one of the very few accounts of the limnology of a river in the tropics, and a very complete and up-to-date bibliography. I hope that it will serve as an example to biologists in other tropical lands where streams are just as threatened by man's activities as are temperate ones. May they also be inspired to go out and find out about their own rivers and from what they need protection.

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Determination of Sex

Genetics of Sex Differentiation. URSULA MITTWOCH. Academic Press, New York, 1973. xiv, 254 pp., illus. $16.50.

While there are numerous theories on the mechanism of sex differentiation, particularly in mammals, no single hypothesis has gained general acceptance. Ursula Mittwoch, who has made important contributions in the past in her studies of nuclear sexing, here presents a distillation of her current ideas on the role of the sex chromosomes in development. She suggests that it may be the mitotic regulatory effects of the X and Y chromosomes that determine gonadal differentiation. She further argues that the differential growth of XX and XY cells is mediated by specific chromosomal regions as well as by intrauterine environmental factors. Mittwoch has obviously come to the conclusion that simple genic determination of the sexual phenotype is invalid.

Fortunately, Mittwoch has developed her arguments in a way that gives the book merit well beyond that of its underlying thesis. She has, for example, provided an incisive review of the classical concepts of sex determination and discussed the possible role of heterochromatin in sex differentiation. She points out that the sex chromosomes contain an inordinate amount of facultative, as opposed to constitutive (or structural), heterochromatin, with the best example of facultative heterochromatinization being the genetic inactivation of one of the two homologous X chromosomes in the mammalian female cell. The critical nature of the largely heterochromatic Y chromosome in sexual differentiation has long been recognized, but the mechanism of Y chromosome action is still not clear. Mittwoch argues against several hypotheses that have been proposed in recent years as alternatives to the classical idea of large numbers of male- and female-determining genes. For example, Hamerton has hypothesized that the Y bears a controlling center that activates a specific gene located on the X chromosome. This X-linked gene is said to produce an inducer which stimulates the medulla of the primitive gonad with subsequent differentiation of that gonad into a testis. As Mittwoch suggests, while the Y is indeed the primary sex determiner, there is no evidence for an inducer gene, let alone for its location on the X chromosome.

The sex differentiation hypotheses of Boczowski and Ohno are also discussed—Boczowski's idea requiring hypothetical genes on the X (a gonadal inhibitor gene) and Y (a repressor-producing gene which is specific for the X-linked inhibitor gene), and Ohno's requiring an X-linked regulator of testosterone production.

The reader interested in mechanisms of sex determination will find this a superb review not only of the traditional concepts of sexual differentiation but also of several of the more recent hypotheses. As Mittwoch admits, however, her own hypothesis is formulated as yet only in broad terms. While her hypothesis is thought-provoking, it, like the hypotheses she criticizes, is not totally acceptable. In support of the idea of chromosomal regulation of growth, Mittwoch cites the relationship of chromosomal volume to mitotic activity and the relationship of chromosomal size to the duration of the cell cycle. These observations are generally valid, but it is difficult, indeed, to see how the longer generation time of triploid and tetraploid nuclei may be compared with possible XX and XY replication differences. One can readily concur with Mittwoch's assessment of the limitation of viewing sex determination as the result of simple Mendelian gene control; but it is difficult to accept the notion that sex determination takes place on the basis of preferential growth of XY cells. Mittwoch's fundamental argument is that, in males, the testicular gonadal tissue grows faster than the primitive ovarian tissue because of the presence of a Y chromosome. She may be correct in this, but further proof is needed. With formation of the testis, androgens are secreted and masculinization of the reproductive tract is the result. The normal female reproductive tract is viewed as being produced simply in the absence of the masculinizing effect of fetal androgens.

Mittwoch's book is valuable, then, in two ways: First, it presents an excellent, updated review of fundamental aspects of sex determination, with the discussions of the formation and the function of X and Y heterochromatin being especially well done. Mittwoch ranges over a wide portion of the evolutionary tree in her discussion, which enhances the appeal of this book to biological scientists. Second, she reviews the major theories of sex determination and adds her own. While no one theory seems able as yet to explain sex determination in a totally satisfactory way, the ideas that are presented here are clearly among the best attempts.

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Activity of the Thymus

Thymic Hormones. T. D. LUCKEY, Ed. University Park Press, Baltimore, 1973. xviii, 376 pp., illus. $19.50.

Scientific interest in the thymus was awakened anew in 1960 when Good, Miller, and soon thereafter a host of other investigators demonstrated the critical role the thymus played in the development of the immune system. As so often happens when such a breakthrough occurs, the past is temporarily forgotten as the new concept coupled with new technology leads to a cascade of data and insights.

Thymic Hormones, edited by T. D. Luckey and authored by many of the old-timers in the thymus business, brings together a past and present perspective that should now be again incorporated into our thoughts regarding the role of the thymus. The subject of thymic hormones was, and in some respects remains, a very controversial one. Early work in this area was conceptually sound and fascinating, but the data resulting from much of the experimental work were thin and often failed to support the hypotheses convincingly. *Thymic Hormones* presents a thorough review of past as well as new work in this area. Much of the information is not readily available else-