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

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 *Cœlentcra,* 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 monoecious. 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 *(Apοlemia uvaria, Diphyes acuminata)* the colony itself is entirely male or female. The *Ctemophora* are invariably hermaphrodite; and among the *Hexactinia* this is frequently though not generally the case, completely dioecious 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 Echinodfermata.

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 Oligochretes ; 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, Ne- merteans, 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 pal p 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,