Thury and other cattle-breeders have claimed to determine the sex of cattle on this principle, and Girou long ago alleged that female flowers, fertilized as soon as they are able to receive pollen, produced a distinct excess of female offspring.

Great weight has also been laid on the relative age of the parents. Thus Hofacker, so long ago as 1828, and Sadler a couple of years later, independently published a body of statistics (each of about 2000 births) in favour of the generalization (since known as Hofacker's and Sadler's law) that when the male parent is the elder the offspring are preponderatingly male: while, if the parents be of the same age, or *a fortiori* if the male parent be younger,

[1] As for reproduction in general, so for sex, the most convenient starting-point is the work of Hensen ("Die Zeugung," in Hermann's *Hdb. d. Physiologie*), while other dissertations are to be found in the leading manuals of zoology and botany, especially, however, in special papers too numerous to mention. See also REPRODUCTION, and for fuller bibliographical details see Geddes, "On the Theory of Growth, Reproduction, Sex, and Heredity," *Proc. Roy. Soc. Edin.*, 1886.

female offspring appear in increasing majority. This view has been confirmed by Goehlert, Boulanger, Legoyt, and others; some breeders of horses, cattle, and pigeons have also accepted it. Other breeders, however, deny it altogether; moreover, the recent statistics of Stieda and of Berner (taken independently from Alsace-Lorraine and Scandinavia) seem to stand in irreconcilable contradiction. At any rate at present we do not seem justified in ascribing greater importance to the relative age of parents than as a secondary factor, which may probably take its place among those causes influencing nourishment discussed below.

That good nourishment appears to produce a distinct preponderance of females is perhaps the single result which can at present be regarded as clearly proven and generally accepted. Yet it would be too much to say that unanimity is even here complete; thus, among plants, the experiments of Girou (1823), Haberlandt (1869), and others gave no certain result; those of Heyer (1883) have led him to dispute the validity of the generalization altogether, while Haberlandt (1877) brought evidence for regarding the excess of females as largely due to the greater mortality of the males. The investigations of agricultural observers, especially Meehan (1878), which are essentially corroborated by Düsing (1883), however, leave little doubt that abundant moisture and nourishment tend to produce females. Some of Meehan's points are extremely instructive. Thus old branches of Conifers overgrown and shaded by younger ones produce only male inflorescences, a fact which may be taken in connexion with Sadebeck's observation that some fern prothallia, under unfavourable conditions, can still form antheridia but not archegonia. The formation of female flowers on male heads of maize is ascribed by Knop to better nutrition consequent on abundant moisture. The only seriously contradictory observations are thus those of Heyer, and it is therefore reassuring when a detailed scrutiny of his paper shows his ill-conducted experiments (which land him in the conclusion that the organism is not modifiable by its environment at all) to be largely capable of a reversed interpretation. The agency of temperature is also of considerable importance. Thus Meehan finds that the male plants of hazel grow more actively in heat than the female, and Ascherson states that *Stratiotes aloides* bears only female flowers north of 52° lat., and from 50° southwards only male ones. Other instances might be given.

Passing to the animal kingdom we find the case of insects peculiarly clear; thus Mrs Treat showed that if caterpillars were starved before entering the chrysalis state the resultant butterflies or moths were males, while others of the same brood highly nourished came out females. Gentry too has shown for moths that innutritious or diseased food produced males; hence perhaps a partial explanation of the excess of male insects in autumn, although temperature is probably more important. The recent experiments of Yung on tadpoles are also very conclusive. Thus he raised the percentage of females in one brood from 56 in those unfed to 78 in those fed with beef, and in another supply from 61 to 81 per cent. by feeding with fish; while, when the especially nutritious flesh of frogs was supplied, the percentage rose from 54 to 92. Among mammals the difficulties of proof are greater, but evidence is by no means wanting. Thus an important experiment was long ago made by Girou, who divided a flock of 300 ewes into equal parts, of which the one half were extremely well fed and served by two young rams, while the other was served by two mature rams and poorly fed. The proportion of ewe lambs in the two cases was respectively 60 and 40 per cent. Düsing also states that it is usually the heavier ewes which bring forth ewe lambs.

Nor does sex in the human species appear to be independent of differences of nutrition. After a cholera epidemic or a war more boys are said to be born, and Düsing also points out that in females with small placenta and little menstruation more boys are found, and even affirms that the number of male children varies with the rise in prices. In towns and in prosperous families there are also more females, while males are more numerous in the country and among the poor. The influence of temperature is also marked: more males are born during the colder months, a fact noted also by Schlechter for horses.

The best known and probably still most influential theory is that systematized by Girou and known as that of "comparative vigour." This makes sex of offspring depend on that of the more vigorous parent. But to this view there are serious difficulties: thus consumptive mothers produce a great excess of daughters, not sons as might be expected from the superior health of the father. Still less weight can be attached to that form of the hypothesis which would make sex follow "genital superiority" or "relative ardency" alone. Any new theory has thus to reconcile the arguments in favour of each of the preceding views, and meet the difficulties which beset all. As Starkweather puts it, it must at once account for such facts as "the preponderance of male births in Europe, of females among mulattos and other hybrid races, as also among polygamous animals, and for the equality among other animals. More especially it must suggest some principle of self-adjustment by which not only is the balance of the sexes nearly preserved on the whole, but by which also in cases of special disturbance the balance tends to readjust itself." Starkweather proceeds to attempt this, and his argument may be briefly summarized. Whilst few maintain any essential equality of the sexes, and still fewer any superiority of the female, the weight of authority has been from the earliest times in favour of the doctrine of male superiority. From the earliest ages philosophers have contended that woman is but an undeveloped man; Darwin's theory of sexual selection presupposes a superiority in the male line and entailed on that sex; for Spencer the development of woman is early arrested by procreative functions: in short, Darwin's man is as it were an evolved woman, and Spencer's woman an arrested man. On such grounds we have a number of theories of sex. Hough thinks males are born when the system is at its best, more females when occupied in growth, reparation, or disease. So, too, Tiedman and others regard every embryo as originally female and remaining female if errested, while Velpau conversely regards embryos as all naturally male, but frequently degenerating to the female state. Starkweather points out some of the difficulties to the view of female inferiority, and lays it down as the foundation of his work that "neither sex is physically the superior, but both are essentially equal in a physiological sense." But, while this is true of the average, there are many grades of individual differences and deficiencies in detail, involving a greater or less degree of superiority in one or other of every pair. Starkweather's theory then is "that sex is determined by the superior parent, also that the superior parent produces the opposite sex." The arguments adduced in favour of this view, however, are scarcely worthy of it, since, save a chapter of pseudo-physiological discussion of vital forces and polarities, of superiority,—nervous, electrical, &c.,—they rest mainly on the vague and shifting grounds of physiognomy and temperament. And when superiority is analysed into its factors,—cerebral development and activity, temperament, state of health, of nutrition, &c.,—soon we find under the appearance of simplicity a law has been obtained not by discovering any real unity under the many

apparently different factors, but by simply lumping them under a common name. Nor is a rationale given of the affirmed reversal of sex, which Schlechter and other authorities moreover wholly deny. Despite these and other faults and failures the work is interesting and often suggestive, and that not only on account of its theoretic position but its sanguine proposals for the practical control of sex.

The work of Düsing (1883), while less speculative, is of great importance in respect to the causes which regulate the proportions of the sexes; since, instead of falling back with Darwin on the unexplained operation of natural selection, he seeks to note the circumstances in which a majority of one sex is profitable, and to show that organisms have really the power to produce in such circumstances a majority of one sex,—in short, that disturbances in the proportion of the sexes bring about their own compensation, and further supports these views by calculation and statistical evidence.

He separates the causes determining sex into those affecting (*a*) one parent and (*b*) both alike. Starting with a minority of one sex, he emphasizes the importance of delayed fertilization, accepting it as a fact that females late fertilized bear most males (this corresponding in man to a scarcity of males among the lower animals). He notes that the firstborn child is most frequently a male, especially among older persons, and thus explains how after a war, when there is a want of males, most male children are born. He ascribes importance to the amount of sexual intercourse. Thus, suppose a minority of females: their fertilization tends to occur more frequently, and thus (if the general statement be correct) they should produce a majority of their own sex; or similarly with males. This is supported by reference to cattle-breeding, and it is interpreted physiologically to involve that young spermatozoa produce a majority of males. Suppose a great majority of males: the chances of early fertilization of the females are of course great, but eggs fertilized early tend to produce females. Or suppose conversely a great minority of males: the chances of early fertilization are small, but old eggs tend to produce males, and either excess will thus become compensated. Or again, the more decided the minority of one sex the more frequent the sexual activity of its individuals, the younger their sexual elements, and consequently the more individuals of that sex are produced. Düsing next takes up as indirect causes equivalent to a minority of individuals—(*a*) deficient nutrition; just as frequent copulation overstrains the genital organs the same result may arise from the deficient nutrition of the system; hence an ill-fed cow yields a female to a well-fed bull and *vice versa*; (*b*) relative age; the nearer either parent is to the period of greatest reproductive capacity the less, he thinks, is a birth of that sex probable.

As factors affecting both parents he first discusses variations in nutrition; although means of subsistence may decrease, there is at first no decrease in the number of progeny. But it is necessary to distinguish the reproduction of the species from its multiplication, so that in defective nutrition, though an animal may not reproduce less, it will permanently multiply much less. He agrees with Darwin that the reproductive system is most sensitive to changes of nutrition; gives cases showing the effect of abundant nutrition on reproductive activity, notes the influence of climate, function, &c., and contrasts organisms of high activity, like birds and insects, with parasites. The nutritive relations of the sexes are also contrasted; since females have to give to the embryo more than the male, they are much more dependent on food for vigour of their reproductive capacity, and hence the frequent contrast of their size, &c. Furthermore, animals suit their multiplication to their conditions of nutrition; if food be abundant there is an increase in the number of females, and therefore a further increase in number of individuals of the species; if food, however, be too scarce the more males are produced and the number of the species tends to diminish. Hence the connexion above mentioned between increase of children (especially females) in prosperity and after a good harvest, and the rising proportion of boys during a rise of prices. Similarly for animals: the more food the more females, and the more rapidly the species increases; the less food the more males, and the less rapid the increase. Again, plants on good soil produce more female flowers and more seed with profit to the species; on bad soil male flowers preponderate, mostly perish, and the species tends to disappear. The extreme case of optimum nutrition tends to produce normal parthenogenesis ("thelytokie"), yielding only females, different in cause and operation from the parthenogenesis resulting from the absence of males ("arrenotokie").[1]

[1] See Düsing, *Jena Zeitschr.*, 1885; Starkweather, *Law of Sex*, 1883.

Theory of Reproduction and Sex.—If we now attempt to reach a rational standpoint from which to criticize and compare the innumerable empirical conceptions of sex,—much more if we seek a firm basis for the construction of a really comprehensive theory,—it is evident that such a theory must be addressed not merely to the specialist concerned with problems of reproduction and development, but, while embracing details and anomalies, must be satisfactory alike to the general morphologist and physiologist. We must therefore have before us that conception of the main lines of thought on each of these subjects which has been outlined under the headings PHYSIOLOGY and MORPHOLOGY.

The close coincidence between these two independent developments is especially to be noted. From the vague account of general form and appearance, of habits and temperaments, which made up the descriptive natural history of the past, the two streams of progress, though distinct, are wholly parallel. Thus Buffon furnished a brilliant and synthetic exposition of the oldest view, while one side of their general aspect received new precision at the hands of Linnæus,—to some extent the other also at the hands of his physiological contemporaries. The anatomical advance of Cuvier is parallel to the detailed study of the functions of the organs, while the great step made by Bichat lay in piercing below the conception of the organ and its function as ultimate, and in seeking to interpret both by reference to the component tissues. The cell-theory of Schwann and his successors analysed these tissues a step farther, while the latest and deepest analysis refers all structure ultimately to the substance called protoplasm, and similarly claims to express all function in terms of the construction and destruction, synthesis and analysis, anabolism and katabolism of this. See PHYSIOLOGY, PROTOPLASM, MORPHOLOGY.

Now, since every morphological and physiological fact or theory is in one or other of these few categories, it is evident that we have here the required criterion of theories of reproduction and sex. The question, What is sex? what is meant by male or female? admits of a regular series of answers. The first and earliest is in terms of general aspect, temperament, and habit, and, though crude, empirical, and superficial, it lacks neither unity nor usefulness. At this plane are not only most popular conceptions but many theories like that of Starkweather, which may be mentioned as the most recent. The anatomist contents himself with the recognition of specific organs of sex, or at most with a similarly empirical account of their functions; while the embryologist and histologist will not rest contented without seeking to refer these organs to the tissues of which they are composed and the layer from which they spring, and even reaches and describes the ultimate cellular elements essential to sex,—the ovum and spermatozoon. A parallel physiological interpretation of these is next required, and at this point appear such hypotheses as these of Weismann and others.

Thus the bewildering superabundance of widely different theories at the present juncture becomes intelligible enough; and, each once classified according to its stage of progress, a detailed criticism would be easy. But this is not enough: the demand for an explanation at once rational and ultimate, to comprehend and underlie all the preceding ones, is only the more urgent. Where shall we seek for it? On the one hand the morphological aspect of such an explanation must interpret the forms of sex cells in terms of those of cells in general, and in terms of the structural properties of protoplasm itself; while its more difficult yet more satisfying physiological aspect must express the mysterious difference of male and female in terms of the life processes of that protoplasm,—in terms, 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 amœboid 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 amœboid 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, amœboid, 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 generations" 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.)

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

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 *Posthumous 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 Cœlestis 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]

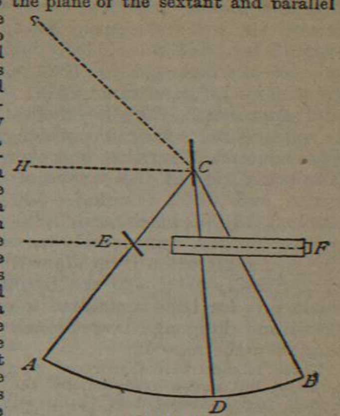
[2] Thus Marshall Ward has lately drawn attention to the association of parasitism with the disappearance of sexual reproduction in *Fungi* (*Quart. Jour. Micr. Sci.*, xxiv.).

[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.

On the 20th May Halley stated to the society that Newton had invented an instrument founded on the same principle, and had communicated an account of it to the society in 1699, but on search being made in the minutes it was only found that Newton had showed a new instrument "for observing the moon and stars for the longitude at sea, being the old instrument mended of some faults," but nothing whatever was found in the minutes concerning the principle of the construction. Halley had evidently only a very dim recollection of Newton's plan, and at a meeting of the Royal Society on December 16, 1731, he declared himself satisfied that Hadley's idea was quite different from Newton's. The new instrument was already in August 1732 tried on board the "Chatham" yacht by order of the Admiralty, and was found satisfactory, but otherwise it does not seem to have superseded the older instruments for at least twenty years. As constructed by Hadley the instrument could only measure angles up to 90°; but in 1757 Captain Campbell of the navy, one of the first to use it assiduously, proposed to enlarge it so as to measure angles up to 120°, in which form it is now generally employed.

Quite independently of Hadley and Newton the sextant was invented by Thomas Godfrey, a poor glazier in Philadelphia. In May 1732 Mr James Logan of that city wrote to Halley that Godfrey had about eighteen months previously showed him a common sea quadrant "to which he had fitted two pieces of looking-glass in such a manner as brought two stars at almost any distance to coincide." The letter gave a full description of the instrument; the principle was the same as that of Hadley's first octant which had the telescope along a radius. At the meeting of the Royal Society on January 31, 1734, two affidavits sworn before the mayor of Philadelphia were read, proving that Godfrey's quadrant was made about November 1730, that on the 28th November it was brought by G. Stewart, mate, on board a sloop, the "Truman," John Cox, master, bound for Jamaica, and that in August 1731 it was used by the same persons on a voyage to Newfoundland. There can thus be no doubt that Godfrey invented the instrument independently; but the statement of several modern writers that a brother of Godfrey, a captain in the West India trade, sold the quadrant at Jamaica to a Captain or Lieutenant Hadley of the British navy, who brought it to London to his brother, an instrument maker in the Strand, has been proved to be devoid of all foundation. Not only is this totally at variance with all the particulars given in the affidavits, but between 1719 and 1743 there was no officer in the British navy of the name of Hadley, and John Hadley cannot possibly have been in the West Indies at that time, as he was present at many meetings of the Royal Society between November 1730 and May 1731; besides, neither Hadley nor his brothers were professional instrument makers. A detailed discussion of this question by Prof. Rigaud is found in the *Nautical Magazine*, vol. ii. No. 21.[1]

The annexed figure gives an idea of the construction of the sextant. ABC is a light framework of brass in the shape of a sector of 60°, the limb AB having a graduated arc of silver (sometimes of gold) inlaid in the brass. It is held in the hand by a small handle at the back, either vertically to measure the altitude of an object, or in the plane passing through two objects the angular distance of which is to be found. CD is a radius movable round C, where a small plane mirror of silvered plate-glass is fixed perpendicular to the plane of the sextant and in the line CD. At D is a vernier read through a small lens, also a clamp and a tangent screw which enable the observer to give the arm CD a very slow motion within certain limits. At E is another mirror "the horizon glass," also perpendicular to the plane of the sextant and parallel to CB. F is a small telescope fixed across CB, parallel to the plane CAB and pointed to the mirror E. Dark glasses can be placed outside E and between E and C when observing the sun. As only the lower half of E is silvered, the observer can see the horizon in the telescope through the unsilvered half, while the light from the sun or a star S may be reflected from the "index glass" C to the silvered half of E and thence through F to the observer's eye. If CD has been moved so as to make the image of a star or of the limb of the sun coincide with that of the horizon, it is easy to see that the angle SCH (the altitude of the star or solar limb) is equal to twice the angle BCD. The limb AB is always graduated so as to avoid the necessity of doubling the measured angle, a space marked as a degree on the limb being in reality only 30′. The vernier should point to 0° 0′ 0″ when the two mirrors are parallel, or in other words, when the direct and reflected images of a very distant object are seen to coincide. For the methods of adjusting the mirrors and finding the index error see NAVIGATION (vol. xvii. p. 268).



Sextant.

If the sextant is employed on land, an artificial horizon has to be used. This is generally a basin of mercury protected from the wind by a roof of plate-glass with perfectly parallel faces; sometimes a glass plate is used (with the lower surface blackened), which can be levelled on three screws by a circular level. The telescope is directed to the image of the celestial object reflected from the artificial horizon, and this image is made to coincide with that reflected from the index-glass. In this case the angle BCD will be double the altitude of the star. Towards the end of last and the beginning of this century the sextant was much used on land for determining latitudes, but, though in the hands of a skilful observer it can give results far superior to what one might expect from a small instrument held in the hand (or attached to a small stand), it has on shore been quite superseded by the portable altazimuth or theodolite, while at sea it continues to be indispensable.

The principle of the sextant has been applied to the construction of reflecting circles, on which the index arm is a diameter with a vernier at each end to eliminate the error of eccentricity. The circles constructed by Pistor and Martins of Berlin have a glass prism instead of the horizon glass and are extremely convenient. (J. L. E. D.)

SEXTUS EMPIRICUS. See SCEPTICISM.

SEYCHELLES, an archipelago of the Indian Ocean, consisting of eighty islands—several of them mere islets—situated between 3° 38′ and 5° 45′ S. lat. and 52° 55′ and 53° 50′ E. long., about 1400 miles south-east of Aden and 1000 miles east of Zanzibar. They are the only small tropical oceanic islands of granitic structure, and rise steeply out of the sea, culminating in the island of Mahé, at an elevation of 2998 feet above the sea-level. The most northerly island is Bird, ½ by ¼ mile; the most southerly, Plate; the most easterly, Frégates; the most westerly, Silhouette. Mahé, the largest island of the group, 3 by 1½ miles, is very nearly central, 60 miles south of Bird, and having to the north and north-east of it La Digne, Félicité, Praslin, and Curieuse. Only a few—Mahé, Praslin, La Digne, Denis, and Bird—are inhabited. The total area is about 50,120 acres, of which Mahé alone comprises 34,749. The beaches of glistening calcareous sand are begirt by coral reefs which form a wall round the islands. The valleys and easier slopes are overlaid with a very fertile soil, and vegetation is most luxuriant. Though the climate is tropical, the heat is tempered and rendered uniform by the sea breezes, and probably this accounts for epidemic diseases and endemic fever being of uncommon

[1] John Hadley was a country gentleman of independent means, and the fact that he was the first to bring the construction of reflecting telescopes to any perfection has made many authors of astronomical books believe that he was a professional instrument maker. His brother George, who assisted him in his pursuits, was a barrister.

occurrence. There are numerous brooks and torrents, making their way to the sea between blocks of granite. The islands are green and fresh at all times, particularly during the wet season from November to May. The total rainfall for 1881 was 113·50 inches. The extreme range of the thermometer in 1881 and 1882 was only 22° (minimum 71°, maximum 93°). The heat is seldom sultry and oppressive. The Seychelles lie too far to the north to receive the hurricanes which occasionally sweep over Bourbon and Mauritius, and even thunderstorms are rare. The population at the census of 1881 was 14,081 (7179 males and 6902 females)—500 white (mostly French creoles), 11,500 black, and 2000 coolies. Since 1881 the population has considerably increased in consequence of a tide of immigration from Mauritius. Men and women of exceptionally great age are frequently met with, and the death-rate for 1880 amounted to only 13·1 per 1000. The prevailing language is a French patois, but English is taught in the schools.

These islands were discovered at the beginning of the 16th century, but never occupied, by the Portuguese. In 1742 the French took possession of them, calling them at first Îles des Labourdonnais, but afterwards the Seychelles, from Count Hérault de Seychelles, an officer of the East Indian fleet. The first settlement was made in 1768 at Mahé, now Port Victoria. In 1794 the English wrested them from the French along with Mauritius, and they are now ruled by a board of six civil commissioners, as a dependency under the governor of Mauritius. In 1834 slavery was abolished, and since then the plantations have been in a declining state. In 1884 there were in the islands 20 primary schools aided by Government grants and attended by 1620 children. There are 16 churches belonging to the Roman Catholics (the dominant faith) and 11 to the Church of England. The main product is the cocoa-nut, but tobacco, coffee, rice, maize, sweet potatoes, and manioc are raised for home consumption, while cotton, pepper, cinnamon, and other spices grow wild. Many of the trees display simultaneously blossoms and unripe and ripe fruit. The so-called sea or Maldive double cocoa-nut, "coco de mer," the fruit of the palm-tree *Lodoicea Sechellarum*, is peculiar to certain of these islands. It was long known only from sea-borne specimens cast up on the Maldive and other coasts, was thought to grow on a submarine palm, and, being esteemed a sovereign antidote to poisons (*Lusiad*, x. 136), commanded exorbitant prices in the East. This palm will grow to a height of 100 feet, and shows fern-like leaves of enormous size. Sensitive plants from America spread like lawns over the soil and quake at every step taken over them. The cocoa-nut palm flourishes in the gardens, overtopping the houses and most other trees, lining the shore, climbing high up the mountains, and in many places forming extensive forests. There are no native mammals, and domestic animals are scarce. The birds comprise gannets, terns in great numbers, and white egrets. Tortoises are common,—among them the gigantic turtle and black turtle, whose flesh is exported. The sea abounds in fish, many of them distinguished by splendid colours, and yields the inhabitants not only a large part of their animal food but also material for building their houses,—a species of massive coral, *Porites gaimardi*, being hewn into square building blocks which at a distance glisten like white marble.

The principal harbour is Port Victoria, situated on Mahé island. The total value of imports here in 1884, including Rs. 27,097 specie, was Rs. 428,605, and of the exports, including Rs. 21,582 specie, Rs. 392,175. The chief imports were coffee and cotton manufactures; the chief exports, cocoa-nut, cocoa-nut oil, and sperm oil. The fiscal receipts for 1884 amounted to Rs. 130,047. The cultivation of cocoa is progressing favourably, but the same cannot be said of the vanilla and clove plantations, which suffer from want of regular labour, attributable to the widespread share system, which the negroes prefer to regular work. The leaf disease affecting coffee has done great injury, and cocoa-nut plantations have suffered from the ravages of an insect, but no effort seems to have yet been made by weeding the plantations to stamp out the disease. Of the 34,749 acres of land making up Mahé, 12,000 acres are laid out in cocoa-nut, 500 in vanilla, coffee, and cloves, and 1500 are in forest; of the uncultivated land 8000 acres are well suited for vanilla, cocoa, and coffee plantations.

SEYMOUR, Edward. See Somerset, Duke of.

SEYNE, La, a town of France, in the department of Var, 5 miles south-west of Toulon, with a population of 9788 in 1881. It owes its importance mainly to its ship-building, the Société des Forges et Chantiers de la Méditerranée having here one of the finest building yards in Europe, in which more than 2000 workmen are employed; contracts are executed for private shipowners, for the great Messageries Maritimes Company, and for various Governments. The port, which has communication by steamer and omnibus with that of Toulon, is 6 acres in extent, and admits vessels of the largest tonnage.

SFAX, a city of Tunis, second in importance only to the capital, is situated 116 miles south of Mahadia, on the coast of the Gulf of Gabes (Syrtis Minor) opposite the Kerkenah Islands. It consists of three distinct portions:—the new European quarter to the south, with roads, piers, and other improvements carried out by the municipality; the Arab town in the middle with its tower-flanked walls entered by only two gates; and to the north the French camp. Round the town for 5 or 6 miles to the north and west stretch orchards and gardens and country houses, where most of the Sfax families have their summer quarters. Dates, almonds, grapes, figs, peaches, apricots, olives, and in rainy years melons and cucumbers, grow there in great abundance without irrigation. Two enormous cisterns maintained by public charitable trusts supply the town with water in dry seasons. Sfax was formerly the terminus of a caravan route to Central Africa, but its inland trade now extends only to Gafsa. The export trade (esparto grass, oil, almonds, pistachio nuts, sponges, wool, &c.) has attained considerable dimensions. Fifty-one English vessels (34,757 tons) visited the port in 1884. The anchorage is 2 miles from the shore, and there is a rise and fall of 5 feet at spring tides (a rare phenomenon in the Mediterranean). In 1881 the population was said to be about 15,000 (including 1200 Arabs, 1500 Tunisian Jews, 1000 Maltese, &c., 500 Europeans); in 1886 it is stated at 32,000 (1200 Maltese, 1000 Europeans).

Sfax (the Arabic Asfâkis or Safâkus, sometimes called the City of Cucumbers) occupies the site of the ancient *Taphrura*. In the Middle Ages it was famous for its vast export of olive oil. The Sicilians took Sfax under Roger the Norman in the 12th century, and the Spaniards occupied it for a brief period in the 16th century. The bombardment of the town in 1881 was one of the principal events of the French conquest of Tunis; it was pillaged by the soldiers on July 16th and the inhabitants had afterwards to pay a war indemnity of £250,000.

SFORZA, House of. See Milan, vol. xvi. p. 293, and Italy, vol. xiii. p. 479.

SHAD is the name given to certain migratory species of Herrings (*Clupea*), which are distinguished from the herrings proper by the total absence of teeth in the jaws. Two species occur in Europe, much resembling each other,—one commonly called Allis Shad (*Clupea alosa*), and the other known as Twaite Shad (*Clupea finta*). Both are, like the majority of herrings, greenish on the back and bright silvery on the sides, but they are distinguished from the other European species of *Clupea* by the presence of a large blackish blotch behind the gill-opening, which is succeeded by a series of several other similar spots along the middle of the side of the body. So closely allied are these two fishes that their distinctness can be proved only by an examination of the gill-apparatus, the allis shad having from sixty to eighty very fine and long gill-rakers along the concave edge of the first branchial arch, whilst the twaite shad possesses from twenty-one to twenty-seven stout and stiff gill-rakers only. In their habits and geographical distribution also the two shads are very similar. They inhabit the coasts of temperate Europe, the twaite shad being more numerous in the Mediterranean. While they are in salt water they live singly or in very small companies, but during May (the twaite shad some weeks later) they congregate, and in great numbers ascend large rivers, such as the Severn (and formerly the Thames), the Seine, the Rhine, the Nile, &c., in order to deposit their

spawn,—sometimes traversing hundreds of miles, until their progress is arrested by some natural obstruction. A few weeks after they may be observed dropping down the river, lean and thoroughly exhausted, numbers floating dead on the surface, so that only a small proportion seem to regain the sea. Although millions of ova must be deposited by them in the upper reaches of a river, the fry does not seem to have been actually observed in fresh water, so that it seems probable that the young fish travel to the sea long before they have attained to any size.

On rivers in which these fishes make their periodical appearance they have become the object of a regular fishery, and their value increases in proportion to the distance from the sea at which they are caught. Thus they are much esteemed on the middle Rhine, where they are generally known as "Maifisch"; those caught on their return journey are worthless and uneatable. The allis shad is caught at a size from 15 to 24 inches, and is considered to be better flavoured than the twaite shad, which generally remains within smaller dimensions.

Other, but closely allied species, occur on the Atlantic coasts of North America, all surpassing the European species in importance as food-fishes and economic value, viz., the American Shad (*Clupea sapidissima*), the Gaspereau or Ale-wife (*C. mattowocca*), and the Menhaden (*C menhaden*). See Menhaden.

SHADDOCK (*Citrus decumana*) is a tree allied to the orange and the lemon, presumably native to the Malay and Polynesian islands, but generally cultivated throughout the tropics. The leaves are like those of the orange, but downy on the under surface, as are also the young shoots. The flowers are large and white, and are succeeded by very large globose or pear-shaped fruits like oranges, but paler in colour, and with less flavour. The name Shaddock is asserted to be that of a captain who introduced the tree to the West Indies. The fruit is also known under the name of pommeloes and "forbidden fruit." There are two varieties commonly met with, one with pale and the other with red pulp.

SHADWELL, Thomas (1640–1692), a playwright and miscellaneous versifier of the Restoration period, Dryden's successor in the laureateship, is remembered now, not by his works, though he was a prolific writer of comedies highly successful in their day, but as the subject of Dryden's satirical portraits "MacFlecknoe" and "Og." He was a native of Norfolk—not an Irishman, as he retorted with significant imbecility when Dryden's satire appeared,—went through the forms of study at Cambridge and the Inner Temple, travelled abroad for a little, returned to London, cultivated the literary society of coffee-houses and taverns, and in 1668, at the age of 28, gained the ear of the stage with a comedy *The Sullen Lovers*. For fourteen years afterwards, till his memorable encounter with Dryden he continued regularly to produce a comedy nearly every year, showing considerable cleverness in caricaturing the oddities of the time. Ben Jonson was his model, but he drew his materials largely from contemporary life. He also acquired standing among the wits as a talker. In the quarrel with Dryden he was the aggressor. They had been good enough friends, and Dryden in 1679 had furnished him with a prologue for his *True Widow*. But when Dryden threw in his lot with the court, and satirized the opposition in *Absalom and Achitophel* and *The Medal*, Shadwell was rash enough to constitute himself the champion of the true-blue Protestants and wrote a grossly personal and scurrilous attack on the poet, entitled *The Medal of John Bayes*. Dryden immediately retorted in *MacFlecknoe*, the most powerful and contemptuously scornful personal satire in our language, adding next month a few more rough touches of supercilious mockery in the second part of *Absalom and Achitophel*, where Shadwell figures as "Og":—

> Og from a treason-tavern rolling home,
> Round as a globe, and liquored every chink;
> Goodly and great he sails behind his link.

Dryden may not be strictly fair when he addresses his enemy as "thou last great prophet of tautology," and makes Flecknoe extol him because "he never deviates into sense," but Shadwell had fairly earned his chastisement, the sting of which lay in its substantial truth. He survived till 1692, and on Dryden's resignation of the laureateship in 1688 was promoted to the office, a sign of the poverty of the Whig side at the time in literary men, and part of the explanation of their anxiety in the next generation to secure literary talent.

A complete edition of Shadwell's works was published in 1720, in 4 vols. 12mo. His dramatic works are—*The Sullen Lovers*, 1668; *The Royal Shepherdess*, 1669; *The Humorist*, 1671; *The Miser*, 1672; *Epsom Wells*, 1673; *Psyche*, 1675; *The Libertine*, 1676; *The Virtuoso*, 1676; *Timon of Athens*, 1678; *A True Widow*, 1679; *The Woman Captain*, 1680; *The Lancashire Witches*, 1682; *The Squire of Alsatia*, 1688; *Bury Fair*, 1689; *The Amorous Bigot*, 1690; *The Scowerers*, 1691; and *The Volunteers*, 1693.

SHAF'Ī, SHAF'ĪTES. See Sunnites.

SHAFTESBURY, Anthony Ashley Cooper, First Earl of (1621–1683), was the son of Sir John Cooper of Rockbourne in Hampshire, and of Anne, the only child of Sir Anthony Ashley, Bart., and was born at Wimborne St Giles, Dorset, on July 22, 1621. His parents died before he was ten years of age, and he inherited extensive estates in Hampshire, Wiltshire, Dorsetshire, and Somersetshire, much reduced, however, by litigation in Chancery. He lived for some time with Sir Daniel Norton, one of his trustees, at Southwick, and upon his death in 1635 with Mr Tooker, an uncle by marriage, at Salisbury. In 1637 he went as a gentleman-commoner to Exeter College, Oxford, where he remained about a year. No record of his studies is to be found, but he has left an amusing account of his part in the wilder doings of the university life of that day, in which, in spite of his small stature, he was recognized by his fellows as their leader. At the age of eighteen, on February 25, 1639, he married Margaret, daughter of Lord Coventry, with whom he and his wife lived at Durham House in the Strand, and at Canonbury House in Islington. In March 1640, though still a minor, he was elected for Tewkesbury, and sat in the parliament which met on April 13, but appears to have taken no active part in its proceedings. In 1640 Lord Coventry died, and Cooper then lived with his brother-in-law at Dorchester House in Covent Garden. For the Long Parliament, which met on November 3, 1640, he was elected for Downton in Wiltshire, but the return was disputed, and he did not take his seat,—his election not being declared valid until the last days of the Rump. He was present as a spectator at the setting up of the king's standard at Nottingham on August 25, 1642; and in 1643 he appeared openly on Charles's side in Dorsetshire, where he raised at his own expense a regiment of foot and a troop of horse of both of which he took the command. He was also appointed governor of Weymouth, sheriff of Dorsetshire for the king, and president of the king's council of war in the county. In the beginning of January 1644, however, for reasons which are variously reported by himself and Clarendon, he resigned his governorship and commissions and went over to the Parliament. He appeared on March 6 before the standing committee of the two Houses to explain his conduct, when he stated that he had come over because he saw danger to the Protestant religion in the king's service, and expressed his willingness to take the Covenant. In July 1644 he went to Dorsetshire on military service, and on August 3 received a commission as field-marshal general. He assisted at the taking of Wareham, and shortly afterwards compounded for his estates by a fine of £500 from