3. Fault bars. The ideal line of pattern contour would of course be given if an instantaneous reaction might be induced at the same collar level with respect to the barbs. An examination of fault bars suggests that they may approach this limiting condition rather more closely than do experimentally induced reactions. We have attempted to transpose the definitive fault bar line to the collar in order to derive the antecedent barb relations. The *apparent* differences in barb growth rates thus arrived at are smaller than are the differences called for by the original curve of barb growth. At this time we record these observations without considering the value of fault bars in plumage analysis to have been demonstrated beyond question.

7494 P

Pattern Analysis in Plumage. II. Methods of Definitive Feather Analysis.

MARY JUHN AND RICHARD M. FRAPS.

From the Whitman Laboratory of Experimental Zoology, University of Chicago.

The correspondence of events in the germ and definitive feather pattern characteristics is implicit in the relations which Lillie and Juhn have shown to exist in the collar during the reaction of barbs at all levels to high concentrations of thyroxin and female hormone. From this point of view measurable elements of pattern are of direct developmental and physiological significance. Definitive pattern relations are also of direct importance in other respects, as in the quantitative formulation of symmetry relations. We report here methods which have been developed to give the desired data.

The characteristics of the definitive feather which can be measured are distances between barbs on rhachis, lengths of barbs, and lengths of pattern elements within the limits of definition as barb or rhachis segment. Barbule lengths and distances between barbules may also be measured in certain instances.

(a) Mounting the feather. In order to obtain the desired measurements on barb length and barb frequency with precision and reasonable rapidity it is necessary that the feather be permanently mounted with reference to simplest possible axes, *i. e.*, with barbs at right angles to rhachis.

The rhachis of the feather is first set in paraffine, applied hot, on the glazed surface of heavy bristol board. The barbs are then

brushed out until they lie approximately at right angles to the rhachis. The bristol board is now clamped down on a base movable in the line of and exactly parallel to the rhachis. Above this sliding frame and at right angles to its line of motion is a guide bar. With a brush kept hot in molten paraffine the barbs are now pulled into position exactly at right angles to the rhachis; in the final operation the brush is held against the transverse guide bar and drawn slowly from rhachis to margin. Surplus paraffine is removed at the same time. The paraffine, when cooled, holds the barbs in place. In measuring distances between barbs the junction of barbs and rhachis must be free of paraffine. This is accomplished by running a small heated metal bar along the rhachis until excess paraffine has flowed completely out of all junctions. The mounted feather may be given a coat of shellac or euparal for permanent protection; if the specimen is to be used for measurement of barb spacing, junctions of barbs and rhachis should be left free.

(b) Barb frequency. Barb frequency is defined as the number of barbs per unit of rhachis length; it is therefore the reciprocal of the distance between 2 barbs, or the reciprocal of average distance between barbs for any number of barbs. The direct datum is of course the distance at the rhachis between 2 or more barbs.

For determination of distance between barbs the mounted feather is clamped down on a stage with the rhachis parallel to the line of movement of the gauge. The gauge carries a needle pointer which may be set at any point on the length of the rhachis. Minor adjustments for exact coincidence of pointer and barb junction are made by changes in the position of the stage carrying the feather. A binocular microscope, travelling in the direction of the gauge axis, is used in making all settings of the pointer.

Two gauges are mounted in combination for various requirements: a micrometer reading directly to 0.01 mm. is used for measuring distances between 2 barbs, etc. By estimation, differences in length of 0.002 mm. are easily determined. The micrometer carries the pointer. The second gauge is a vernier reading to 0.02 mm. It is used in measuring distances between a sufficient number of barbs, barb lengths, etc. The micrometer is clamped directly to the vernier. Either gauge may be used independently by locking the other, or both gauges may be used, as for example in measuring the distance between barbs at given intervals along the rhachis.

(c) Length of barbs and length of pattern segments. The feather mount is fixed upon the stage with rhachis at right angles to the

gauge axes. The barbs then, are parallel with these axes. The gauge pointer can be set for any point along the axis of a barb as in the measurement of barb distances it was set at required points along the rhachis. Measurements are made progressively from apex of barb through all intervening pattern loci to junction of barb and rhachis. The stage carrying the feather is free to move in the line of the rhachis; any barb on the rhachis can be set under the pointer of the measuring gauge.

Measurement of barb frequency, barb length, and length of pattern segment with these methods becomes a relatively simple operation. A very high degree of accuracy is easily attained. Barbule frequencies and barbule lengths have been determined in some instances, although not to the degree of accuracy possible in the determination of barb and rhachis characteristics.

Determination of barb frequencies in various feathers points to a characteristic form of curve in the several feather tracts. Curves for breast differ greatly from curves for saddle and back. Some evidence is at hand indicating orderly relations of barb frequency to asymmetries of feather and tract. These general relations will be reported in detail elsewhere.

7495 P

Pattern Analysis in Plumage. III. Action of Thyroxin in High Concentrations.

MARY JUHN AND RICHARD M. FRAPS.

From the Whitman Laboratory of Experimental Zoology, University of Chicago

The sequence of response of the components of the definitive feather to increasing thyroxin concentrations—blanching of barbs, barbule formation, and pigment deposition—and the manner of estimating barb growth in the germ by observation of the order of appearance of pigment following injection of thyroxin have been established by Lillie and Juhn.[1]

An examination of definitive feathers subjected to heavy thyroxin dosages (10 mg., single injection) during development shows that both barb frequency and barb lengths are markedly altered. Barb frequency increases to a level around twice the barb frequency of a normal feather; a sudden drop then occurs to a level below that

[1] Lillie, Frank R., and Juhn, Mary, *Physiol. Zool.*, 1932, **5**, 124.