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The thoracic chaetotaxy of the last three larval instars of four New England species of Aedes (Diptera: Culicidae).

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THE THORACIC CHAETOTAXY OF THE LAST THREE LARVAL INSTARS OF FOUR NEW ENGLAND SPECIES OF AEDES (DIPTERA:CULICIDAE)

A Dissertation Presented

By

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INTRODUCTION

The thoracic chaetotaxy of the second, third and fourth instars of Aedes (Ochlerotatus) abserratus (Felt & Young), A. (Finlaya) atropalpus (Coquillett), A. (Aedes) cinereus Meigen and A. (Aedimorphus) vexans (Meigen) is described and compared both intra- and interspecifically. These species represent the four subgenera of Aedes found in New England, therefore providing the widest range of subgeneric representation for the genus in this geographical area. The complete range of abserratus is southeastern Canada and northeastern United States; atropalpus is found in Canada, the United States, Mexico, El Salvador, Nicaragua, Costa Rica and Panama; Cinereus is northern Holarctic; and the range of vexans includes the Holarctic and Oriental regions, the Pacific Islands and Transvaal.

In the genus Aedes few studies include the thoracic chaetotaxy of the second and third instars and the thoracic chaetotaxal descriptions of the fourth instar are usually incomplete. Often only hairs used in species identification are described; such characters as relative hair length, barbed condition, basal sclerotization and ontogenetic development are usually omitted; and variability in hair branching is poorly described. Therefore, these studies do not thoroughly depict the thoracic chaetotaxy or contribute to an understanding of its geographic variation.

The present study, when compared with future similar studies of other populations of the same species, will provide an understanding of geographic variations that may occur within any of the given species. An understanding of geographic variation will facilitate identification of the species over their entire ranges in all three instars and aid in discovering subspecies or possibly even new species now unrecognized within the species studied; this is especially pertinent to atropalpus, cinereus and vexans which have such a wide geographic distribution. Comparison of this work with studies of other species should contribute towards a better understanding of ontogenetic, serial and interspecific chaetotaxal homologies which in turn will aid in understanding culicid phylogeny.

The only references known to the author to the thoracic chaetotaxy of the second and third instars in the species studied are for absserratus in which the thoracic chaetotaxy of the second and third instars is described by MacKenzie (1966) and incorporated into the present study, and Barr (1958) who described the branching of prothoracic hair 1 of instar III. For the fourth instar of the species covered in this paper, LaCasse and Yamaguti (1950) and Yamaguti and LaCasse (1951) provide the most detailed but still inadequate description of the thoracic chaetotaxy with a written description of the branching of many of the hairs and with illustrations of the thorax; Carpenter and LaCasse (1955) describe the branching of prothoracic hairs 1 through 7 in all four species and provide illustrations of the thorax for cinereus and vexans; Barr (1958) briefly mentions prothoracic hair 1 for absserratus and vexans; and Harmston and Lawson (1967) describe the branching of mesothoracic hair 1 of atropalpus and illustrate the dorsal aspect of the thorax for all four species. The following references were not available to the author but may include information on the thoracic chaetotaxy: Bohart and Ingram (1946), Yamaguti and LaCasse (1950), Knight and Hull (1953).

The description of each thoracic hair in the three instars of each species includes the position, length and branching; also, where applicable, the diameter, barbed condition and basal sclerotization. Ontogenetic development is described and interspecific comparisons made. Cervical hairs, though not really part of the thorax, are included in this study. The system used for numbering the hairs is that of Belkin (1951). In the tables and drawings P denotes the prothorax, MS the mesothorax and MT the metathorax. In all cases the use of Roman numerals is restricted to instar designation.

METHODS AND PROCEDURES

Collection Locations

Material used in this study was collected within a 20-mile radius of Amherst, Massachusetts. *Abserratus* specimens were collected from three locations: (1) Belchertown Bog located next to Route 181 approximately 1.5 miles southeast of the junction of Route 181 and Route 202 in Belchertown; (2) Federal Street Bog, also located in Belchertown, approximately .5 miles from the eastern junction of Federal Street with Route 9; (3) Cushman Bog in Amherst located near the railroad tracks approximately 450 yards from the Pine Street crossing. Specimens were collected in these areas in the Spring: Belchertown Bog in 1963, 1964 and 1967; Federal Street Bog and Cushman Bog in 1964.

Specimens of the remaining species were collected in the Spring of 1967. *Atropalpus* specimens were collected from rockpools at Chesterfield Gorge in the town of Chesterfield. *Cinereus* specimens were found at Federal Street Bog in the same location as *abserratus*. *Vexans* specimens were collected at two locations: from a ditch bisected by Russelville Road approximately one mile from the junction of Russelville Road and Route 47 in North Hadley and from temporary pools in open fields just to the west of the football stadium at the University of Massachusetts.

Rearing and Preserving Specimens for Study

Specimens were collected with a long-handled dipper and transported back to the laboratory in jars. Some specimens were killed in hot water and preserved in 70% alcohol immediately upon return to the laboratory. Specimens to be reared, along with water and pieces of vegetation from the collecting site, were placed in four-dram vials, one specimen to a vial. Presumably, microorganisms in the water and on the vegetation provided food for the larvae. On several occasions, larvae were successfully reared to the next instar without the presence of vegetation. Collections were numbered sequentially and each reared specimen was identified by the collection number and a specimen subscript such as 31_3. This identification remained with the specimen throughout the course of this study.

The larvae were reared at room temperature. Daily inspection for cast skins revealed whether molting had occurred. After molting the larvae were killed in hot water and preserved in vials of 70% alcohol along with the cast skin.

Species Identification

Specimens were identified to species by the author using a key to the larvae of *Aedes* mosquitoes of New England (Smith 1969).

Instar Identification

Larvae

Field collected specimens were initially identified by simple observation of head capsule width, there being a distinct difference between instars. Confirmation of instar identification on the basis of other characters varied with the instar and species. Four larval instars is assumed a constant factor in mosquitoes. Instar II of all species was identified by the absence of both an egg breaker and metathoracic hair 7 (the egg breaker is present only in instar I and metathoracic hair 7 only in instars III and IV). Instar III was distinguished from instar IV in *abserratus*, *cinereus* and *vexans* by characteristics of the anal saddle

(Smith 1969). These instars were differentiated in atropalpus by taking a number of specimens with the same head capsule width and preserving some for study and rearing the remainder. The reared specimens were identified to instar in the following manner and the preserved specimens identified by association. Larvae that were either instar III or IV were placed in individual vials. If, at the succeeding molt, the emerged specimen was still in the larval stage, it was interpreted as having been in the third instar when placed in the vial. If the emerged specimen was in the pupal stage, it was interpreted as having been in the fourth instar when placed in the vial.

Cast Skins

Cast skins of known instar were obtained by individual rearings of larvae of known instar.

Hair Variety and Terminology

All hairs are usually easily identified as belonging to one of two types for convenience of description. Type 1: Hairs of this type are rigid, barbed, and relatively large with their branches being easily seen under the dissecting microscope. The branches have a common level of origin near the base of the hair and are on the same plane, spread out like the ribs of a fan (Fig. 11). Basal sclerotization is characteristic of these hairs except for the submedian prothoracic group of abserratus. Type 2: Hairs of this type are, with few exceptions, much less rigid than type 1 hairs, normally lack barbs, and are usually shorter and thinner than type 1 hairs. Their branches, if present, usually are clearly seen only under the higher powers of the compound microscope. Most of the type 2 hairs have the branches arising relatively far away from the base of the hair, usually have slightly different points of origin if more than two branches are present, and the branches are usually on the same plane (Fig. 12). A few type 2 hairs have branches located on more than one plane and when this condition is obvious because of a large number of branches they are called stellate. Some type 2 hairs have branches decidedly unequal in length and point of origin giving the hair a dentritic appearance when viewed laterally (Fig. 13). Basal sclerotization is not usually associated with type 2 hairs. Table I identifies the hairs studied as to type.

Techniques for Mounting Specimens on Microscope Slides

Observations are more easily made on specimens mounted in Hoyer's solution although satisfactory observations can be made in balsam.

Cast skins and larvae were mounted utilizing three methods: cast skins in Hoyer's solution; dissected larvae in Hoyer's solution; and whole mounts of larvae in Hoyer's solution or balsam. The method used depended on the nature of the observations to be made. The first two methods were utilized for observations on hair length, diameter, branching, barbed condition and basal sclerotization. Both methods required clearing the musculature, viscera and trachael remains from the cuticle because these tissues obscure the hairs and basal sclerotization. These are alternate methods, the one used depending on whether the cast skin or cuticle of the larvae happened to be the cleanest or on which a particular numbered hair was more easily seen. Observations on hair position were made on undistorted larval whole mounts rather than on fragmented or flattened specimens.

Manipulation of specimens on the microscope slide prior to application of the Hoyer's solution was done in water rather than alcohol because alcohol evaporates more quickly. Parts of the cast skin or larvae not utilized were preserved for possible future examination.

Cast Skins

Skins mounted by the following method expose to the viewer the dorsal, lateral, and ventral hairs. The removal of the head capsule and abdomen allows the full weight of the cover slip to flatten the cuticle causing the hairs to rest in a position horizontal to the microscope stage; a position essential for accurate measurements.

Preparation for mounting.

1. Transfer cast skin with a pipette from the preservative to water in a Syracuse dish.

2. Fully extend the cast skin, which is usually compressed antero-posteriorly and to a lesser extent from side to side after ecdysis, by manipulation with probes made from minuten nadeln.

3. Remove tracheal remains from inside the thorax because being dark they tend to obscure the smaller hairs.

4. Clean the ends of the hairs of all debris (this may be difficult for the minute hairs and it is therefore best to collect and rear the larvae in as clean an environment as possible).

5. Separate with a probe hairs that are entangled or obscured so that they may be clearly seen after mounting.

6. Separate the thorax from the head capsule and from the abdomen.

7. Cut the thorax dorsally along its entire length and flatten it in a single layer.

Mounting in Hoyer's solution.

1. Transfer cast skin in a drop of water from Syracuse dish to slide with a pipette. Position the skin in the drop of water so that the exterior of the cuticle faces upwards.

2. Draw off water from around specimen with an absorbant paper towel until the specimen is flattened against the slide but not dried out.

3. Apply Hoyer's solution directly on top of the cast skin which will maintain its shape and position on the slide although shrivelling of the larger hairs may occur. These will regain their normal shape after several hours on the slide.

4. Remove immediately with an insect pin any bubbles which may have formed in the Hoyer's solution.

5. Apply a round, 12 mm, #2 cover slip by first touching the edge of the cover slip in the Hoyer's solution above the anterior end of the cast skin and carefully lower the cover slip down over the cast skin. A few bubbles may form but should not be removed because of the danger of disturbing the skin position.

Dissected Larvae

Preparation for mounting. Remove the head and abdomen from the thorax and, using a microscalpel, divide the thorax longitudinally into two halves. Clean each half of the thorax of all viscera and musculature by using two pairs of fine pointed tweezers and a probe. The cuticle is surprisingly tough, even in instar II, and is seldom torn during this cleaning procedure. Positioning of the thoracic pieces on the microscope slide depends on which hairs one wishes to observe; a piece may be mounted with dorsal, lateral or ventral aspect towards the observer.

Mounting in Hoyer's solution. Mount in Hoyer's solution in the same manner as the cast skin.

Whole Mounts

Preparation for mounting. No special preparation of the specimen was required for whole mounts.

Mounting in Hoyer's solution and balsam. Specimens were mounted directly from alcohol. Specimens mounted in balsam were dehydrated in cellosolve prior to mounting.

Certain techniques can be used with the above methods in order to see specific hairs. The cuticle may be teased into a particular shape prior to being mounted. Often the presence of some hairs obscures the view of other hairs. During the preparation of the specimen for mounting, the offending hairs may be removed. In all mounts using Hoyer's solution, it is possible, for about ten minutes after mounting, to shift the position of the hairs by applying pressure to the cover slip, thus bringing certain hairs into a position more suitable for observation. In whole mounts, prothoracic hairs 1-4 can be easily observed after removing the head capsule.

Study of Specimens

Length measurements and determinations of hair branching were made with ordinary light and phase contrast. Phase contract makes the task easier, particularly for observing tips and branches of fine hairs which blend with the background using ordinary light. However, if sclerotized parts lie between the light source and the hair under observation, phase contract cannot be used because of optical distortion. Hair diameter, barbed condition, and basal sclerotization were more clearly observed with ordinary light.

Only one observation per specimen was recorded for any particular characteristic in order to observe the greatest variation possible for the number of observations made. Larvae are bilaterally symmetrical and, although variations exist between sides, it was assumed that these variations occur randomly on either side of the larvae. Therefore, a random selection of the side on which the character was observed provided unbiased data. If both members of the pair of characters were visible on the slide, the one on the observer's left was utilized. This character could belong to either side of the larva depending on its position on the slide.

Duncan's new multiple-range test (Steel and Torrie 1960) was used to detect significant differences at the 5% level of significance in hair length, diameter and branching between instars within a species. The facilities of the research computer center at the University of Massachusetts were used for running the statistical analysis.

Hair Position

Hair position was determined after drawing one specimen and comparing four additional specimens with the drawing to check for variation.

Hair Length

Length measurements were made with a binocular compound microscope equipped with an ocular micrometer. Magnifications of 100X and 430X were used depending on the size of the hair. Only hairs reasonably straight and parallel to the microscope stage were measured. Any deviation from this parallel position would give an unrealistically short measurement. Inaccuracy due to curvature of the hair within the plane parallel to the microscope stage was reduced to insignificance by measuring consecutive sections rather than the whole hair at once. On hairs with multiple shafts the longest branch was measured. Length measurements were first recorded in micrometer units and then converted to microns. Mean lengths were rounded to the nearest whole micron.

The hairs of type 2, being relatively thin and flexible, are very difficult to measure accurately. Thus for detailed statistical analysis of length only type 1 hairs were used. The ranges, means, and standard deviations of the twelve specimens utilized for observations on type 1 hairs and the means of the five specimens utilized for type 2 hairs are presented in Tables II-V. Most of the hairs on a particular thoracic segment are of unequal length. The relative lengths of these hairs are presented for study by plotting the mean lengths of each numbered hair and connecting the points to produce a line graph. This graph of hair length for each thoracic segment is referred to as a profile.

Even though the author was not able to get a complete profile for any segment from one specimen, it was obvious that the relative lengths of the different numbered hairs are so nearly constant from specimen to specimen that almost any profile from one individual would closely match the profile of the means.

Hair Diameter

Diameter measurements were made at 430X to the nearest one-half unit of the ocular micrometer. Each micrometer unit was 2.6 microns. After the original diameter measurement of each hair was converted to microns, the maximum potential measuring error was .65 microns. Only hairs at least one micrometer unit in diameter were measured. In branched hairs, the widest branch was measured. The diameter reading was taken at the widest point of the shaft.

Twelve specimens were observed for each numbered hair and the range, mean and standard deviation are presented in Tables VI-IX.

Hair Branching

The number of branches were accurately determined for the majority of numbered hairs in all instars. The exceptions included some of the stellate hairs and the minute hair 11 of the meso- and metathorax. No statistical analysis was made on these hairs and if the number of branches could be estimated only the frequency distribution of the number of branches per hair and the mean of these observations is presented in the tables. All other branched hairs were analyzed statistically for significant differences between the instars in the mean number of branches per hair utilizing observations on twelve or more specimens in each instar. The frequency distribution of the number of branches per hair, the mean and standard deviation for these hairs are presented in Tables X-XVI. The range and number of specimens observed can be ascertained from the information in the tables. The number 1 in the tables, when used in conjunction with the number of branches per hair, means the hair is unbranched.

The number of specimens on which observations were made varied from one numbered hair to another depending upon whether or not a trend of change from instar to instar was subtle or relatively large and obvious. The number of specimens was considered sufficient if (1) very limited or no variation in the number of branches per hair was observed either within or between instars or (2) if a distinct trend of change from instar to instar was established. For example, observations on twelve specimens of <u>cinereus</u> showed an obvious increase through succeeding instars in the number of branches per hair for prothoracic hair 11 and this increase is reflected in the means being significantly different between the instars. The use of further specimens would only substantiate an already established divergence between instars (Table XII). For other hairs, trends were not so obvious and observations on additional specimens were required. For example, in cinereus the instar II and III means of prothoracic hair 4 were not significantly different statistically from each other after twelve observations. However, there were fewer two-branched hairs and more three-branched hairs in instar III than in instar II and this suggested the possibility of a real trend towards divergence between these instars. Observations on eight additional specimens statistically confirmed this viewpoint and further observations were therefore unnecessary (Table XVII). For some hairs the number of additional observations required to establish a statistically significant difference between instars that are suggested by the frequence distribution were not made.

Barbed Condition

The density of barbs along the shaft and their length is referred to as the barbed condition. The barbed condition of a numbered hair was usually determined after drawing a hair from an instar IV specimen and comparing at least five additional specimens with the drawing to check for variation. At least five examples each of instars II and III were also compared to the drawing for the determination of the barbed condition for these instars. For some numbered hairs the barbed condition could be described by comparing the hair with the drawing of a previously described numbered hair.

Basal Sclerotization

The darkened sclerotization of the integument that is associated with the alveolus of most of the larger hairs is referred to as the basal sclerotization. The description of the basal sclerotization of each numbered hair is based upon observations on ten specimens, five with the dissecting microscope to determine size, shape and position, and another five under the compound microscope to determine details not visible under lower power. The shape of the basal sclerotization as it appears under the dissecting microscope is illustrated on the drawings of the thorax (Figs. 17-40). Further description of the basal sclerotization is presented if the figures do not clearly show the shape or if there is variation in the shape of the basal sclerotization, or if the compound microscope reveals characteristics not observed under the dissecting microscope.

Drawings and Illustrations

Specimens in alcohol, rather than on slides, were used for the drawings of the thorax because they could be easily and accurately positioned and repositioned when necessary. Such specimens required some preparation prior to the drawing. The drawing of the outline of the thorax and the alveoli of certain hairs required the removal of large obscuring hairs. Removal of the large hairs also made positioning of the specimen less difficult as does removal of the terminal abdominal segments.

The specimen was lightly pressed into petroleum jelly to keep it stationary during the period of time required for the drawing. A small patch of jelly was placed on the bottom of a dry watch glass and covered with alcohol several hours prior to use. Apparently, the tackiness of the jelly increases with exposure to alcohol. The specimen is positioned by placing the head capsule or abdominal segments into the jelly. Parts to be observed should be kept free of jelly because of its tendency to stick to the cuticle, thus obscuring certain structures.

Some hairs, especially in instar II, are minute and very lightly pigmented. However, most hairs can be seen under the dissecting microscope at 144 power. Changing the lighting while observing is extremely important as slight changes in the angle of the light on the specimen sometimes reveals an otherwise invisible hair. If a known hair could not be seen with the dissecting microscope, its position relative to neighboring hairs was determined on a slide-mounted specimen under the compound microscope.

Thoracic drawings were made utilizing a dissecting microscope with an ocular grid. Tracing paper was placed over graph paper and the drawing made on the tracing paper matching squares of the ocular grid with those of the graph paper. The enlargement ratio was uniform for each instar to illustrate the relative size of each species. Four additional specimens were compared to the original drawings to determine what variations existed between individuals. Only very minor variations were noted and adjustments were made so that the drawings are model representations. The pencil sketches on the tracing paper were then traced on to velum and inked.

The drawings of the hairs on the figures of the thorax illustrate the position of the different numbered hairs with the exception of the hairs associated with the pleural tubercles. Additionally, these drawings present the general appearance of many of the numbered hairs; specific data on size, branching and barbed condition must be obtained from the text.

OBSERVATIONS AND CONCLUSIONS

Hair Position

The position of all hairs, except those of the pleural groups which can be seen only from certain angles, are illustrated on the drawings of the thorax (Figs. 17-40). For position of the hairs of the pleural groups see page 40.

Ontogenetic Changes

Only relatively minor ontogenetic differences in hair position were noted. It is possible that in some cases even these differences were more apparent than real as a result of unequal integumentary distortion between hairs on different specimens.

Transitory hairs, meso- and metathoracic hairs 8 and 7 respectively, appear for the first time after the molt to instar III and persist in instar IV in all the species. The presence of these hairs in *abserratus* was established by MacKenzie (1966). For *atropalpus*, *cinereus* and *vexans* five individual specimens of each species were reared from instar II to instar IV. These transitory hairs were present only in instars III and IV.

Interspecific Comparisons

The two most conspicuous variations in hair position are on the pro- and metathorax. On the prothorax of *atropalpus*, *cinereus* and *vexans*, hair 7 is separated from hair 6 by a greater distance than hair 5 is from hair 6; in *abserratus* these distances are equal. On the metathorax of *abserratus*, *cinereus* and *vexans*, hair 3 is mesad of and slightly anterior to hair 4; in *atropalpus* hair 3 is only slightly mesad of and distinctly posterior to hair 4.

The positions of the submedian prothoracic hairs were determined with assurance because the close proximity of the hairs to each other and the relatively high power of magnification used eliminated the possibility of not seeing any integumentary distortion that might have occurred between the hairs. The submedian prothoracic group consists of hairs 1, 2 and 3 which form a row nearly parallel to the sagittal line (Fig.17). The hairs form a straight row or hair 2 is either slightly mesad or laterad of a line drawn between hairs 1 and 3. In abserratus, instar II, the hairs form a straight row or hair 2 is mesad of the line; while in instars III and IV hair 2 is mesad of the line. In all instars of atropalpus these hairs form a straight row or hair 2 is laterad of the line. In cinereus, instar II, the hairs form a straight row or hair 2 is laterad of the line; in instar III the hairs form a straight row, in instar IV hair 2 is mesad of the line. In vexans, instar II, these hairs form a straight row; while in instars III and IV they form a straight row or hair 2 is mesad of the line. In all species except atropalpus hair 1 is always separated from hair 2 by a greater distance than hair 2 is from hair 3. In some specimens of atropalpus the hairs are equidistant in instars III and IV.

Hair Length

The mean of type 1 hairs showed a statistically significant increase in length from instar II to III and instar III to IV. In the majority of these hairs the largest increase took place in the molt to instar IV. All type 2 hairs except those too small to measure (meso- and metathoracic hair 11 on atropalpus, cinereus, and vexans) increased in length from instar II to IV except prothoracic hair 9 of abserratus which showed no increase in length through succeeding instars. In the majority of type 2 hairs the largest increase in length took place from instar III to IV. However, in some hairs the greatest increase was from instar II to III and in others the increase was about equal in the two molts. (See Tables II - V for data on specific hairs.)

The hair profile of a segment changes between instars whenever a disproportionately large increase or decrease in the length of any hair or hairs occurs as a result of a molt. The changing profiles of the thoracic segments are compared below in two different ways.

Ontogenetic Changes of Profile in a Single Segment

All of the data are presented in Graphs 1-12. A comparison of the profiles will show the differential growth rates which result in a change in profile. The differential growth rate of a particular hair may be described by comparing the growth of that hair to the growth (or lack thereof) of the next lower numbered hair. The most obvious changes in hair profile are on the pro- and mesothorax, two on each. On the prothorax hair 2 of *atropalpus*, *cinereus* and *vexans* decreases in length in succeeding instars in relation to hair 1 as does hair 9 of *cinereus* and *vexans* in relation to hair 8. On the mesothorax hair 6 of *abserratus*, *cinereus* and *vexans* decreases in length in succeeding instars in relation to hair 5 as does hair 2 of *atropalpus* in relation to hair 1.

Within a given species, with the possible exception of *atropalpus*, there is more ontogenetic change in the hair profile of the prothorax than there is in the mesothorax and the mesothoracic profile shows greater change than that of the metathorax.

Interspecific Comparisons in Profile Ontogeny of a Single Segment (Graphs 13-21)

The hair profile of a segment is different for each species. Additionally, each species has its own pattern of change in profile through succeeding instars in each segment. Therefore, there is a change in the relationship of the profiles of any two species from instar to instar. The pro- and mesothoracic pattern of ontogenetic development shows more divergence between species through succeeding instars than does that of the metathorax in which only hairs 1 through 5 of atropalpus do not parallel the development in the other species.

Intraspecific Comparisons among Pro-, Meso- and Metathoracic Profiles Within Each Instar (Graphs 22-33)

The profiles of the three thoracic segments are largely dissimilar. However, the profiles of the pro- and mesothorax appear more similar to each other than either is to the metathorax. The only obvious similarity between the segments in all instars of all species is between the hairs of the three pleural groups (hairs 9-11) (see section on pleural groups).

Hair Diameter

Every hair that was measured showed a statistically significant increase in diameter after a molt.

Hair Branching

A numbered hair is considered unbranched if no more than two, two-branched hairs were observed in any one instar. All other hairs are considered to be branched and show one of four developmental patterns.

Ontogenetic Changes

Pattern 1: No statistically significant increase in the mean number of branches per hair in either the molt to instar III or IV. Pattern 2: A statistically significant increase in the mean number of branches per hair in the molt to instar III only. Pattern 3: A statistically significant increase in the mean number of branches per hair in the molt to instar IV only, Pattern 4: A statistically significant increase in the mean number of branches per hair in the molts to both instar III and IV.

The number of the pattern of development, described above, is presented for each numbered hair in Table XVIII. For some hairs there are inadequate data and therefore the declared developmental pattern is suspect. Such pattern designations in the table are placed in parentheses. The only hairs not included in the following paragraph or in Table XVIII are meso- and metathoracic hairs 11 which are so minute and difficult to see that observations were made on twelve or fewer specimens; in no case was this sufficient to provide even a suspected developmental pattern.

Of the total of 160 hairs on the thoraces of the four species studied 60 are unbranched. The branched remainder show a significant increase in the mean number of branches per hair in either the molt to instar III or IV or in both molts with the exception of prothoracic hair 9 of cinereus and metathoracic hair 5 of atropalpus, both of which showed no significant increase in either molt. For the hairs that branch, a significant increase in the mean number of branches per hair is more common in the molt to instar IV than to instar III. The mean number of branches per hair of 74 hairs increases significantly in the molt to both instar III and IV (Pattern 4). However, the mean of ten other hairs increases significantly only in the molt to instar IV (Pattern 3) while the mean of only two hairs increase significantly in the molt to instar III but not in the molt to instar IV (Pattern 2). The mean of all the transient hairs increases significantly in the molt to instar IV. Patterns 3 and 4 are dominant with Patterns 1 and 2 having only two numbered hairs each.

Interspecific Comparisons

There is considerable similarity in the developmental pattern (or lack thereof) of hair branching between correspondingly numbered hairs of different species. Out of a total of thirty-nine such hairs (meso- and metathoracic hair 11 is excluded), twenty-three were either unbranched or had the same developmental pattern in all the species and eleven were similar in three of the species. Only prothoracic hair 9 had a different developmental pattern for each species.

Similarities and differences in branching are described only for the terminal instar. More exact data than is provided below can be obtained from the appropriate tables.

Prothorax. Hair 0 stellate in all species, this condition being least obvious in atropalpus. Hair 1 branched in abserratus and atropalpus, unbranched in cinereus and vexans. Hair 2 branched only in cinereus. Hair 3 branched in all species except abserratus. Hair 4 branched in all species except atropalpus. Hair 5 branched only in atropalpus. Hair 6 unbranched in all species. Hair 7 branched in all species. Hair 8 branched in all species except abserratus. Hair 9 branched in all species except atropalpus. Hair 10 unbranched in all species. Hair 11 branched in all species. Hair 12 unbranched in all species. Hair 14 branched in atropalpus and cinereus, unbranched in abserratus and vexans.

Mesothorax. Hairs 1 and 2 branched in all species. Hair 3 unbranched in all species. Hair 4 branched in all species except atropalpus. Hair 5 branched only in atropalpus. Hair 6 branched in all species. Hair 7 unbranched in all species. Hairs 8 and 9 branched in all species. Hair 10 unbranched in all species. Hair 11 minute, branched in all species. Hair 12 unbranched in all species. Hairs 13 and 14 stellate in all species, this condition being least obvious in atropalpus.

Metathorax. Hair 1 branched in all species, being very lightly pigmented in abserratus, cinereus and vexans. Hair 2 branched in all species except atropalpus. Hair 3 branched in all species with an exceptionally large number of branches in abserratus, cinereus and vexans. Hair 4 branched in all species. Hair 5 single and more spike-like than the typical type 2 hair in all species; in atropalpus this hair is unusual in that no other hair studied had a frequency distribution in which instar II had such a high number of branched hairs compared to instar IV (Table XI). Hair 6 branched only in cinereus. Hair 7 branched in all species. Hair 8 stellate in all species, this condition being least obvious in atropalpus. Hair 9 branched in all species. Hair 10 unbranched in all species. Hair 11 minute, branched in all species. Hair 12 unbranched in all species. Hair 13 stellate in all species, this condition being least obvious in atropalpus.

Atropalpus has the most numbered hairs that are uniquely, in this species, either branched or unbranched with three on the prothorax (hairs 4, 5 and 9), two on the mesothorax (hairs 4 and 5) and one on the metathorax (hair 2); cinereus has one hair each on the pro- and metathorax (hairs 2 and 6 respectively); abserratus has two hairs on the prothorax (hairs 3 and 8); and vexans has no unique differences.

Intersegmental Comparisons

The prothorax has the fewest numbered hairs in instar IV that are either branched or unbranched in all four species. Therefore the prothorax shows more variation interspecfically in this respect than the meso- and metathorax which are similar to each other. The prothorax has only 6 of the 14 numbered hairs being similar in all species whereas the meso- and metathorax have 12 out of 14 and 11 out of 13 respectively.

Barbed Condition

Barbs originate from what appear to be notches in the branches. Some of the numbered hairs are distinctive in having numerous and very long barbs the length of which may be thirteen times greater than the width of the branch at the base of the barb (Fig. 3). This condition may be reduced in instars II and III. The remainder of the barbed hairs are characterized by shorter barbs in varying abundance. Each numbered hair has its own characteristic barb length and number.

Species Description

The barbed condition of each numbered hair is described for each instar. If the barbed condition for all three instars is not similar, the most highly developed condition (more and longer barbs) is described first. A decrease in barb numbers and/or length in comparison with a more highly developed barbed condition is referred to as reduced. Table I presents the barbed hairs.

A. abserratus. PROTHORAX — Hairs 1-3, 5-8 and 12 in all instars similar to Fig. 1. MESOTHORAX — Hair 5 in instar IV similer to Fig. 6; instars II and III similar to instar IV or barbed condition reduced with some hairs having barbs so small as to be difficult to see; hair 5 with the least developed barbed condition of all mesothoracic hairs. Hairs 6 and 9 similar to Fig. 3 in all instars. Hair 7 in instar IV similar to Fig. 6; instars II and III with barbed condition reduced. Hair 8 similar to Fig. 3 in instars III and IV. Hairs 10 and 12 similar to Fig. 6 in all instars. METATHORAX — Hair 7 in instar IV similar to Fig. 3; instar III similar to instar IV or barbed condition reduced. Hair 9 in instar IV similar to Fig. 3; instar III similar to instar IV or barbed condition reduced; instar II with barbed condition even further reduced. Hair 10 similar to Fig. 6 in all instars.

A. atropalpus. PROTHORAX — Hairs 1, 5 and 6 in instars II and IV similar to Fig. 2; instar II with barbed condition reduced. Hairs 2 and 4 in instar IV similar to Fig. 2 or barbed condition reduced; instar III similar to IV or barbless; instar II barbless. Hair 3 in instar IV similar to Fig. 2 or barbed condition reduced; instars II and III similar to IV or barbless. Hair 7 in instars III and IV similar to Fig. 3; instar II with barbed condition reduced. Hair 8 in instar IV similar to Fig. 2 or barbed condition reduced; instar III with reduced barbed condition similar to that of instar IV or barbless; instar II with one or two minute barbs or barbless. Hair 9 in instar IV similar to Fig. 2 or barbed condition reduced; instars II and III with one or two minute barbs or barbless. Hair 10 in instar IV similar to Fig. 2, with barbed condition reduced, or barbless; instar III with reduced barbed condition similar to that of instar IV or barbless; instar II barbless. Hair 12 in instar IV similar to Fig. 2, with barbed condition reduced, or barbless; instar III with reduced barbed condition similar to that of instar IV or barbless; instar II with with one or two minute barbs or barbless. MESOTHORAX — Hair 1 in all instars similar to Fig. 7 or with barbed condition reduced. Hair 3 in instars III and IV with one to three small barbs or barbless; instar II barbless. Hair 4 in instar IV with one to three small barbs or barbless; instars II and III barbless. Hairs 5, 7 and 12 in instars III and IV similar to Fig. 2; instar II with barbed condition reduced. Hairs 6 and 9 in instars III and IV similar to Fig. 3; instar II with barbed condition reduced. Hair 8 in instars III and IV similar to Fig. 3. Hair 10, in all instars, similar to Fig. 2 and occasionally with some exceptionally long barbs along with the normal shorter barbs thus imparting to this hair a resemblance to the closely associated hair 9. METATHORAX — Hair 6 in instar IV with one to three barbs or barbless; instars II and III barbless. Hair 7 in instars III and IV similar to Fig. 3. Hair 9 in instars III and IV similar to Fig. 3; instar II with barbed condition reduced. Hair 10 in instars III and IV similar to Fig. 10; instar II with barbed condition reduced.

A. cinereus. PROTHORAX — Hair 1 in instar IV similar to Fig. 5 or barbed condition reduced or barbless; instar III with one to three barbs or barbless; instar II barbless. Hairs 5 and 6 in instars III and IV similar to Fig. 4; instar II with barbed condition reduced. Hair 7 in instar IV similar to Fig. 3; instars II and III with reduced barbed condition. Hair 8 in instars III and IV similar to Fig. 3 or barbed condition reduced; instar II similar to instars III and IV or barbed condition further reduced. Hairs 10 and 12 in all instars with one to three barbs or barbless. MESOTHORAX — Hair 3 in instar IV with one to three small barbs or barbless. Hairs 5 and 12 in instar IV similar to Fig. 4; instars II and III with barbed condition reduced. Hair 6 in instars III and IV similar to Fig. 3;

instar II with barbed condition reduced. Hair 7 in instars III and IV similar to Fig. 4; instar II with barbed condition reduced; in all instars some exceptionally long barbs sometimes are present along with the normally shorter barbs giving this hair a resemblance to the closely associated hair 6. Hair 8 in instars III and IV similar to Fig. 3. Hair 9 in all instars similar to Fig. 3. Hair 10 in instar IV similar to Fig. 4; instars II and III with barbed condition reduced; in all instars some exceptionally long barbs sometimes are present along with the normally shorter barbs giving this hair a resemblance to the closely associated hair 9. METATHORAX — Hair 7 in instars III and IV similar to Fig. 3. Hair 9 in instars III and IV similar to Fig. 3 or barbed condition reduced; instar II with barbed condition further reduced than instars III and IV. Hair 10 in instar IV similar to Fig. 10 or with barbed condition reduced; instar III with barbed condition more reduced than instar IV; instar II with barbed condition even further reduced; in all instars some hairs having a few long barbs towards the distal end.

A. vexans. PROTHORAX — Hairs 5 and 6 in instars III and IV similar to Fig. 4; instar II with barbed condition reduced. Hair 7 in instar IV similar to Fig. 3 or with barbed condition reduced; instar III similar to IV or barbed condition further reduced; instar II with barbed condition still further reduced. Hair 8 in instar IV similar to Fig. 3 or with barbed condition reduced; instar III with a strikingly reduced barbed condition; instar II barbless; the dramatic increase in the barbed condition through succeeding instars accompanying an equally dramatic increase in the size of this hair. MESOTHORAX — Hair 5 in instars III and IV similar to Fig. 8; instar II with barbed condition reduced. Hair 6 in instars III and IV similar to Fig. 3; instar II with barbed condition reduced. Hair 7 in instars III and IV similar to Fig. 8 or 9; instar II similar to instars III and IV or with barbed condition reduced; in all instars hairs sometimes having exceptionally long barbs towards the distal end of the shaft. Hair 8 in instars III and IV similar to Fig. 3. Hair 9 in all instars similar to Fig. 3. Hair 10 in all instars similar to Fig. 9 and sometimes having exceptionally long barbs along with the normally shorter barbs, thus giving this hair a resemblance to the closely associated hair 9. Hair 12 in instars III and IV similar to Figs. 8 or 9, sometimes with longer barbs towards the distal end of the shaft; instar II similar to Fig. 9 or barbed condition reduced. METATHORAX — Hair 7 in instars III and IV similar to Fig. 3. Hair 9 in instars III and IV similar to Fig. 3; instar II with barbed condition reduced. Hair 10 in all instars similar to Fig. 8; sometimes with long barbs, especially towards the distal end of the shaft.

Ontogenetic Changes

In some hairs there is no change in the length and/or number of barbs through succeeding instars. In others, an increase occurs in the molt to instar III. In still others, an increase occurs in the molt to instar IV. Finally, there may be an increase in both molts. The transitory hairs are similar in barbed condition in both instars except for metathoracic hair 7 of _abserratus_ in which some specimens have a greater development of the barbed condition in instar IV.

The barbed condition appears to be correlated with hair size. The length and/or number of barbs either stays the same or increases during ontogenetic development. Also, the larger a numbered hair is in relation to other numbered hairs in any instar, the more likely it is to be barbed, and the largest hairs in all instars are barbed. In _vexans_, however, and to a lesser extent in other species, many of the barbless hairs are as large as their barbed counterparts on other species. Therefore, the threshold size for the presence of barbs differs from species to species for any particular hair.

Interspecific Comparisons

Atropalpus has the greatest number of barbed hairs with 25, abserratus and cinereus 18 each, and vexans the least with 14. In the prothoracic hairs the distinctive barbed condition illustrated by Fig. 3 does not occur in all species, hair 7 of atropalpus, cinereus and vexans and hair 8 of cinereus and vexans having this appearance while the same numbered hairs on the other species do not. In the meso- and metathorax there is no interspecific variation. All of the large multi-branched hairs of the mesothorax (6, 8 and 9) and metathorax (7 and 9) have the barbs long and numerous.

Intersegmental Comparisons

In all species the pro- and mesothorax had approximately the same number of barbed hairs and the metathorax the fewest.

Basal Sclerotization

The basal sclerotization when present, surrounds the alveolus either as a simple ring or with the posterior portion expanded to a varying degree depending on the particular numbered hair (Fig. 15). On the sclerotization of certain numbered hairs, especially in instars III and IV, there is a row of serrations completely or partially surrounding the alveolus, the most common condition being a semicircle posterior to the alveolus (Fig. 15). These serrations are clearly seen only under the compound microscope unless otherwise noted in the description.

Generally speaking, the basal sclerotization and associated serrations gradually increase in size through succeeding instars. Only unusual changes in size between instars are noted in the descriptions. The shape of the basal sclerotization and the row of serrations, if present, are to be considered similar in all instars unless described otherwise.

Species Description

A. abserratus. PROTHORAX — Hairs 5 and 6 in instar IV with a ring of sclerotization around each alveolus; instar III with hairs having a limited posterior expansion or some specimens with the expansions enlarged and connected in a manner similar to Fig. 37; instar II similar to Fig. 37 in shape. Hair 7 in all instars with basal sclerotization similar in shape to Figs. 29, 33 and 37; instar II in some specimens with posterior expansion connected to the sclerotization posterior to hairs 5 and 6. Hair 8 in instars III and IV with a ring of sclerotization around the alveolus or in some specimens a small posterior expansion; instar II with a very thin ring around the alveolus. MESOTHORAX — Hair 5 in all instars with a posterior expansion of the basal sclerotization. Instars III and IV with a distinct, or in some specimens faint, semicircular row of serrations posterior to the alveolus; instar II similar to instars III and IV or in some specimens serrations missing. Hairs 6 and 7 in all instars sharing the same basal sclerotization which is similar in shape to Figs. 29, 33 and 37. Hair 6 in instars III and IV with a semicircular row of serrations posterior to the alveolus; instar II similar to instars III and IV or in some specimens serrations relatively smaller than those in instars III and IV. Instar IV with a group of small sclerotizations posterior and ventral to the basal sclerotization of hairs 6 and 7 (Fig. 29) which are darker in color than the sclerotization of hairs 6 and 7 and which vary in number, shape and arrangement from specimen to specimen. These sclerotizations missing in instars II and III. Hair 8 in instars III and IV with basal sclerotization similar in shape to Figs. 29 and 33. Instar IV with a semicircular row of serrations just posterior to the alveolus; instar III with serrations poorly seen or apparently absent in some specimens although the row of serrations may be present but so close to the alveolus as not to be distinguishable from the rim of the alveolus. METATHORAX — Hair 6 in instars III and IV with some specimens having a very narrow ring of sclerotization around the alveolus, visible only under the compound microscope; instar II without sclerotization. Hair 7 in instars III and IV with basal sclerotization similar in shape to Figs. 29 and 33. Instar IV with a semicircular row of very small serrations posterior to the alveolus; instar III with serrations missing in most specimens. Instar IV with a group of small sclerotizations posterior to the dorsal edge of the basal sclerotization of hair 7 (Fig. 29) which are darker in color than the sclerotization at the base of hair 7 and which vary in number, shape and arrangement from specimen to specimen. On some specimens these sclerotized areas are reduced to dots visible only under the compound microscope. These sclerotizations missing in instars II and III.

A. atropalpus. PROTHORAX — Hairs 1-3 in instar IV with some specimens having very light rings of sclerotization, visible only under the compound microscope, around each of the alveoli; instars II and III without this sclerotization. Hairs 5 and 6 in all instars with a narrow ring of sclerotizations around each alveolus. Hair 7 in instars III and IV with a ring of sclerotizations around alveolus, some specimens with a slight posterior expansion; instar II with a ring around the alveolus. MESOTHORAX —

Hair 5 in all instars with a ring of sclerotization around the alveolus or some specimens with a small posterior expansion. Hairs 6 and 7 in all instars sharing the same basal sclerotization which is similar in shape to Figs. 30, 34 and 38. Hair 6 in instar IV with a semicircular row of serrations posterior to the alveolus or some specimens with serrations missing; instar III with row of serrations shorter or some specimens with serrations missing; instar II with no serrations. Hair 8 in instars III and IV with basal sclerotization similar in shape to Figs. 30 and 34. Instar IV appearing to have, at least on some specimens, a semicircular row of very small serrations so close to the posterior edge of the alveolus as to make observations difficult. These serrations apparently missing in instar III. METATHORAX — Hair 6 in instars III and IV with some specimens having a very narrow ring of sclerotization around the alveolus, visible only under the compound microscope; instar II without sclerotization. An anomaly was observed in an instar III specimen in which there was a narrow posterior expansion of the basal sclerotization. Hair 7 in instars III and IV with basal sclerotization similar in shape to Figs. 30 and 34. Instar IV with a semicircular row of very small serrations posterior to the alveolus; instar III with serrations missing.

A. cinereus. PROTHORAX — Hair 5 in all instars with a ring of sclerotization around the alveolus, sometimes with a small posterior expansion. Hair 6 in all instars with a ring of sclerotization around the alveolus. Hair 7 in all instars with a posterior expansion of the basal sclerotization; the increase in size of the sclerotization from instar II to III unusually great. Instars III and IV with a semicircular row of serrations posterior to the alveolus; instar II with serrations missing.

Hair 8 in instars III and IV with a very lightly sclerotized ring around the alveolus (usually clearly visible only under the compound microscope) or in some specimens no sclerotization; instar II without sclerotization. MESOTHORAX — Hair 5 in all instars with a posterior expansion of the basal sclerotization and a distinct semicircular row of serrations posterior to the alveolus. Hairs 6 and 7 in all instars sharing the same basal sclerotization which is similar in shape to Figs. 31, 35 and 39. Hair 6 in all instars with a distinct semicircular row of serrations posterior to the alveolus being clearly seen on instars III and IV under the dissecting microscope. The serrations associated with hair 6 usually the largest on the mesothorax. Hair 7 in instar IV with a single chisel-shaped projection of the sclerotization posterior to the alveolus; instars II and III with projection missing. Hair 8 in instars III and IV with basal sclerotization similar in shape to Figs. 31 and 35 and a distinct semicircular row of serrations posterior to the alveolus which are visible on some specimens of both instars under the dissecting microscope. These serrations similar in size or only slightly smaller than those associated with hair 6. METATHORAX — Hair 6 in instar IV with some specimens having a very narrow ring of sclerotization around the alveolus, visible only under the compound microscope; instars II and III without basal sclerotization. Hair 7 in instars III and IV with basal sclerotization similar in shape to Figs. 31 and 35 and a semicircular row of serrations posterior to the alveolus being visible under the dissecting microscope on instar IV and some specimens of instar III. The increase in size of the serrations from instar III to IV is unusually great.

A. vexans. PROTHORAX — Hair 5 in all instars with a ring of sclerotization around the alveolus. Instar IV in some specimens with a circle of very faint serrations around outer edge of sclerotization, there being random gaps in the circle where serrations are missing; instars II and III without serrations. Hair 6 in all instars with a ring of sclerotization around the alveolus. Instar IV in some specimens with a faint circle of serrations surrounding the alveolus, there being random gaps in the circle where serrations are missing; instar III similar to instar IV except serrations, when present, are even less easily seen; instar II without serrations. Hair 7 in all instars with a posterior expansion of the basal sclerotization or some specimens of instar II with only a ring around the alveolus. The increase in size of the basal sclerotization from instar II to III unusually great. Instar IV with a circle of serrations around the alveolus with the smallest serrations anterior to the alveolus or in some specimens anterior serrations missing. Instar III similar to instar IV except for anterior serrations being extremely reduced or in most specimens missing; in both instars III and IV the posterior portion of the ring clearly visible under the compound microscope. Instar II without serrations. Hair 8 in instar IV with a thin ring of light sclerotization around the alveolus or in some specimens no sclerotization; instars II and III without basal sclerotization. MESOTHORAX — Hair 5 in all instars with a posterior expansion of the basal sclerotization and a distinct semicircular row of serrations posterior to the alveolus which is clearly seen under the dissecting microscope on instar IV and some specimens of instars II and III. Hairs 6 and 7 in all instars sharing the same basal sclerotization which is similar in shape to Figs. 32,36 &40. Hair 6 in all instars with a distinct semicircular row of serrations posterior to the alveolus being clearly seen under the dissecting microscope on instars III and IV and on some specimens of instar II. The serrations exceedingly large in instar IV and relatively smaller in instars II and III but in all instars are always the largest on the mesothorax. Hair 7 in instar IV with a simple chisel-shaped projection of the sclerotization posterior to the alveolus; instar III similar to instar IV or some specimens with projection missing; instar II with projection missing. Hair 8 in instars III and IV with basal sclerotization similar in shape to Figs. 32 and 36 and a distinct semicircular row of serrations posterior to the alveolus which are visible under the dissecting microscope on instar IV. These serrations, on some instar IV specimens, are almost as large as those associated with hair 6; in instar III serrations smaller than those of hair 6. METATHORAX — Hair 7 in instars III and IV with basal sclerotization similar in shape to Fig. 32 and 36 and a semicircular row of serrations posterior to the alveolus which is visible under the dissecting microscope on instar IV and some specimens of instar III. The increase in size of the serrations from instar III to IV is unusually great.

<u>Ontogenetic Changes</u>

Usually the shape of the basal sclerotization and its size in relation to the rest of the larva remains roughly the same through succeeding instars; or sometimes there is an unusually large increase in the amount of sclerotization in the molt to instar III, often associated with a slight change in shape in some specimens. The only exception is the basal sclerotizations of prothoracic hairs 5 and 6 of <u>abserratus</u> which become reduced in amount through succeeding instars. Normally the basal sclerotization is present in instar II. However, in some numbered hairs it may appear for the first time in instar III or IV depending upon the particular numbered hair.

The general shape and position of the row of serrations in relation to the alveolus does not change through succeeding instars for any given numbered hair. Usually the size of the serrations in relation to the rest of the larva remains the same through succeeding instars. However, in some numbered hairs, there is an unusually large increase in size of the serrations from one instar to another, especially from instar III to IV. Serrations sometimes appear for the first time in instar III or IV depending upon the particular numbered hair.

Interspecific Comparisons

There is a considerable amount of similarity amongst species in the specific numbered hairs that have or do not have basal sclerotization. In the prothorax, hairs 5, 6 and 7 have basal sclerotization in all species, hair 8 in abserratus, cinereus, and vexans and hairs 1, 2 and 3 in only atropalpus. In the mesothorax, hairs 5-8 have basal sclerotization in all species. In the metathorax, hair 7 has basal sclerotization in all species, hair 6 in abserratus, atropalpus and cinereus. The shape and relative size of the basal sclerotizations also show a great deal of similarity between species in all instars. This is particularly true in mesothoracic hairs 6 and 7 which have a common sclerotization, and in the transitory hairs of the meso- and metathorax.

The presence of serrations is most common in vexans with three hairs on the prothorax (5, 6 and 7), four on the mesothorax (5, 6, 7 and 8) and one (7) on the metathorax having serrations associated with the basal sclerotization. _Cinereus_ is the same as _vexans_ except that in the prothorax only hair 7 has serrations. _Abserratus_ and _atropalpus_ have no hairs with serrations on the prothorax, three (5, 6 and 8) and two (6 and 8) respectively on the mesothorax and one (7) each on the metathorax. The serrations of _vexans_ are generally the largest in the four species and on certain numbered hairs are clearly visible under the lower power of the dissecting microscope. Serrations may also be visible under the dissecting microscope on _cinereus_ but are reduced in size on _abserratus_ and _atropalpus_ being visible only under the compound microscope. Metathoracic hair 7 of _cinereus_ and _vexans_ has the semicircular row posterior to the alveolus reduced to a single chisel-like projection.

The only darkened sclerotized areas observed on the thorax were associated with the alveoli of various numbered hairs of the pleural tubercles except in instar IV of _abserratus_ in which there was a group of small sclerotizations posterior and ventral to the basal sclerotization of mesothoracic hairs 6 and 7 and posterior to the dorsal edge of the sclerotization of metathoracic hair 7 (Fig. 29). These two groups of sclerotizations have three similarities: they are positioned similarly in relation to the sclerotization of the transitory hairs; they both vary in the number, shape and arrangement of their components from specimen to specimen; and both groups are darker in color than the basal sclerotizations of the thoracic hairs. The mesothoracic group, however, usually has the more abundant and larger sclerotizations.

Prothorax. Hairs 1-3 (submedian prothoracic group) have no basal sclerotization except in instar IV of _atropalpus_ where it is visible only under the compound microscope. In _abserratus_ these hairs arise from a nonsclerotized tubercle and are the only thoracic hairs of such large size in any of the species that lack basal sclerotization.

Hairs 5 and 6 have a ring around the alveolus or in some specimens a limited posterior expansion in all instars of atropalpus, cinereus and vexans. Abserratus is unusual in that the basal sclerotizations of these hairs in instar II consist of relatively large posterior expansions which are interconnected. By instar IV the basal sclerotizations have become reduced to rings around the alveoli. Serrations are found in instar IV, sometimes in instar III, and never in instar II on the basal sclerotization of both hairs in vexans.

Hair 7 is characterized by an obvious posterior expansion especially in instars III and IV except in atropalpus in which the sclerotization is a ring around the alveolus in all instars. On the basal sclerotization of this hair in vexans and cinereus serrations are found in instar IV, occasionally in instar III, and never in instar II.

Hair 8 has the weakest basal sclerotization of the prothoracic hairs except in instars III and IV of abserratus which have a well developed ring around the alveolus or in some specimens a slight posterior expansion; instar II has only a very thin ring around the alveolus. In cinereus some specimens of instars III and IV have a very lightly sclerotized ring around the alveolus and instar II has no sclerotization. In vexans only in instar IV do some specimens have a thin ring of light sclerotization around the alveolus. There is no basal sclerotization for hair 8 in atropalpus.

Mesothorax. Hair 5 with the basal sclerotization consisting of a posterior expansion with a semicircular row of serrations posterior to the alveolus in instars III and IV and some specimens of instar II in abserratus and all instars of cinereus and vexans. The basal sclerotization for atropalpus, in all instars, consists of a ring around the alveolus or in some specimens a small posterior expansion; there are no serrations. Hair 5 has the smallest basal scelerotization of all the mesothoracic hairs.

Hairs 6 and 7 in all species share the same basal sclerotization which is greatly expanded posteriorly. This sclerotized area is similar in shape amongst all species and is larger than that of hair 8 except in instar IV of atropalpus. There is a semicircular row of serrations posterior to the alveolus of hair 6 in all instars of abserratus, cinereus and vexans and in some specimens of instars III and IV of atropalpus. The serrations of instar IV of vexans are by far the largest found in any of the species. In all species, the largest serrations are usually associated with hair 6. Hair 7 in instar IV of cinereus and instar IV and some specimens of instar III of vexans has a chisel-like projection of the sclerotization posterior to the alveolus. Posterior and ventral to the basal sclerotization of hairs 6 and 7 there is a group of small sclerotizations which are unique to instar IV of abserratus.

Hair 8 with the basal sclerotization consisting of a large posterior expansion which is similarly shaped in all species. There is a semicircular row of serrations posterior to the alveolus in instars III and IV of cinereus and vexans. This row of serrations is also present in instar IV and probably some specimens of instar III of abserratus and at least in some specimens of instar IV of atropalpus. The close proximity of the serrations to the posterior rim in these two species makes the serrations difficult to see.

Metathorax. Hair 6 has a very thin ring of sclerotization around the alveolus on some specimens of instars III and IV of abserratus and atropalpus and some specimens of instar IV of cinereus.

Hair 7 in all species has the basal sclerotization characterized by an enlarged posterior expansion. There is a semicircular row of serrations posterior to the alveolus in instar IV of all species, these serrations being relatively large in cinereus and vexans. In instar III, depending on the species, the serrations may not have developed at all, may appear only in a few specimens or may appear in all specimens but are much smaller than in instar IV.

Pleural Groups

Hairs 9, 10, 11 and 12 on each thoracic segment are called the pleural group. Certain characteristics are common to the pleural groups of all the thoracic segments. The hairs are located on a tubercle which has the posterior side and the apical portion sclerotized; the anterior side is membranous. The only exception to the above is the absence of sclerotization on the prothoracic tubercle in instar II of vexans. The hairs occur in two pairs, an anterior pair composed of hairs 9 and 10 and a posterior pair composed of hairs 11 and 12; hairs 9 and 11 are the closest to the middorsal line (Fig. 16).

The individual identity of the four hairs of the tubercle can be difficult to determine by position alone because of visual difficulties. However, in addition to relative position, the relative size and branching of the hairs, the serrations associated with the alveoli, and a sclerotized process between hairs 9 and 11 only make the hairs more easily identifiable.

More specific data on relative length and branching than is contained in the following discussion are presented in the appropriate graphs and tables. Unless otherwise stated, the discussion below under species description and interspecific comparisons and intersegmental comparisons applies to all instars.

Species Description and Interspecific Comparisons

Prothorax. The relative position of the four hairs is similar in all species. The profile is also similar in all species (Graphs 1, 4, 7 and 10) although in abserratus hair 10 is relatively long. The anterior pair of hairs belongs to type 2 in all species; hair 9 may be branched in some instars of abserratus, cinereus and vexans but is unbranched in atropalpus and hair 10 is unbranched in all species. The posterior pair of hairs in atropalpus, cinereus and vexans belong to type 2; hair 11 is the shortest hair of the pleural group and may be branched, hair 12 is unbranched. In abserratus hair 11 is similar to the other species but hair 12 is an unbranched type 1 hair with a single semicircular row of serrations, clearly seen under the dissecting microscope, ventral and posterior to the alveolus (Fig. 16). In all species a sclerotized process projects upwards between hairs 9 and 11. In abserratus there is along the base of the anterior membranous portion of the tubercle a thin complete or broken line of sclerotization in some specimens of instar IV.

Mesothorax. The relative position of the four hairs is similar in all species. The profile is similar in abserratus, cinereus and vexans (Graphs 2, 8 and 11). In atropalpus hair 12 becomes relatively longer through succeeding instars (Graph 5). The anterior pair of hairs in all species belongs to type 1 and consists of branched hair 9 which lacks serrations associated with the alveolus and unbranched hair 10 with a semicircular row of serrations, clearly seen under the dissecting microscope, posterior to the alveolus. In vexans, one, sometimes two, of these serrations are extremely long. The posterior pair of hairs is similar in all species; their alveoli are much closer together than those of the anterior pair; hair 11 is minute, the insertion being difficult to see even under the compound microscope; and hair 12 is an unbranched type 1 hair with a semicircular row of serrations, visible under the dissecting microscope, posterior to the alveolus. In abserratus there is a semicircular row of very small serrations visible only under the compound microscope posterior to the alveolus of hair 11. In all species the serrations associated with hair 10 are larger than those associated with hair 12. In abserratus, cinereus and vexans a sclerotized process projects upwards between hairs 9 and 11. In abserratus, along the base of the anterior membranous portion of the tubercle, there is a thin broken line of sclerotization in some specimens of instar IV.

Metathorax. The relative position of the four hairs is similar in all species. The profile is also similar in all species (Graphs 3, 6, 9 and 12). The anterior pair of hairs in all species belongs to type 1 and consists of branched hair 9, which lacks serrations associated with the alveolus, and unbranched hair 10 with a semicircular row of serrations, clearly seen under the dissecting microscope, posterior to the alveolus. The posterior pair of hairs is similar in all species; the alveoli are much closer together than those of the anterior pair, hair 11 is minute, the insertion being difficult to see even under the compound microscope; and hair 12 is an essentially unbranched type 2 hair. In abserratus a semicircular row of very small serrations, seen only under the compound microscope, is located posterior to the alveoli of hairs 11 and 12. In *cinereus* a short row of very small serrations is visible (only under the compound microscope) on some specimens of instars II, III and IV posterior to the alveolus of hair 12. In *abserratus*, *cinereus* and *vexans* a sclerotized process projects upwards between hairs 9 and 11. In *abserratus*, along the base of the anterior membranous portion of the tubercle, there is a thin complete or broken line of sclerotization in some specimens of instar IV.

Discussion. The pleural groups are, in general, very similar amongst species. However, differences do occur and the more obvious are: prothoracic hair 1 of type 1 in *abserratus* and type 2 in the other species; relatively large increase in length of mesothoracic hair 12 of *atropalpus* through succeeding instars; absence of a sclerotized process between hairs 9 and 11 on the meso- and metathoracic tubercles of *atropalpus*; extra sclerotization associated with the pleural tubercles of instar IV of *abserratus*; one or two extremely long serrations associated with metothoracic hair 10 of *vexans*; obvious serrations associated with prothoracic hair 10 of *abserratus*; absence of sclerotization in *vexans* on the prothoracic tubercle of instar II; different developmental patterns of branching for prothoracic hair 9 in *abserratus*, *cinereus*, and *vexans*, this hair being unbranched in *abserratus*.

Serrations clearly seen under the dissecting microscope include those associated with prothoracic hair 12 of *abserratus* and, in all species, mesothoracic hairs 10 and 12 and metathoracic hair 10.

Ontogenetic Changes

There is no noticeable change in any of the species in the position of the thoracic tubercles or the hairs associated with them through succeedinstars. There are only minor changes in profile during ontogenetic development in the three pleural groups, the most obvious being the relatively large increase in length of mesothoracic hair 12 of atropalpus (Graphs 1-12 and Table III). The developmental pattern of hair branching in the three pleural groups in all species is pattern 4 except for prothoracic hair 9 of cinereus and vexans which have patterns 1 and 3 respectively (Table XVIII). The shape of the tubercular sclerotization remains similar through succeeding instars in all species as does the amount of sclerotization in relation to the size of the specimen except in vexans in which the sclerotization of the prothoracic tubercle does not appear until Instar III.

The composition of the hairs of the prothoracic tubercle, in regards to the type to which each hair belongs, differs somewhat from the type composition of the tubercular hairs of the meso- and metathorax which in turn are very similar to each other. In abserratus the prothorax has two hairs (11 and 12) belonging to the same type as their homologues on the mesothorax and one hair (11) corresponding in type with the metathoracic hairs. In atropalpus, cinereus and vexans the hairs of the prothoracic tubercle have one similarity in type with the mesothoracic hairs (hair 11) and two with the metathoracic hairs (hairs 11 and 12). In all species three hairs (9, 10 and 11) of the meso- and metathorax belong to the same type.

The profiles of the three thoracic pleural groups within each species are very similar except that hair 12 is progressively shorter, in all species, proceeding from the prothorax to the metathorax (Graphs 22-33).

Intersegmental Comparisons

The three thoracic tubercles fall in a straight line from the almost ventral prothoracic tubercle to the higher lateral metathoracic tubercle in all species (Fig. 29). The sclerotized area of the prothoracic tubercle is the smallest; those of the meso- and metathorax are similar in size with that of the mesothorax being slightly larger.

In each species the relative position of each hair on the three thoracic tubercles is very similar except that on the meso- and metathorax the alveoli of the posterior pair of hairs are closer together than those on the prothorax. The degree of development of the four hairs, however, may differ from segment to segment. Hair 9 in all species is either an unbranched or branched type 2 hair on the prothorax and is a branched type 1 hair on the meso- and metathorax. Hair 10 in all species is an unbranched type 2 hair on the prothorax and an unbranched type 1 hair on the meso- and metathorax. Hair 11 in all species is an unbranched or branched type 2 hair on all three thoracic segments. It is the only hair of the pleural groups belonging to the same type on all three segments; also, it is the smallest hair in each of the pleural groups and is especially small on the meso- and metathorax. Hair 12 in atropalpus, cinereus and vexans, on the prothorax, is an unbranched type 2 hair but in abserratus it is an unbranched type 1 hair; in all species on the mesothorax it is an unbranched type 1 hair and on the metathorax an unbranched type 2 hair.

Cervical Hairs

Cervical hairs were found on the neck of third and fourth instar larvae on the four species studied and appeared to be located ventro-laterally.

The exact position of the hairs was not determined because they could be seen only with considerable difficulty, by utilizing flattened specimens on microscope slides. Abserratus had two cervical hairs on each side of the neck whereas atropalpus, cinereus and vexans had only one. The two hairs in abserratus were close together. The cervical hairs in all species were similarily shaped (Fig. 14), very small and normally unbranched (Table XIX). In instar II, in all species, tiny spots suspected of being cervical hairs because of their position were observed. One anomalous instar IV specimen of atropalpus had two hairs on one side of the neck.

SUMMARY

There are 14, 14 and 13 hairs respectively on each side of the pro- meso- and metathorax of each species giving a combined total of 160 pairs for the four species. For ease of description and for statistical purposes each of these hairs was assigned to one of two types, these types being defined according to certain morphological characteristics. Basically, type 1 hairs are large, easily seen and easily measured whereas type 2 hairs are small and difficult to see.

Hair position is constant between instars in all species and, with two minor exceptions, is similar interspecifically. Transitory hairs, meso- and metathoracic hairs 8 and 7 respectively, appear for the first time after the molt to instar III and persist in instar IV in all the species.

Mean hair length, with one exception, increases from instar II to instar IV, with the largest increase taking place in the molt to instar IV in the majority of cases. For type 1 hairs the mean increase was statistically significant in both the molt to instar III and to instar IV. The hair profile of each thoracic segment is different for each instar intraspecifically due to differential growth in hair length through succeeding instars. Also each species has its own pattern of profile development in the three thoracic segments. Therefore, the relationship of the profiles of each segment between species changes from instar to instar. The smallest difference of profiles between species in each of the three thoracic segments is in instar II and the smallest difference between species in each of the three instars is in the metathorax.

The mean diameter of all hairs measured showed a statistically significant increase at each molt.

Sixty of the 160 hairs studied were unbranched. Each of the branched remainder showed one of four developmental patterns. Pattern 1: No statistically significant increase in the mean number of branches per hair in either the molt to instar III or IV. Pattern 2: A statistically significant increase in the mean number of branches per hair in the molt to instar III only. Pattern 3: A statistically significant increase in the mean number of branches per hair in the molt to instar IV only. Pattern 4: A statistically significant increase in the mean number of branches per hair in the molts to both instar III and IV. Patterns 3 and 4 are the most common patterns 1 and 2 having only two numbered hairs each. There is considerable similarity in the developmental pattern of hair branching (or lack thereof) between correspondingly numbered hairs of different species; atropalpus has only six numbered hairs that are uniquely, to this species, either unbranched or branched, abserratus and cinereus have two and vexans none.

Barbs originate from what appear to be notches in the shaft and their presence seems to be correlated with size. It is the larger numbered hairs in any instar that have barbs or, in some numbered hairs, barbs appear during ontogenetic development. The threshold size for the appearance of barbs differs from species to species for any particular numbered hair. Certain numbered hairs of the pro-, meso- and metathorax have numerous and exceptionally long barbs. The barbed condition may be similar in all three instars studied or an increase may occur in either the molt to instar III or IV in both molts. Atropalpus has the greatest number of hairs with barbs.

Basal sclerotization is associated principally with the alveoli of the larger thoracic hairs and is in the form of a ring around the alveolus or is distorted by the posterior portion being expanded to a varying degree depending on the particular numbered hair. A row of serrations completely or partially surrounding the alveolus may occur on the basal sclerotization of certain numbered hairs, the most common condition being a semicircular row posterior to the alveolus. These serrations may be visible only under the higher power of the compound microscope. With a few exceptions, the shape of the basal sclerotization is similar in all instars and a gradual increase in size during ontogenetic development occurs. The general shape and position of the row of serrations in relation to the alveolus does not change through succeeding instars but usually the size of the serrations increases gradually during ontogenetic development. Basal sclerotization and serrations, if associated with a numbered hair, are present in instar II except for a few hairs in which they appear for the first time in instar III or IV. There is a considerable amount of similarity between species in the presence of sclerotization for a particular numbered hair. The shape and relative size of the basal sclerotization in all instars is also generally similar between species. The presence of serrations, however, is variable amongst the species. In instar IV of abserratus there is a group of small dark sclerotizations posterior and ventral to the basal sclerotization of mesothoracic hairs 6 and 7 and posterior to the dorsal edge of the sclerotization of metathoracic hair 7.

Hairs 9-12 on each thoracic segment are located on a tubercle and are called the pro-, meso- or metathoracic pleural group. The identity of these hairs is determined by their relative position on the tubercle. Identification of the hairs is facilitated by their relative size and branching and the presence or absence of serrations associated with the alveoli.

During ontogenetic development there is no noticeable change in either the position of the tubercles on the thorax or the hairs of the pleural group. Also the hair profile, shape of the tubercular sclerotization and amount of sclerotization in relation to the size of the specimen, with minor exceptions, remains similar through succeeding instars. Interspecifically there is no difference in the position of the tubercle on the thorax or the position of the hairs on the tubercle. The hair profile of the three thoracic pleural groups is, with minor exceptions, similar between species as is the hair branching. Prominent serrations are associated with prothoracic hair 12 of abserratus and, in all species, mesothoracic hairs 11 and 12 and metathoracic hair 10.

Minute hairs on the neck region, called cervical hairs, were found on all four species. Abserratus had two hairs on each side of the neck whereas atropalpus, cinereus and vexans had only one. These hairs are present in instars III and IV and suspected of being present in instar II. To the author's knowledge, these hairs have not been reported before in the Culicidae (s.s.).

The three thoracic segments have certain chaetotaxal features in common in all the species studied. The hairs form roughly a line extending from the dorsum around the pleuron to the thoracic tubercle except for a single type 2 hair on the venter; a thoracic tubercle is present in approximately the same position on each segment and the hair position and profiles of their hairs are similar. The overall hair profiles of the three thoracic segments, however, are largely unalike although the profiles of the pro- and mesothorax appear more similar to each other than either does to the metathorax. Development through succeeding instars within a species involves more change in the hair profile of the prothorax than there is in the mesothorax, and the mesothoracic profile shows more change than that of the metathorax. Possibly because of this differential in ontogenetic change there is more divergence between species in the pro- and mesothorax than in the metathorax. In other chaetotaxal characters the prothorax in all species is somewhat different from the meso- and metathorax which are similar to each other. Hair 0 on the prothorax is missing on the meso- and metathorax. Prothoracic hairs 1-3 (submedian prothoracic group) form a row nearly parallel to the saggital line whereas these hairs on the meso- and metathorax form a line at right angles to the saggital line. The composition of the hairs of the prothoracic tubercle, in regards to the type to which each hair belongs, differs somewhat from the composition of the meso- and metathorax which are very similar to each other. The prothorax lacks a lateral stellate hair and a transitory hair, both of which are found in similar positions on the meso- and metathorax. Finally, the prothorax has more numbered hairs in instar IV in which the branched or unbranched condition is unique to one species only than does the meso- and metathorax which have an equal number.

The metathorax appears to display the most primitive chaetotaxy of the three thoracic segments because it is the most similar in profile amongst all the species and shows the least change during ontogenetic development. The mesothorax probably has the next most primitive chaetotaxy having many similarities with the metathorax. On the other hand, its hair profile is more like that of the prothorax than the metathorax and it has more change in profile ontogeny than the metathorax. The prothorax, showing a high degree of evolutionary plasticity, appears to have the most specialized chaetotaxy being very different in many characteristics from the meso- and metathorax including the largest change in profile during ontogenetic development. Additionally, it has the greatest number of hairs in instar IV in which the branched or unbranched condition is unique to one species only.

In general there is a great deal of similarity in the thoracic chaetotaxy between the four species. There are, however, many differences amongst the species, some quite distinct. In atropalpus hair 3 is only slightly mesad of and distinctly posterior to hair 4 whereas in abserratus, cinereus and vexans hair 3 is mesad of and slightly anterior to hair 4. In atropalpus, cinereus and vexans, on the prothorax, hair 2 decreases in length relative to hair 1 during ontogenetic development as does hair 9 on cinereus and vexans in relation to hair 8; in abserratus, cinereus and vexans, on the mesothorax, hair 6 decreases in length relative to hair 5 during ontogenetic development as does hair 2 of atropalpus in relation to hair 1. Also in atropalpus the ontogenetic development of the hair profile of metathoracic hairs 1 through 5 differs from the development of these hairs in the other species for which the ontogenetic development is similar. Atropalpus has the largest amount of numbered hairs in instar IV that are uniquely, to this species, either branched or unbranched with six, abserratus and cinereus have two and vexans has none. Atropalpus has the largest number of hairs with barbs. In abserratus prothoracic hairs 5 and 6 are the only hairs in all the species for which the basal sclerotization becomes reduced through succeeding instars. Only in abserratus is there a group of small dark sclerotizations posterior and ventral to the basal sclerotization of mesothoracic hairs 6 and 7 and posterior to the dorsal edge of the sclerotization of metathoracic hair 7. Serrations associated with the basal sclerotization are larger in cinereus, and particularly in vexans, than in abserratus and atropalpus; additionally, cinereus and vexans have more hairs with associated serrations than abserratus and atropalpus. Only in abserratus there is, along the base of the anterior membranous portion of the thoracic tubercle in all three segments, a small amount of sclerotization. In vexans there are one or two extremely large serrations at the base of mesothoracic hair 10. In abserratus the three hairs of the submedian prothoracic group are large type 1 hairs whereas the same hairs on the other species are much smaller. Also in abserratus, prothoracic hair 12 is type 1 with obvious serrations associated with the alveolus while this hair in the other species belongs to type 2 and lacks serrations. In atropalpus mesothoracic hair 1 is much larger than in the other species. Also in atropalpus the branches of metathoracic hair 1 are much greater in diameter and more darkly pigmented than on the other species in which it has very thin branches, is lightly pigmented and very difficult to see. Probably the mose significant character relationship amongst the species is the presence in abserratus of two cervical hairs on each side of the neck and only one in atropalpus, cinereus and vexans.

The correspondingly numbered thoracic hairs amongst the species studied appear to be interspecifically and ontogenetically homologous because of the similarity in position between the species and through succeeding instars. Serial homologies are not so securely established. The three pleural hair groups can be considered homodynamous because of their association with the pleural tubercles. Individually, the position of the hairs on all three tubercles is very similar as is the size and branching of the hairs on the meso- and metathorax. Hairs 8 and 7 on the meso- and metathoracic segments respectively are transitory in nature, occupy the same position relative to the pleural tubercle, are similar in size, branching, barbed condition and basal sclerotization. Hairs 13 and 8 on the meso- and metathoracic segments respectively occupy the same position relative to the pleural tubercle and are stellate. Hairs 14 and 13 on the meso- and metathoracic segments respectively are similar in position but not to the extent of the aforementioned hairs and are stellate. It would seem that the above hairs, exclusive of the pleural groups, are incorrectly homologized under Belkin's system of numbering. However, a final decision can be made only after further comparative studies on all the mosquito groups.

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EXPLANATION OF PLATES

PLATE I

Figs. 1-10. Typical barbed conditions of instar IV thoracic hairs

PLATE II

Fig. 11. Type 1 hair

12. Type 2 hair

13. Type 2 hair illustrating dendritic appearance

14. Cervical hairs of _A. abserratus_, left ventral view

15. Basal sclerotization

16. Prothoracic tubercle of _A. abserratus_, ventrolateral view

PLATE III

Instar IV thoraces, dorsal and ventral view

Fig. 17. _A. abserratus_

18. _A. atropalpus_

19. _A. cinereus_

20. _A. vexans_

PLATE IV

Instar III thoraces, dorsal and ventral view

Fig. 21. _A. abserratus_

22. _A. atropalpus_

23. _A. cinereus_

24. _A. vexans_

PLATE V

Instar II thoraces, dorsal and ventral view

Fig. 25. *A. abserratus*

26. *A. atropalpus*

27. *A. cinereus*

28. *A. vexans*

PLATE VI

Instar III and IV thoraces, lateral view

Fig. 29. *A. abserratus*, instar IV

30. *A. atropalpus*, instar IV

31. *A. cinereus*, instar IV

32. *A. vexans*, instar IV

33. *A. abserratus*, instar III

34. *A. atropalpus*, instar III

35. *A. cinereus*, instar III

36. *A. vexans*, instar III

PLATE VII

Instar II thoraces, lateral view

Fig. 37. *A. abserratus*

38. *A. atropalpus*

39. *A. cinereus*

40. *A. vexans*

EXPLANATION OF GRAPHS

GRAPHS 1-12

Intraspecific thoracic profile comparison

Graph 1. Prothorax, *A. abserratus*

2. Mesothorax, *A. abserratus*

3. Metathorax, *A. abserratus*

4. Prothorax, *A. atropalpus*

5. Mesothorax, *A. atropalpus*

6. Metathorax, *A. atropalpus*

7. Prothorax, *A. cinereus*

8. Mesothorax. *A. cinereus*

9. Metathorax. *A. cinereus*

10. Prothorax, *A. vexans*

11. Mesothorax, *A. vexans*

12. Metathorax, *A. vexans*

GRAPHS 13-21

Interspecific thoracic profile comparison

Graph 13. Prothorax, instar II

14. Prothorax, instar III

15. Prothorax, instar IV

16. Mesothorax, instar II

17. Mesothorax, instar III

18. Mesothorax, instar IV

19. Metathorax, instar II

20. Metathorax, instar III

21. Metathorax, instar IV

GRAPHS 22-33

Intersegmental thoracic profile comparison

Graph 22. Instar II, _A_. _abserratus_

23. Instar III, _A_. _abserratus_

24. Instar IV, _A_. _abserratus_

25. Instar II, _A_. _atropalpus_

26. Instar III, _A_. _atropalpus_

27. Instar IV, _A_. _atropalpus_

28. Instar II, _A_. _cinereus_

29. Instar III, _A_. _cinereus_

30. Instar IV, _A_. _cinereus_

31. Instar II, _A_. _vexans_

32. Instar III, _A_. _vexans_

33. Instar IV, _A_. _vexans_

PLATE I

Fig. 11

Fig. 12

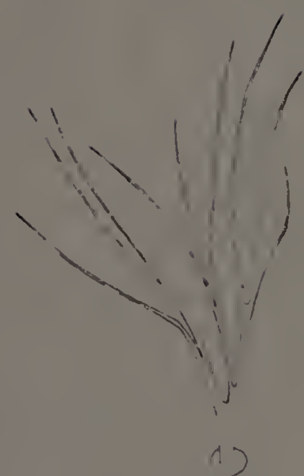


Fig. 13

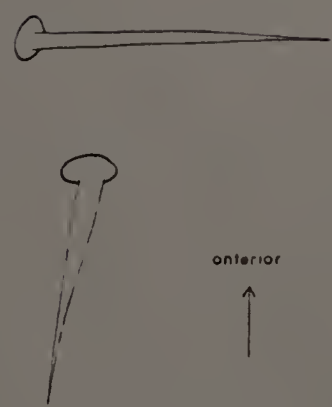


Fig. 14

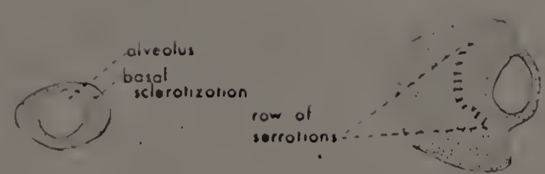


Fig. 15

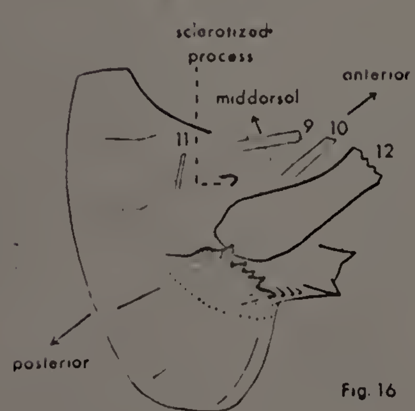


Fig. 16

PLATE 11

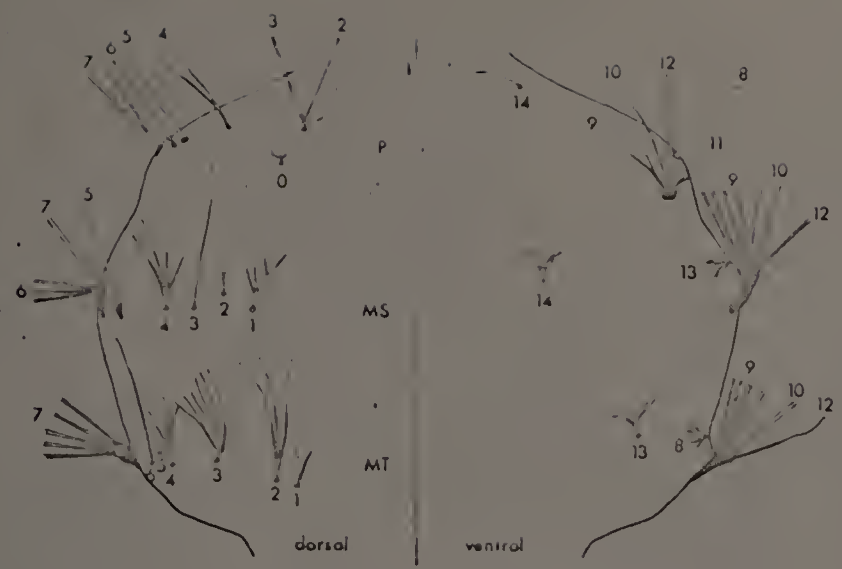


Fig. 17

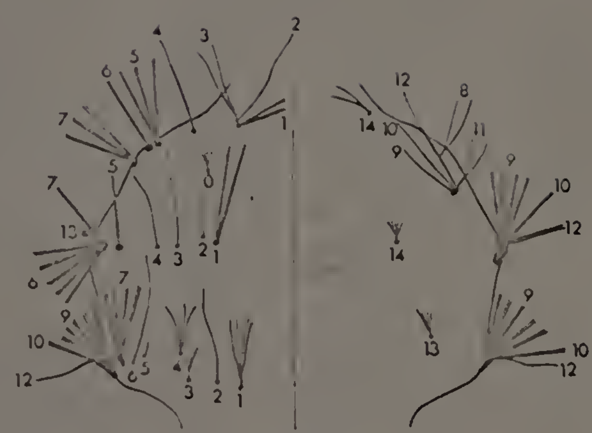


Fig 18

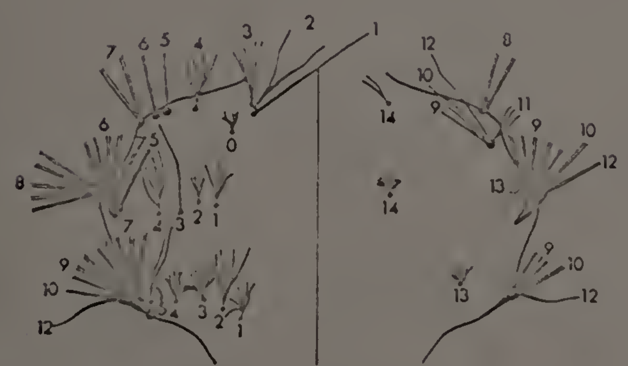


Fig 19

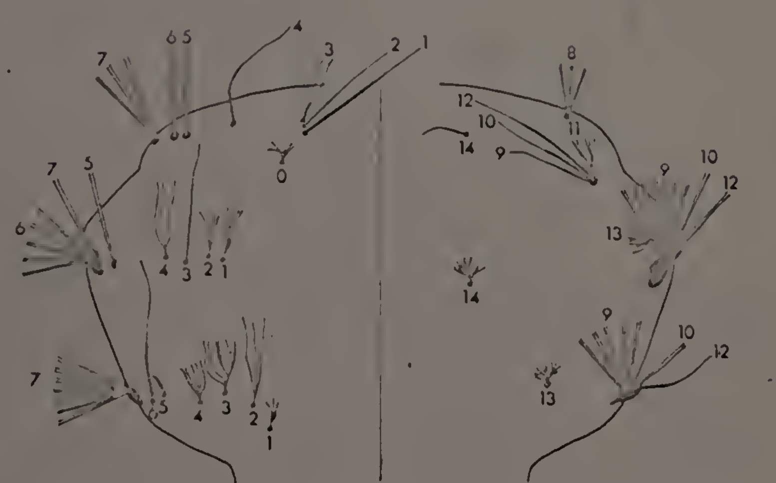


Fig 20

PLATE III

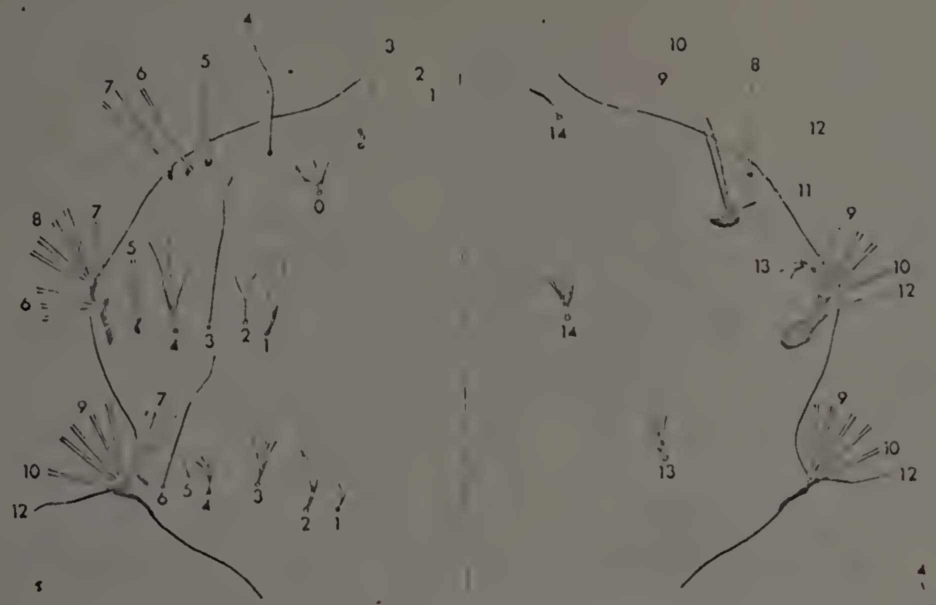


Fig 21

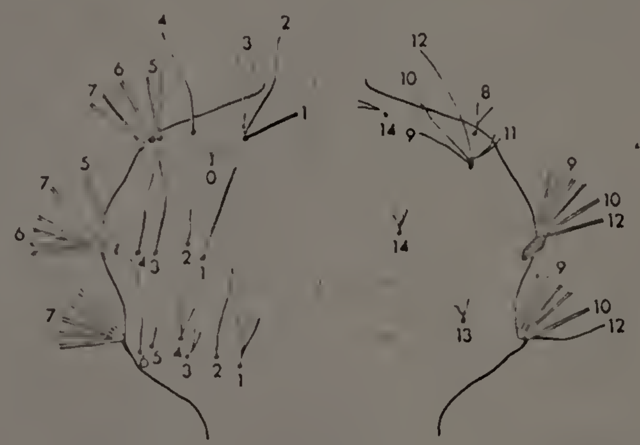


Fig 22

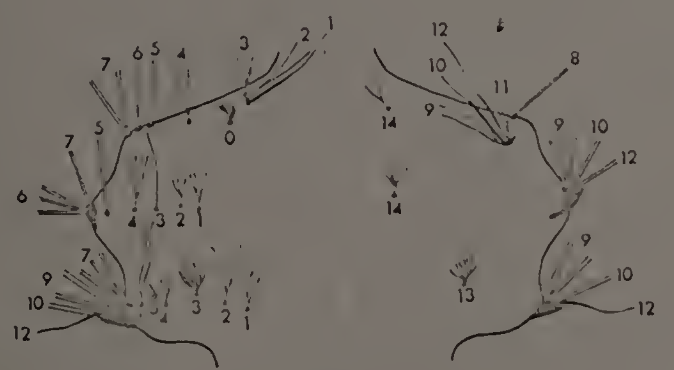


Fig 23

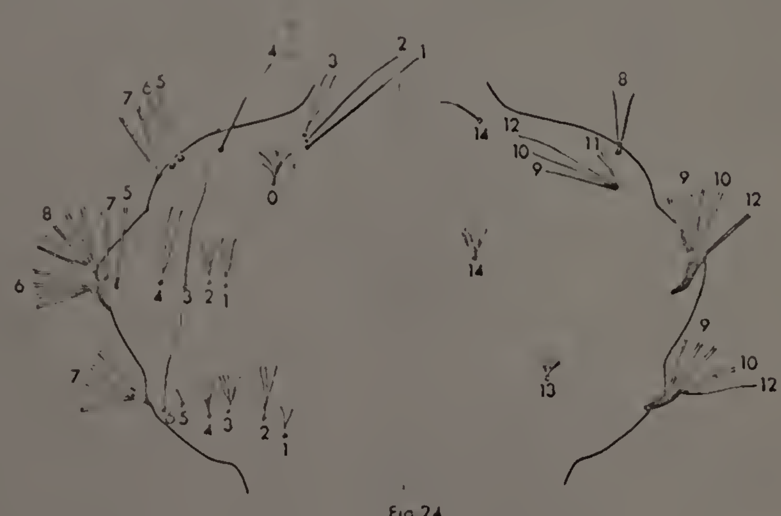


Fig 24

PLATE IV

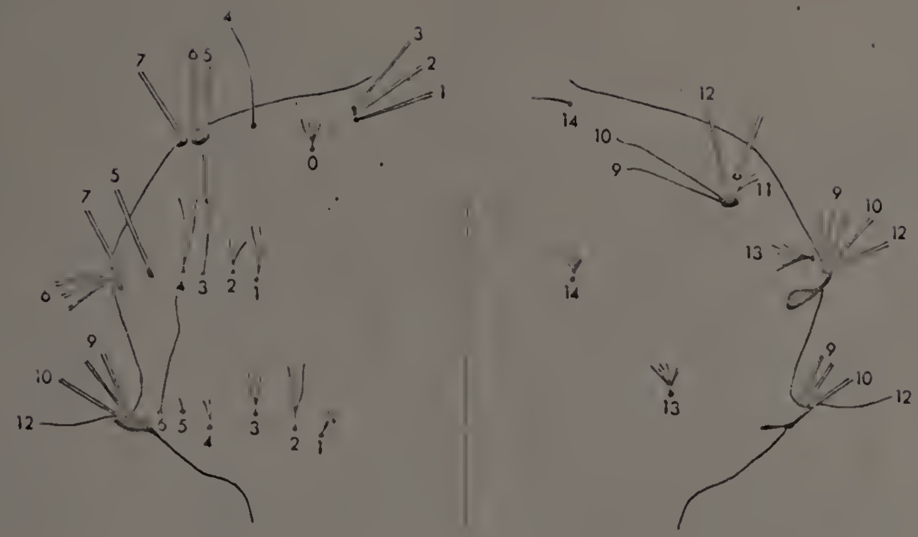


Fig 25

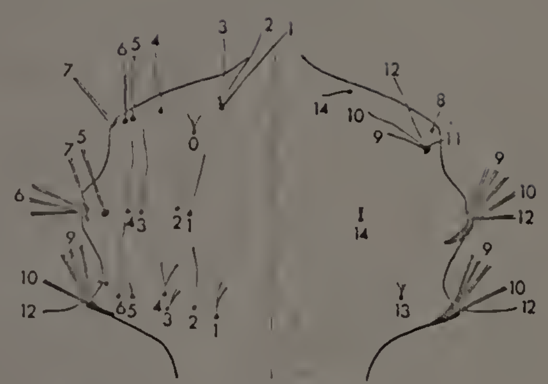


Fig 26

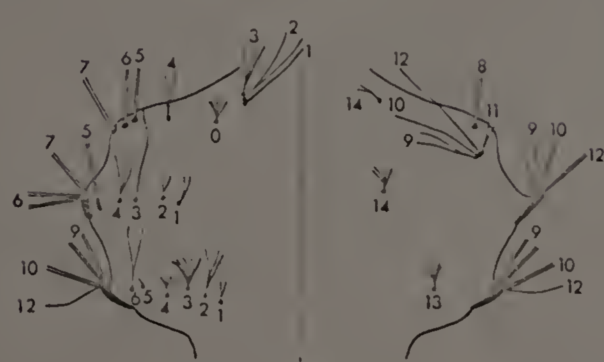


Fig 27

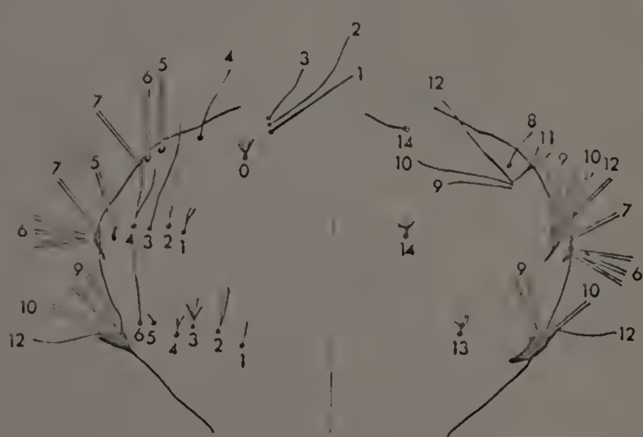


Fig 28

PLATE V

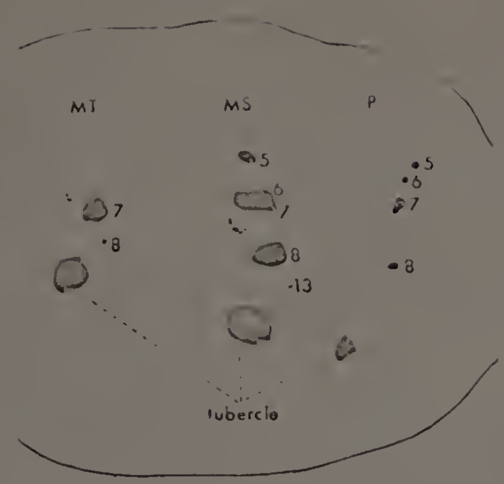


Fig 29

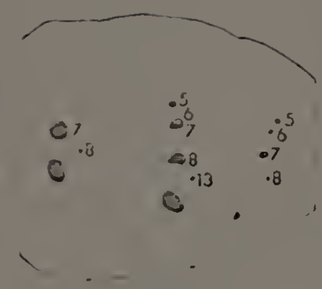


Fig 30

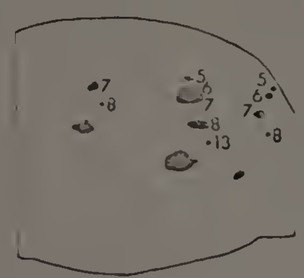


Fig 31

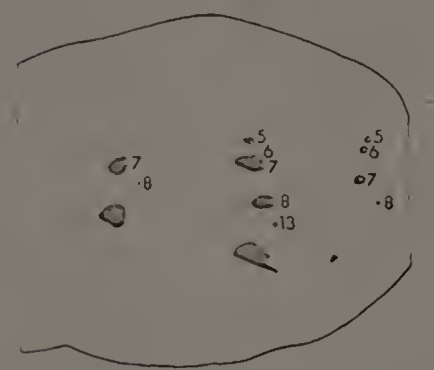


Fig 32

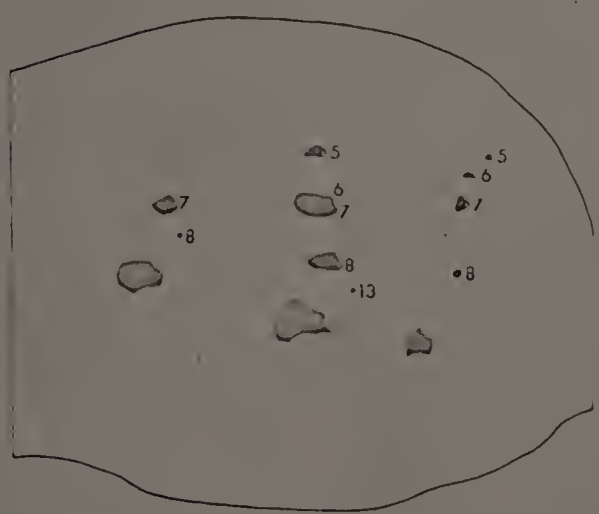


Fig 33

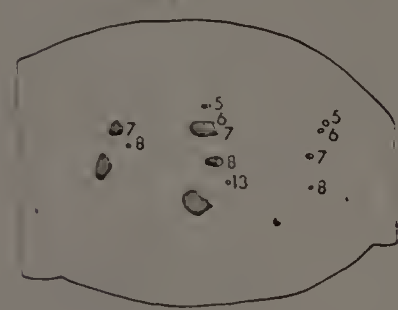


Fig 34

Fig 35

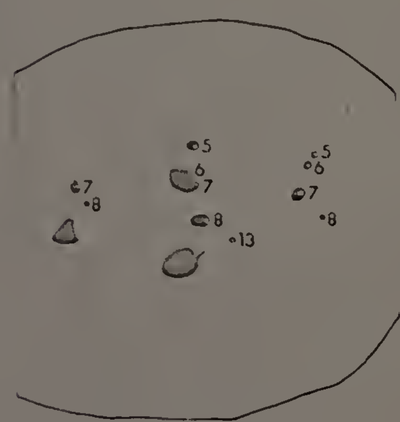


Fig 36

PLATE VI

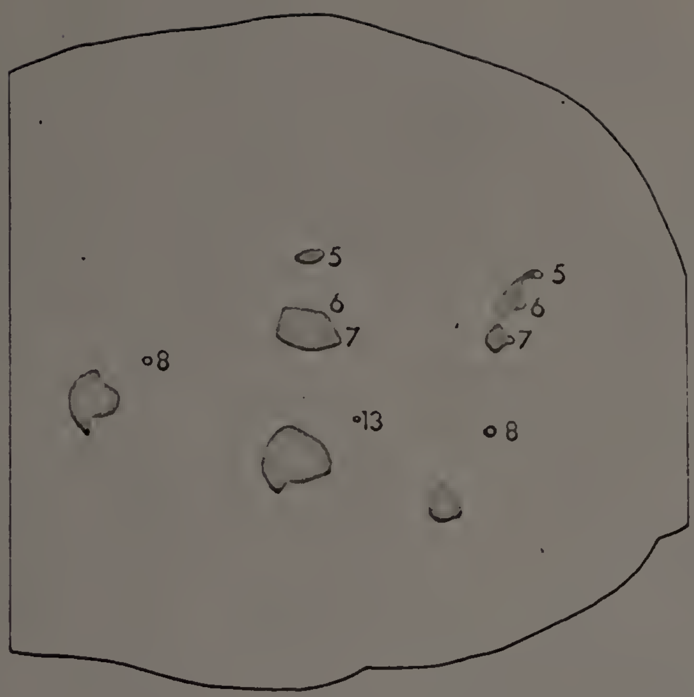


Fig. 37

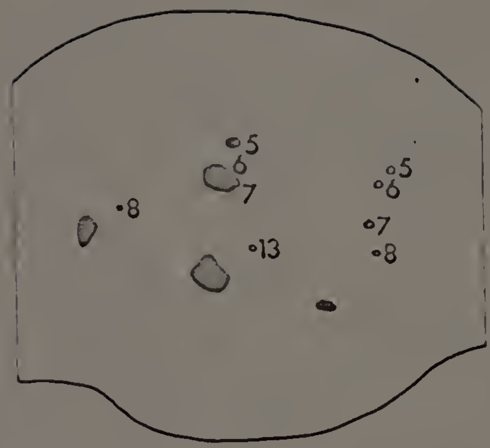


Fig. 38

Fig. 39

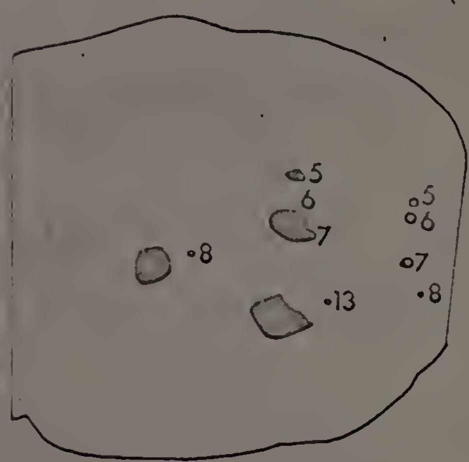
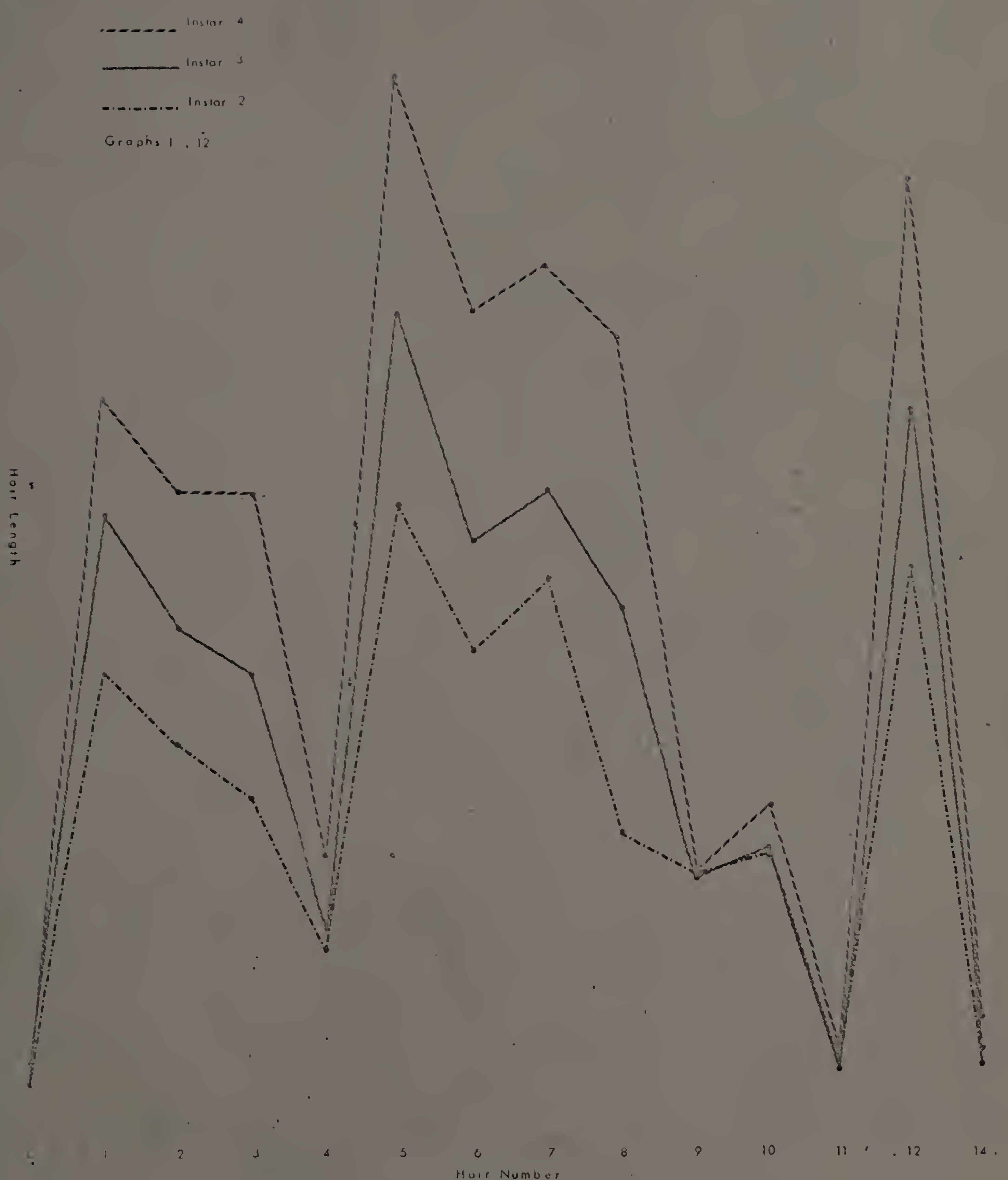
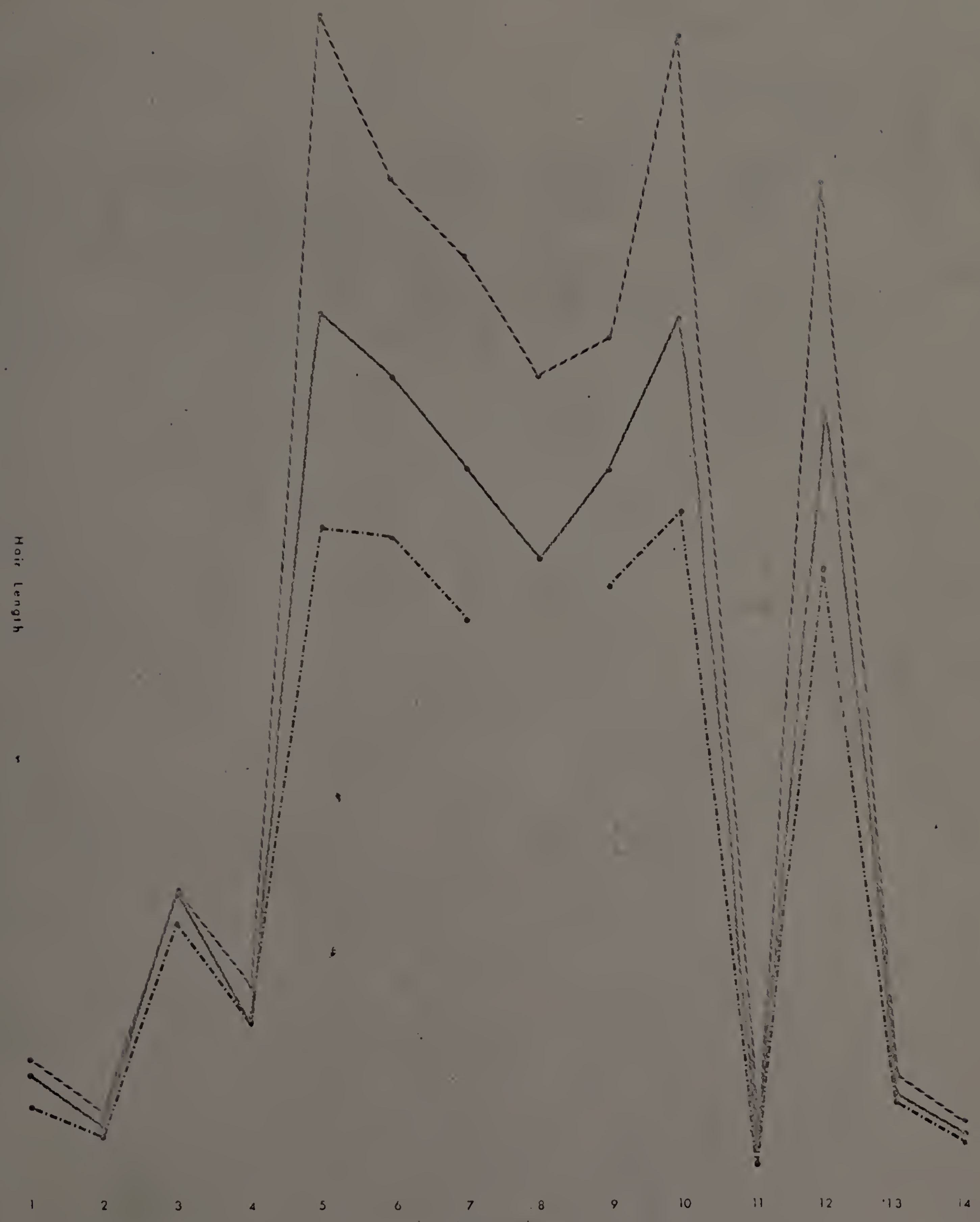


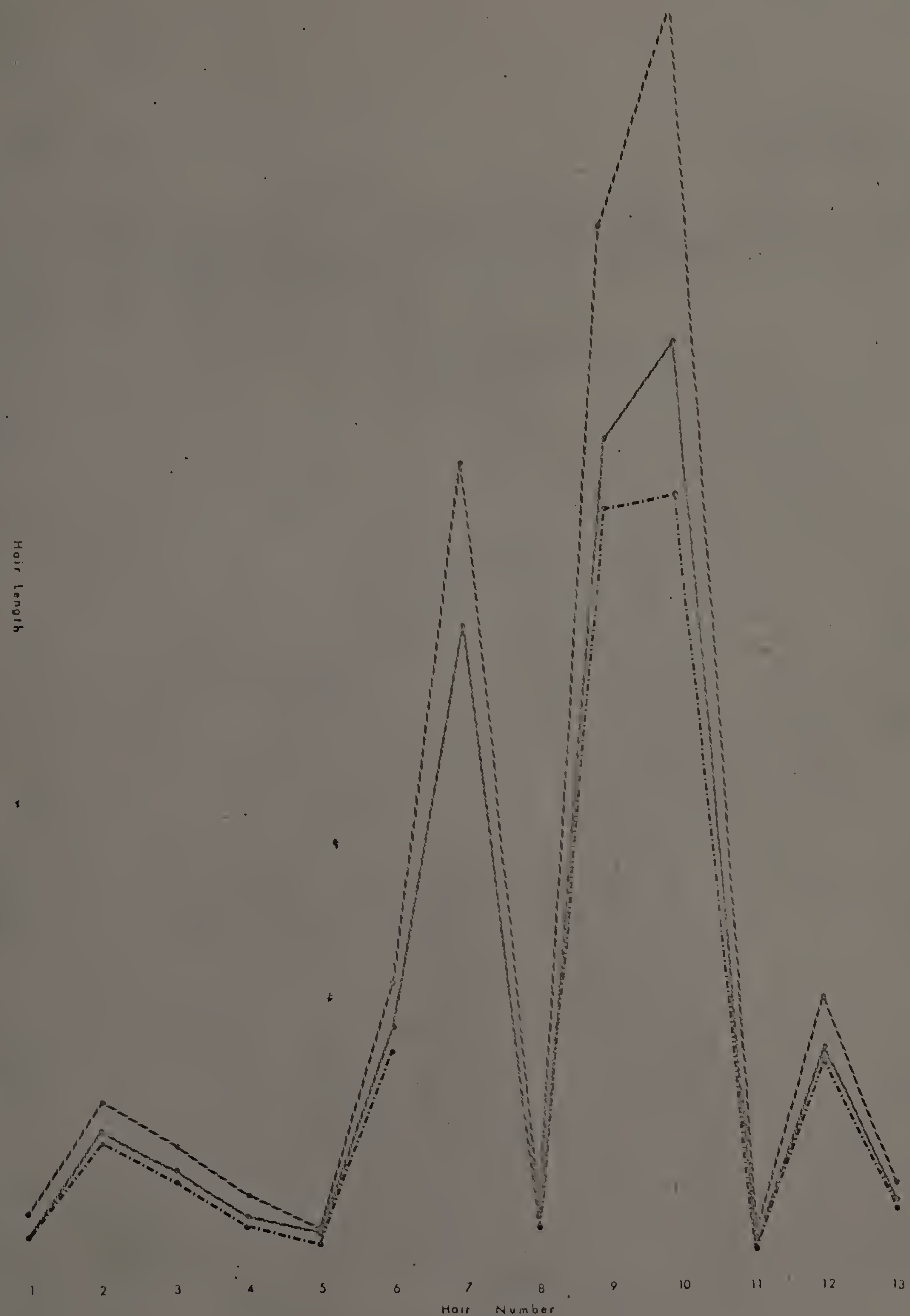
Fig. 40

PLATE VII

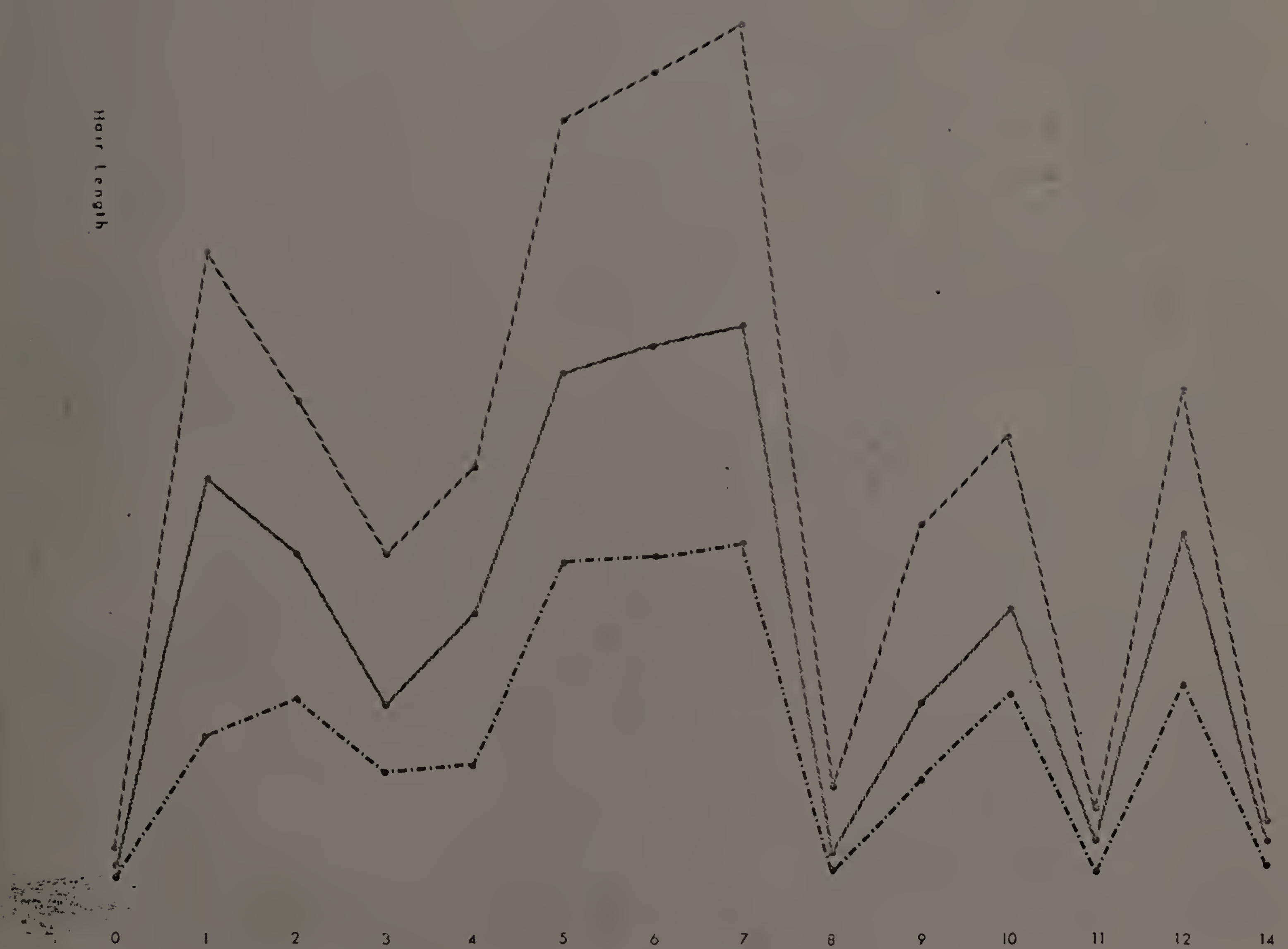

Instar 4
Instar 3
Instar 2
Graphs 1 , 12
Hair Length
1 2 3 4 5 6 7 8 9 10 11 12 14
Hair Number
Graph 1



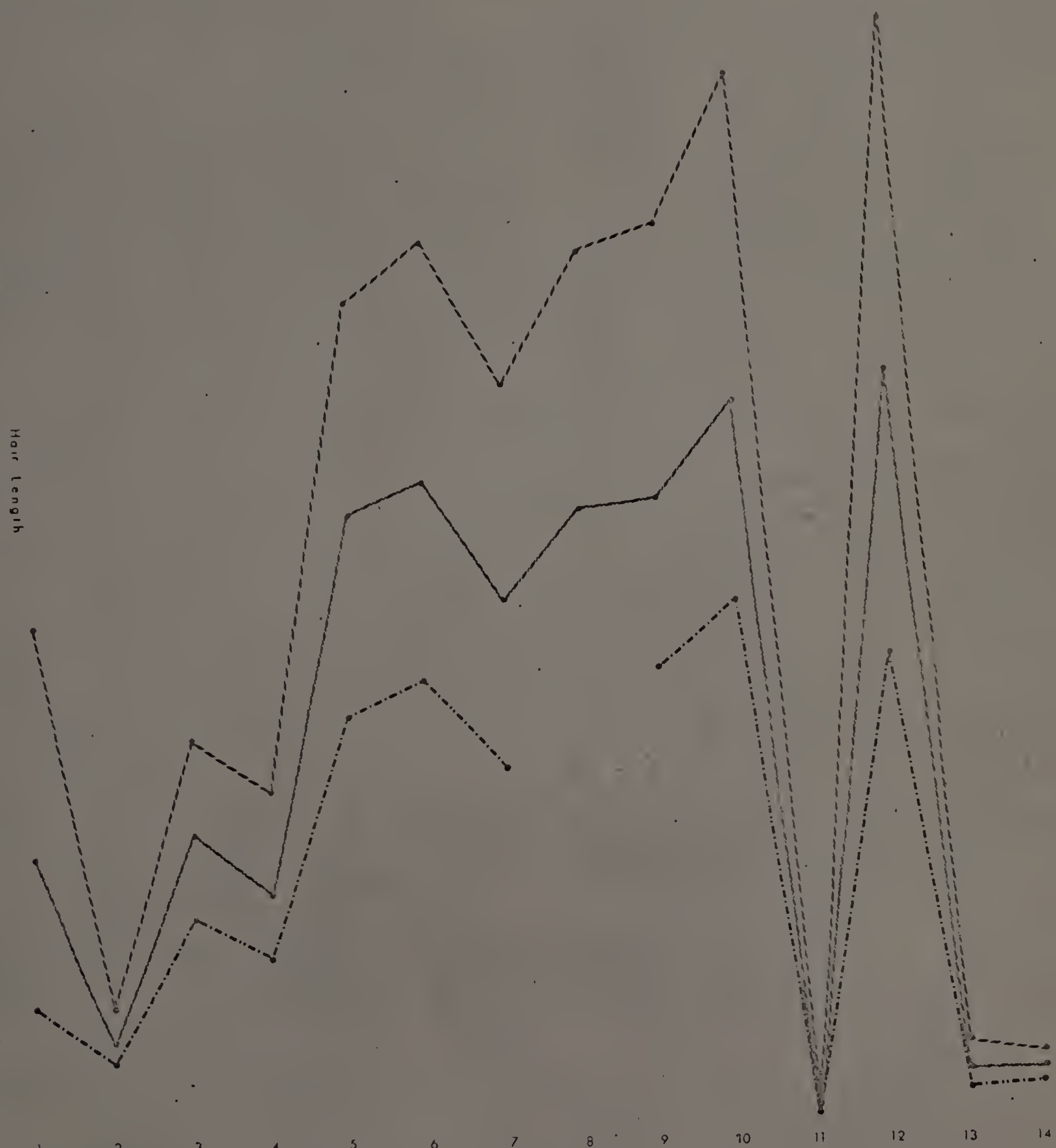
Graph 2



Graph 3

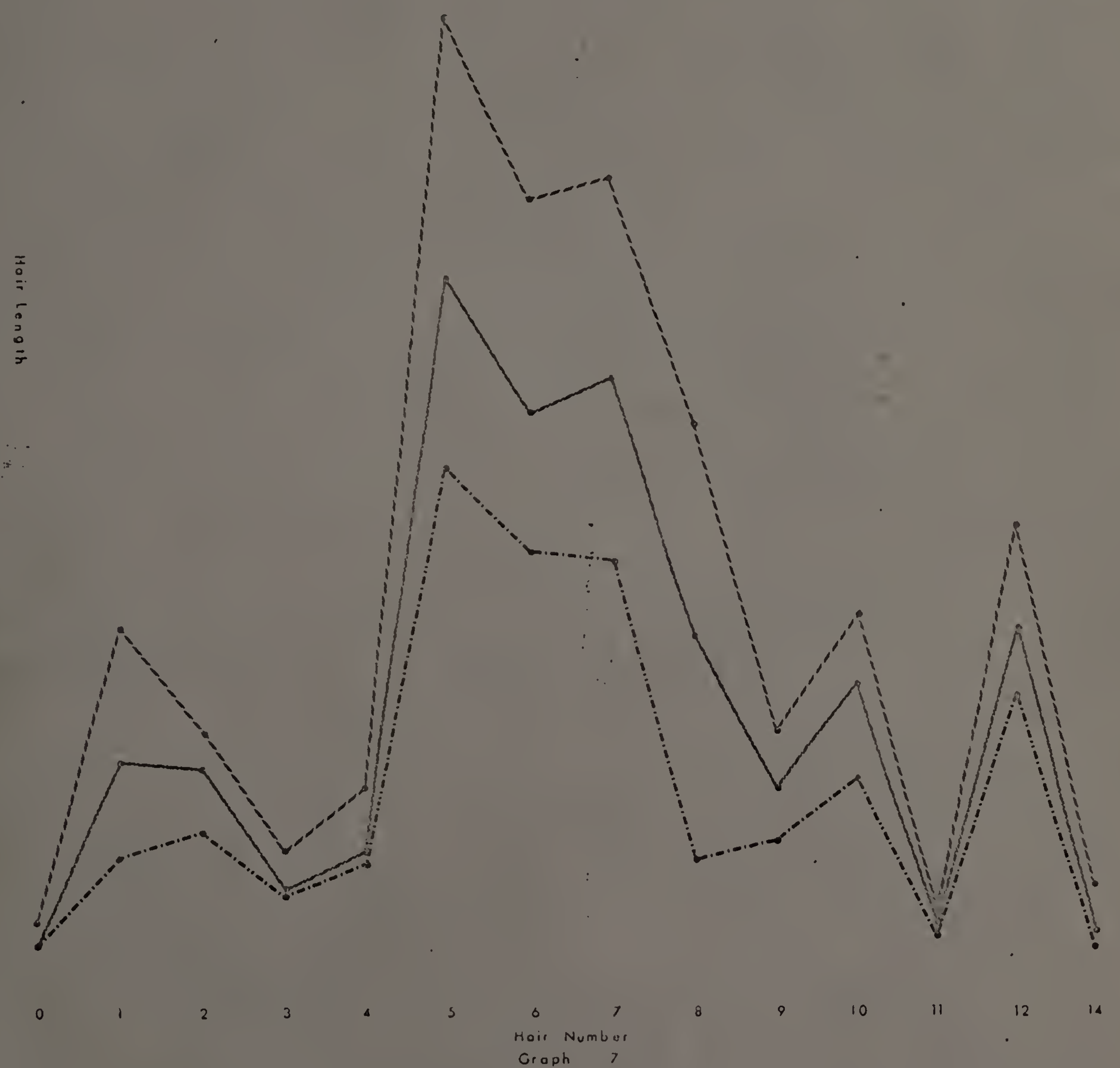


Hair Number
Graph 4

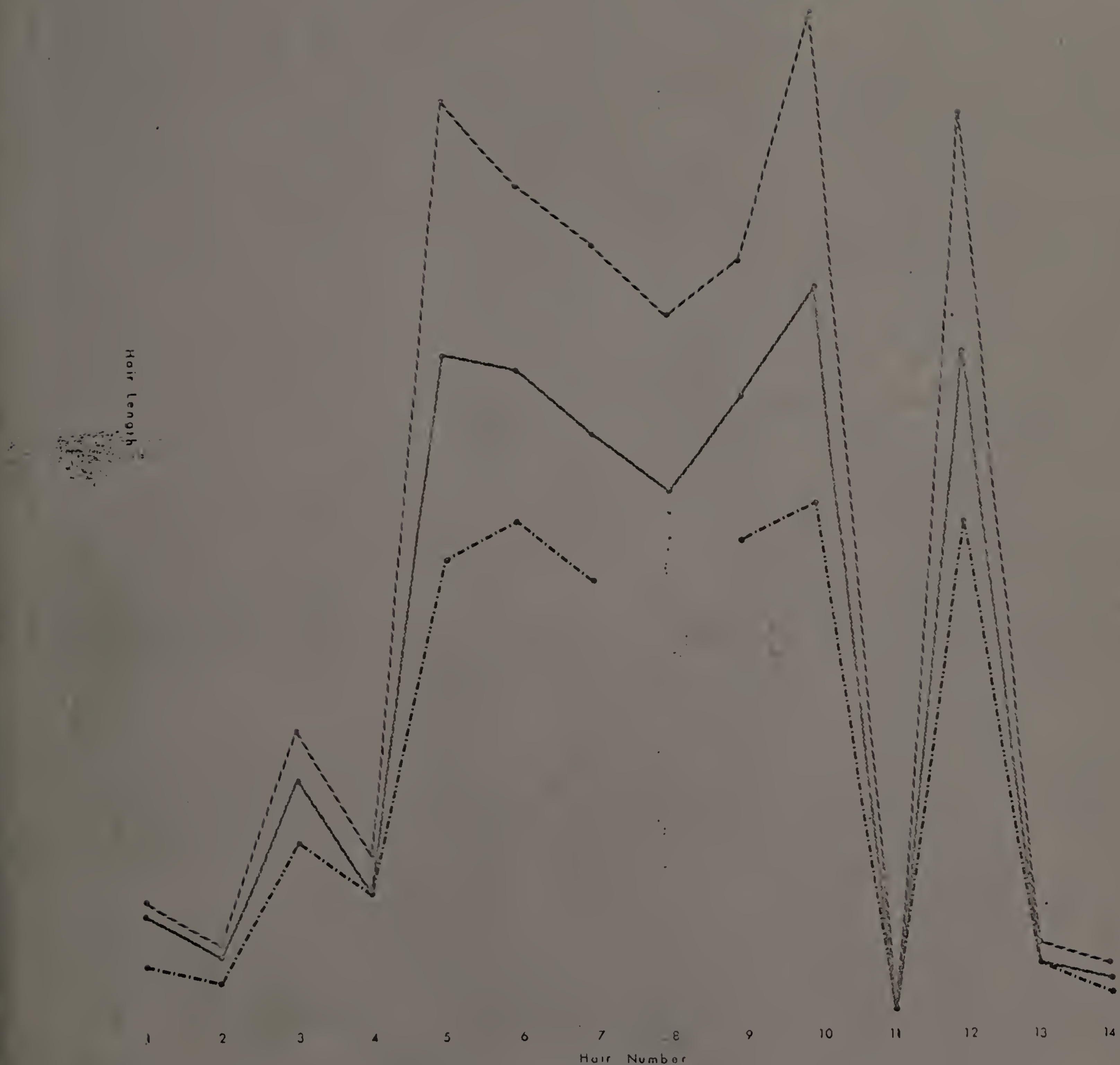


Graph 5

Graph 6

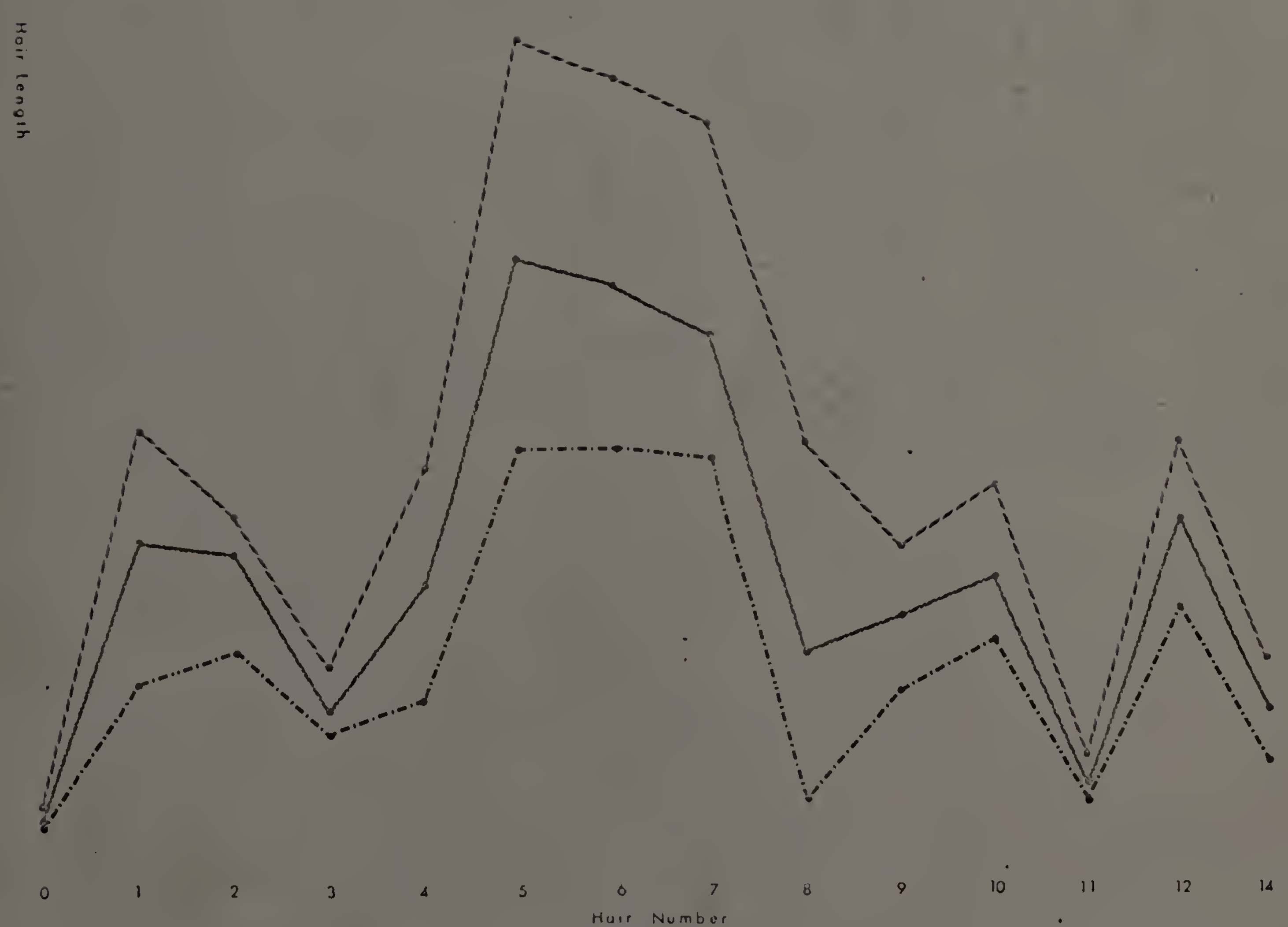


Graph 7

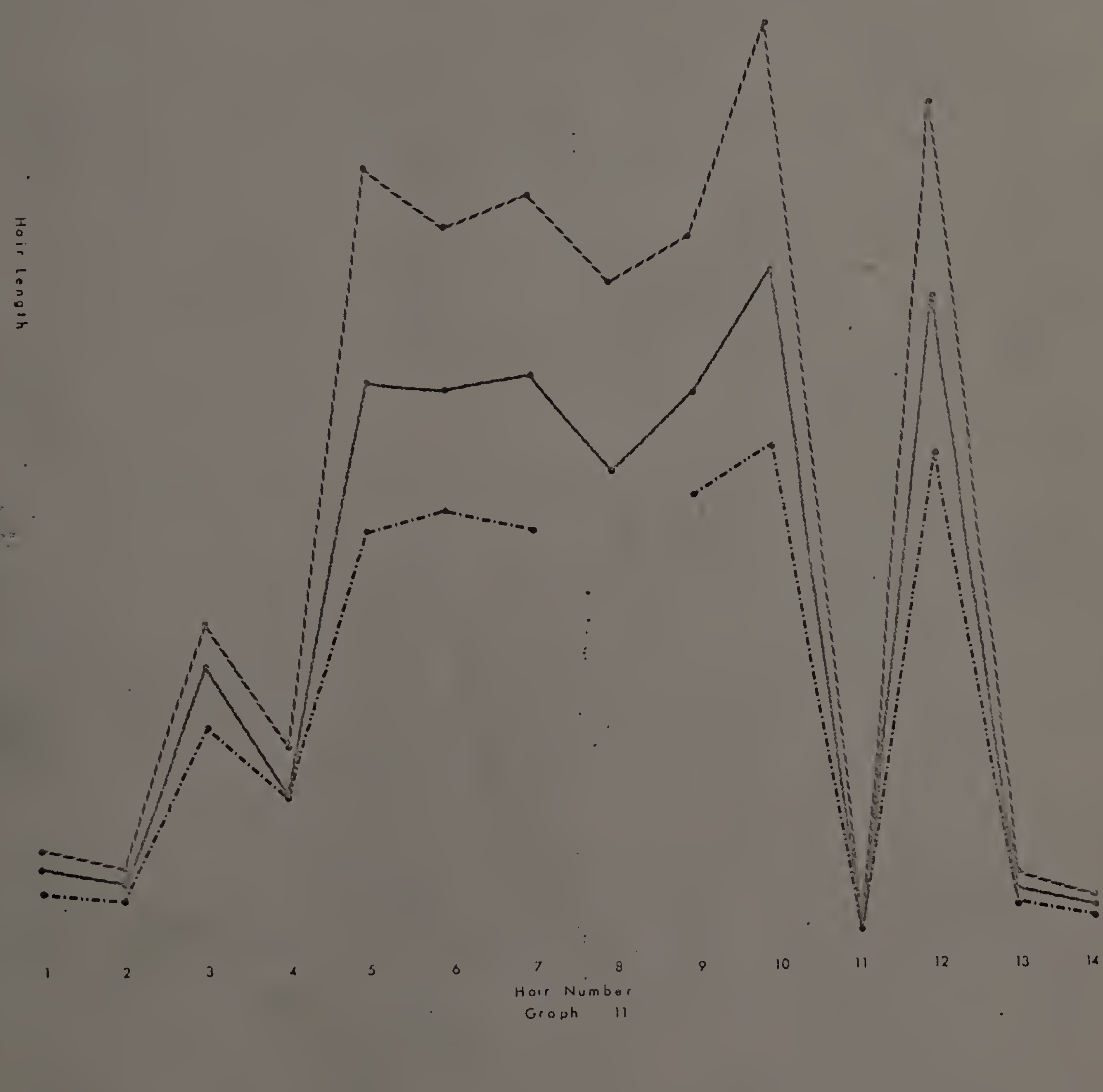


Graph 8

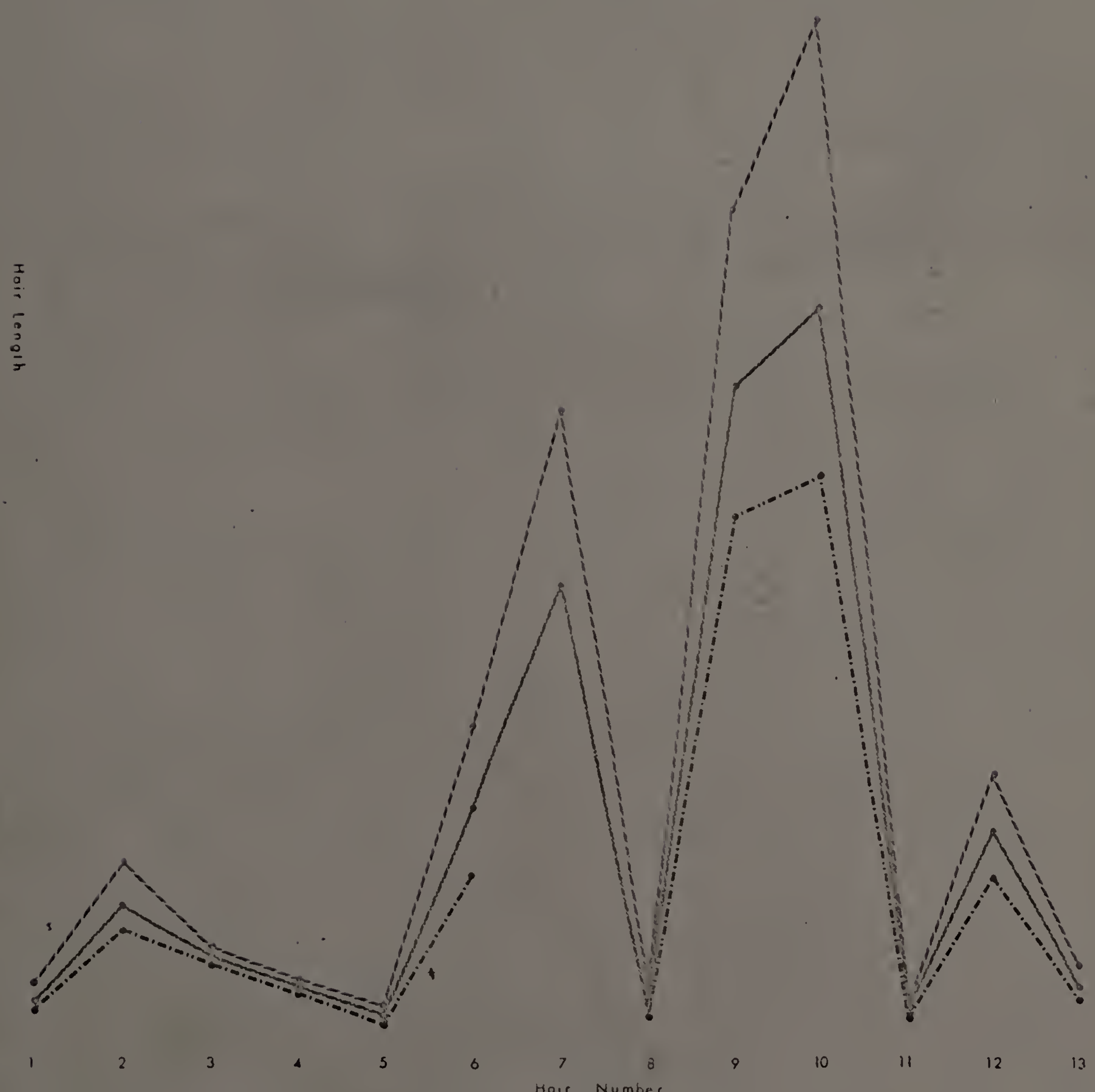
Graph 9



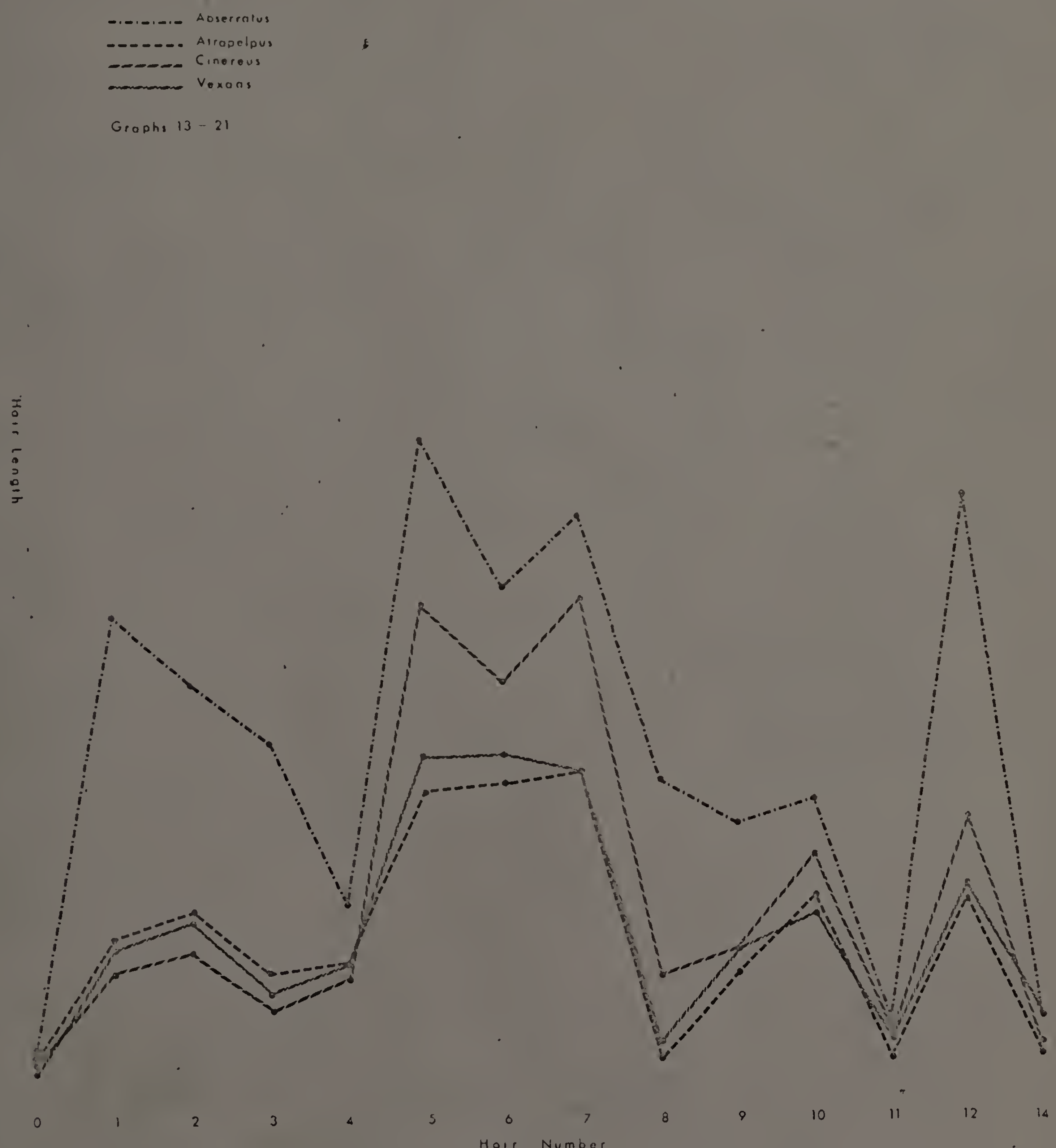
Graph 10

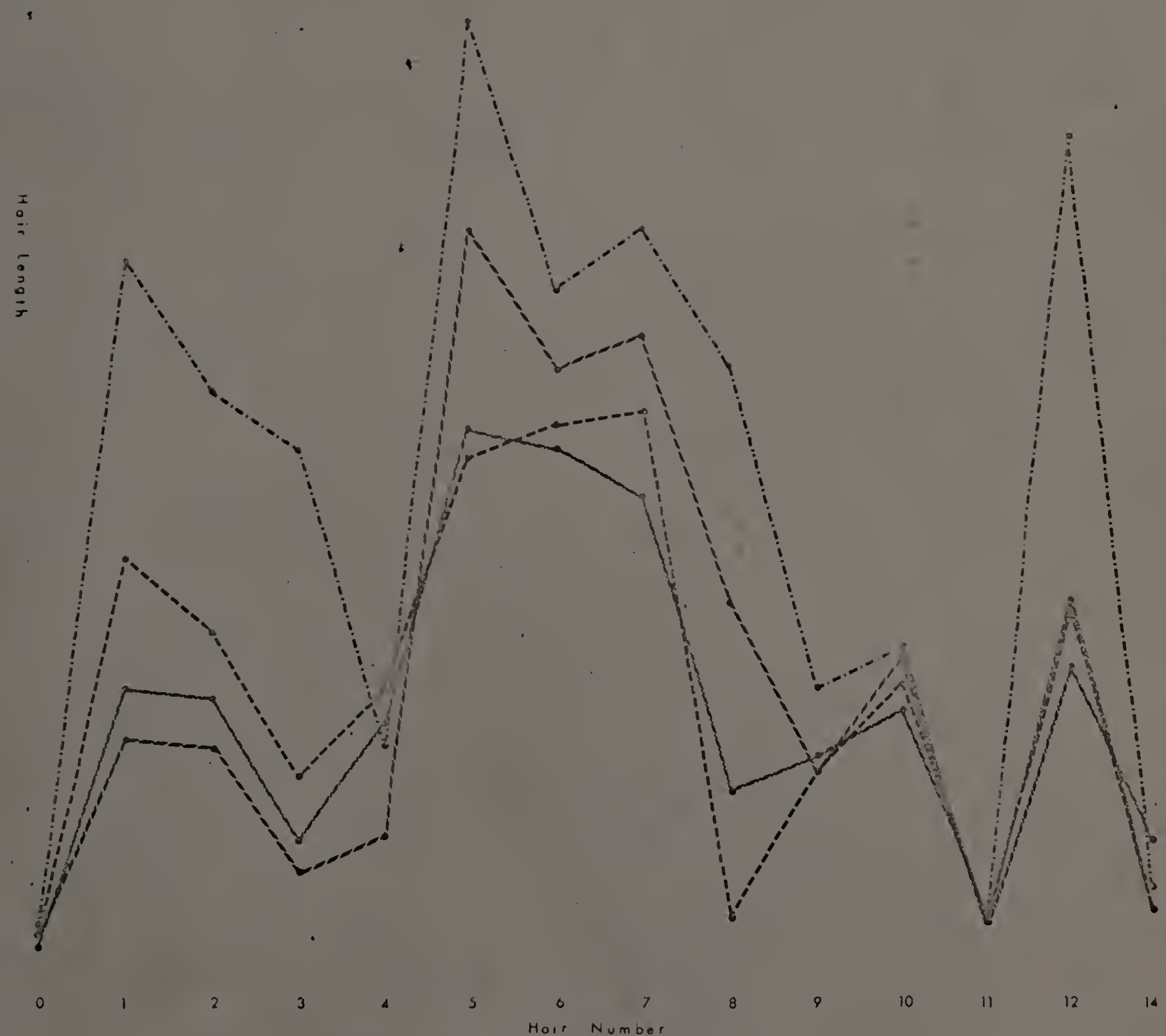


Graph 11

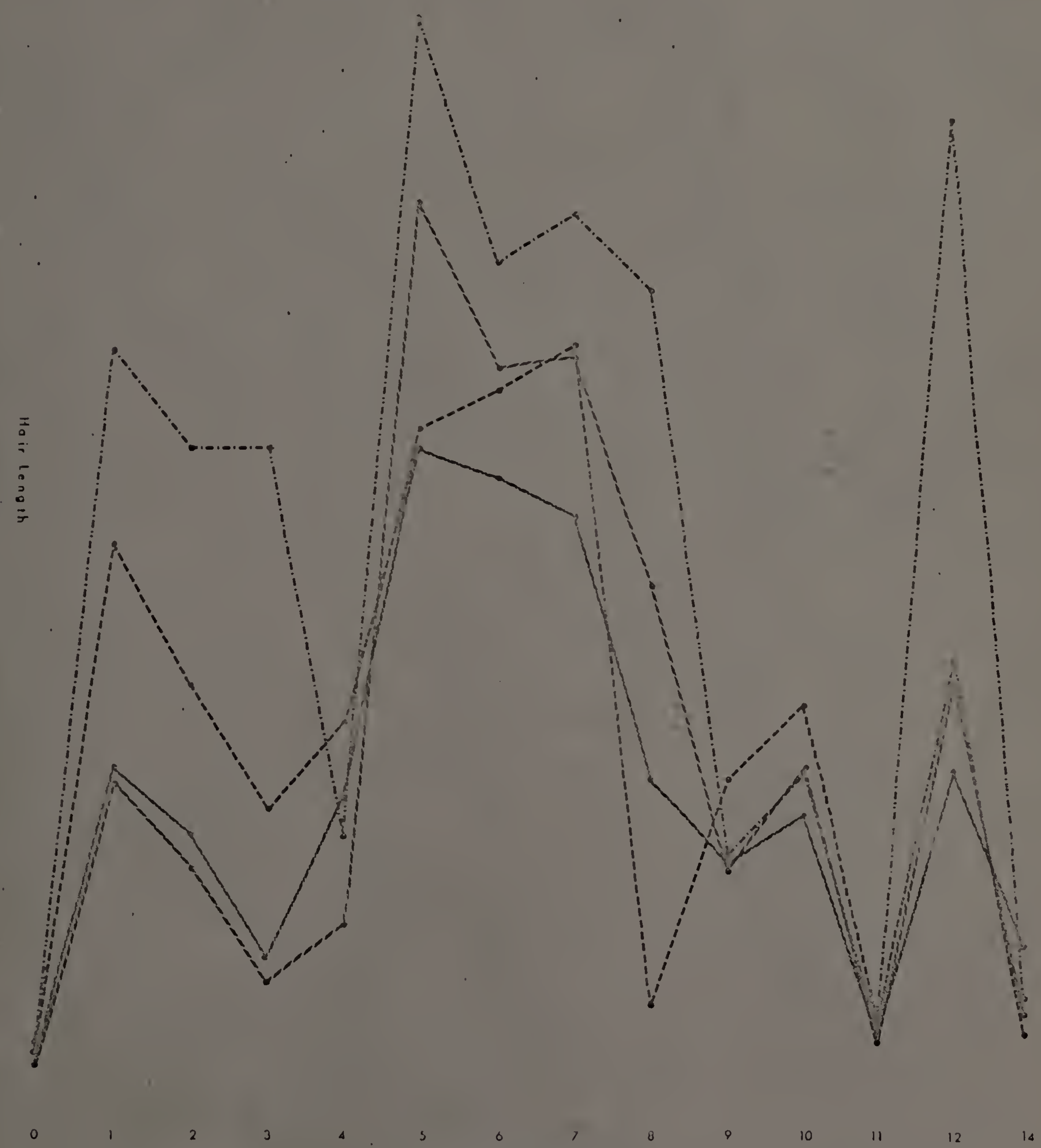


Graph 12

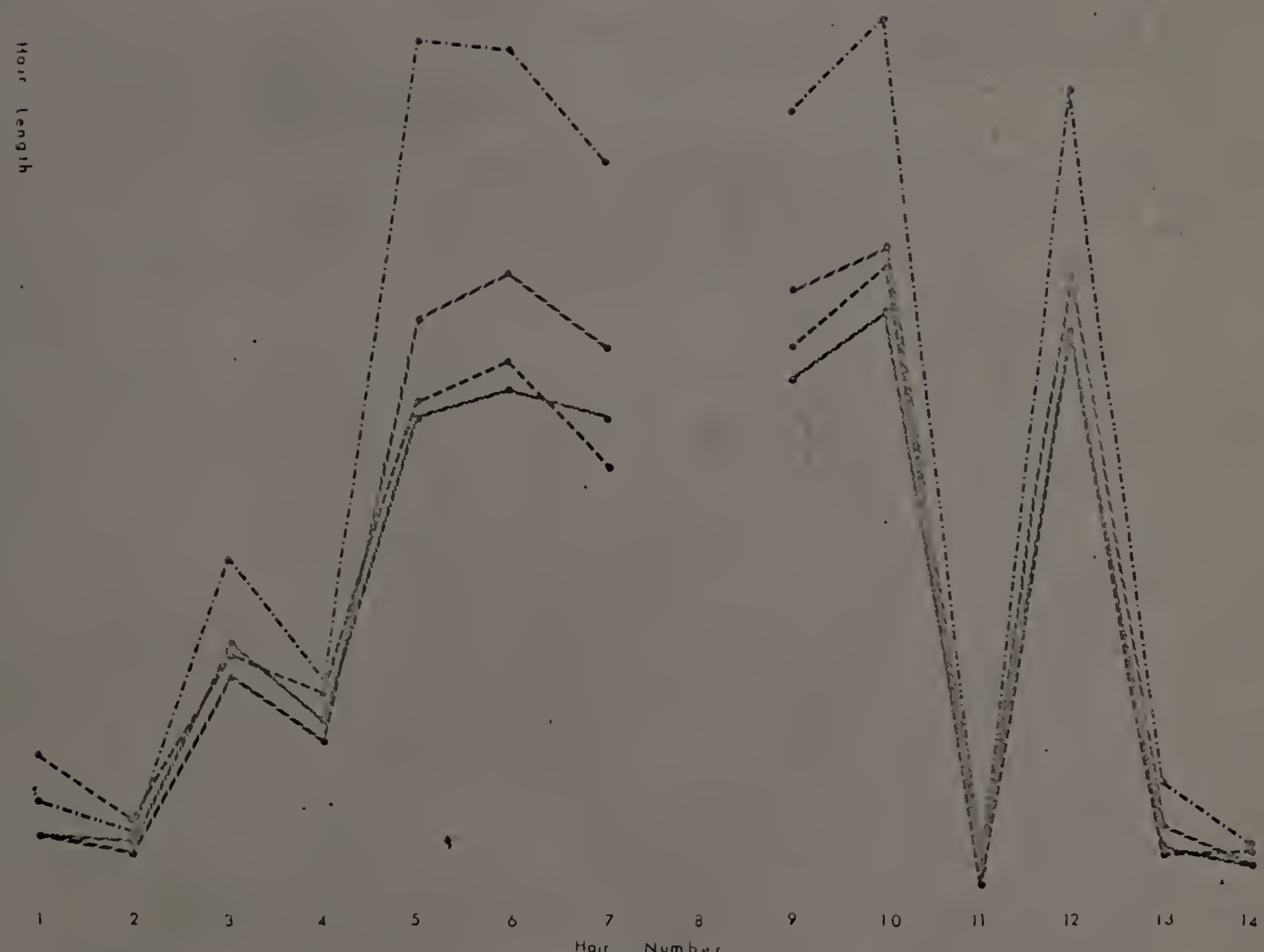

Aberratus
Atropalpus
Cinereus
Vexans
Graphs 13 – 21
Hair Length
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hair Number
Graph 13



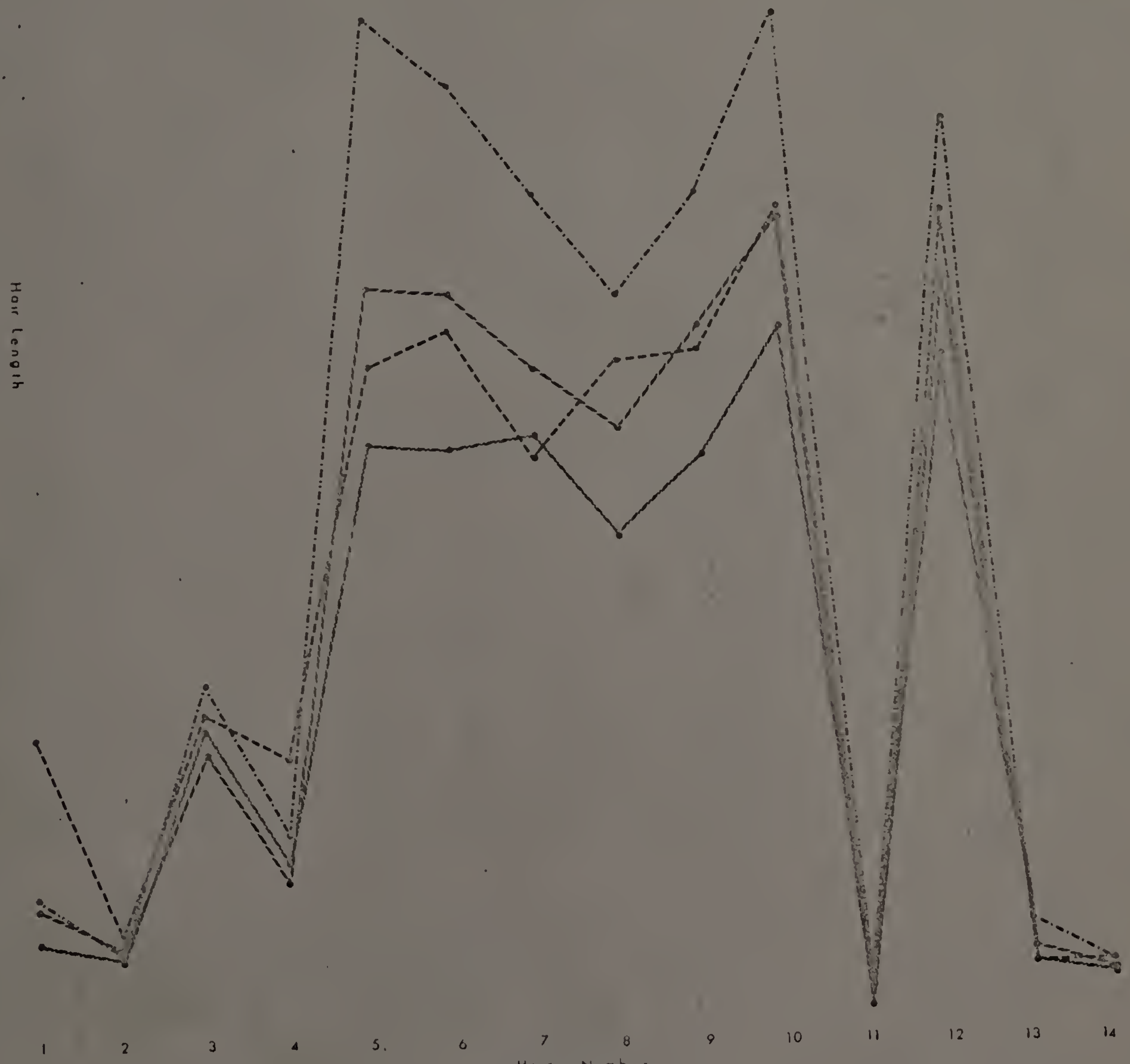
Graph 14



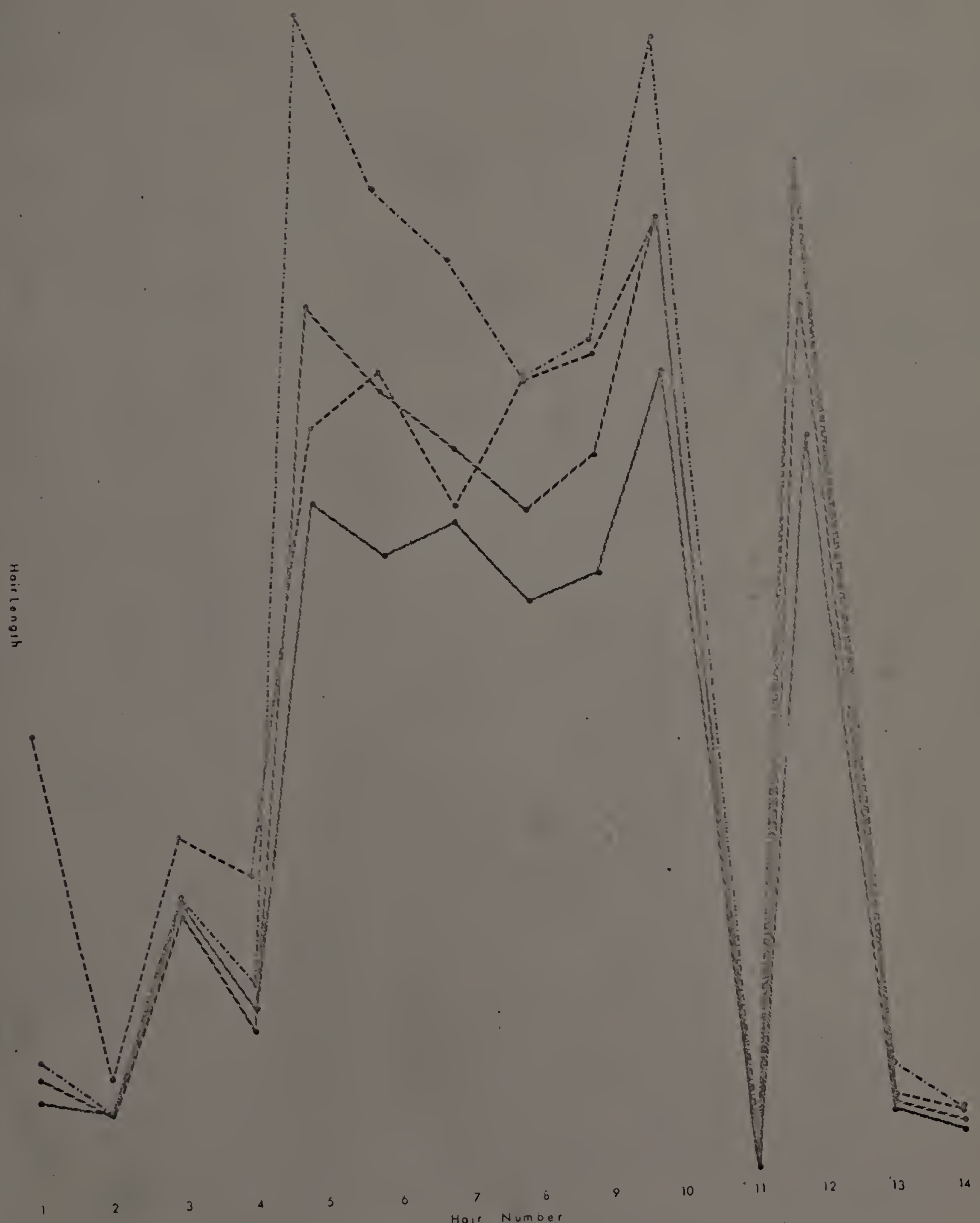
Graph 15



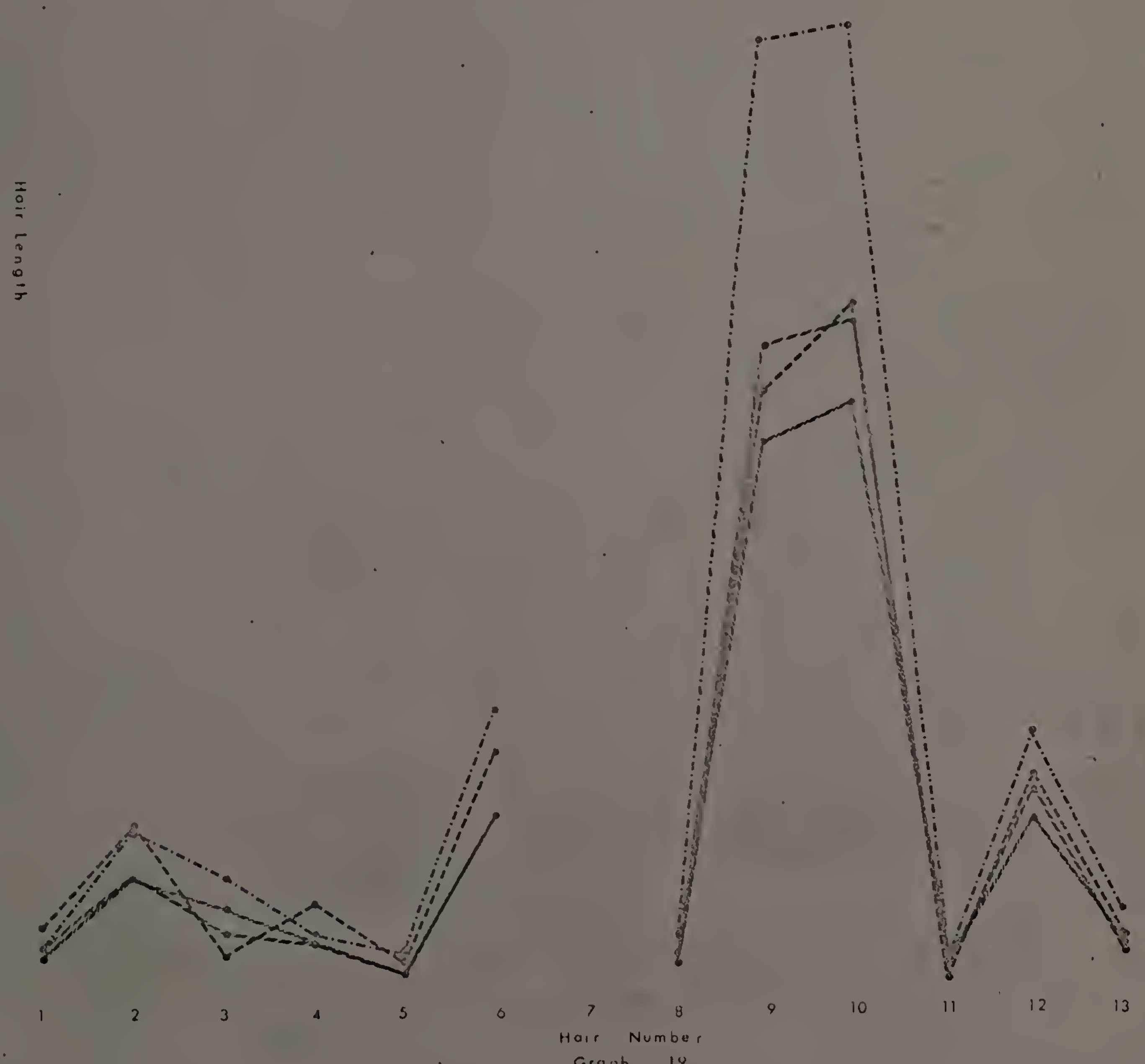
Graph 16



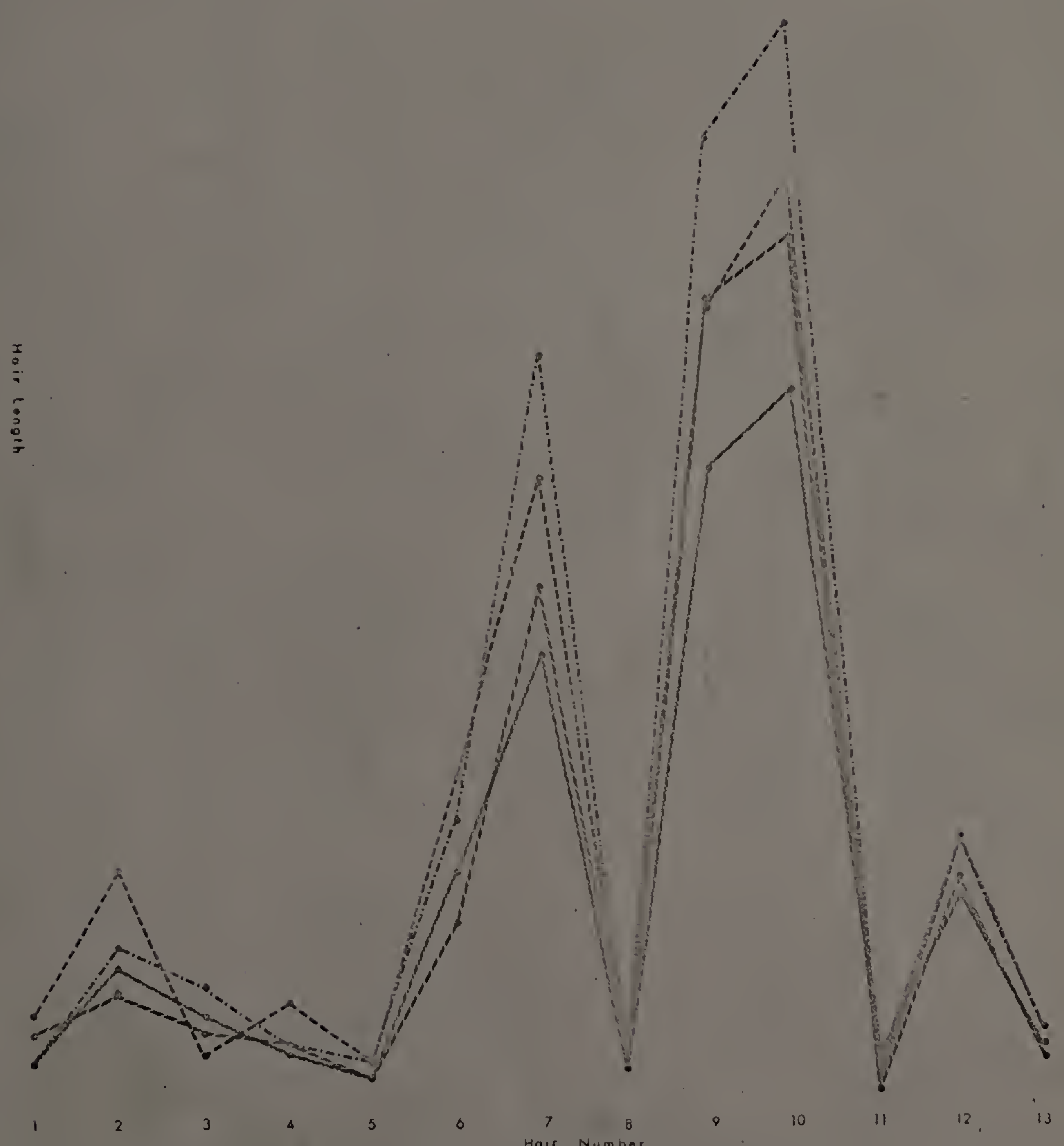
Graph 17



Graph 18

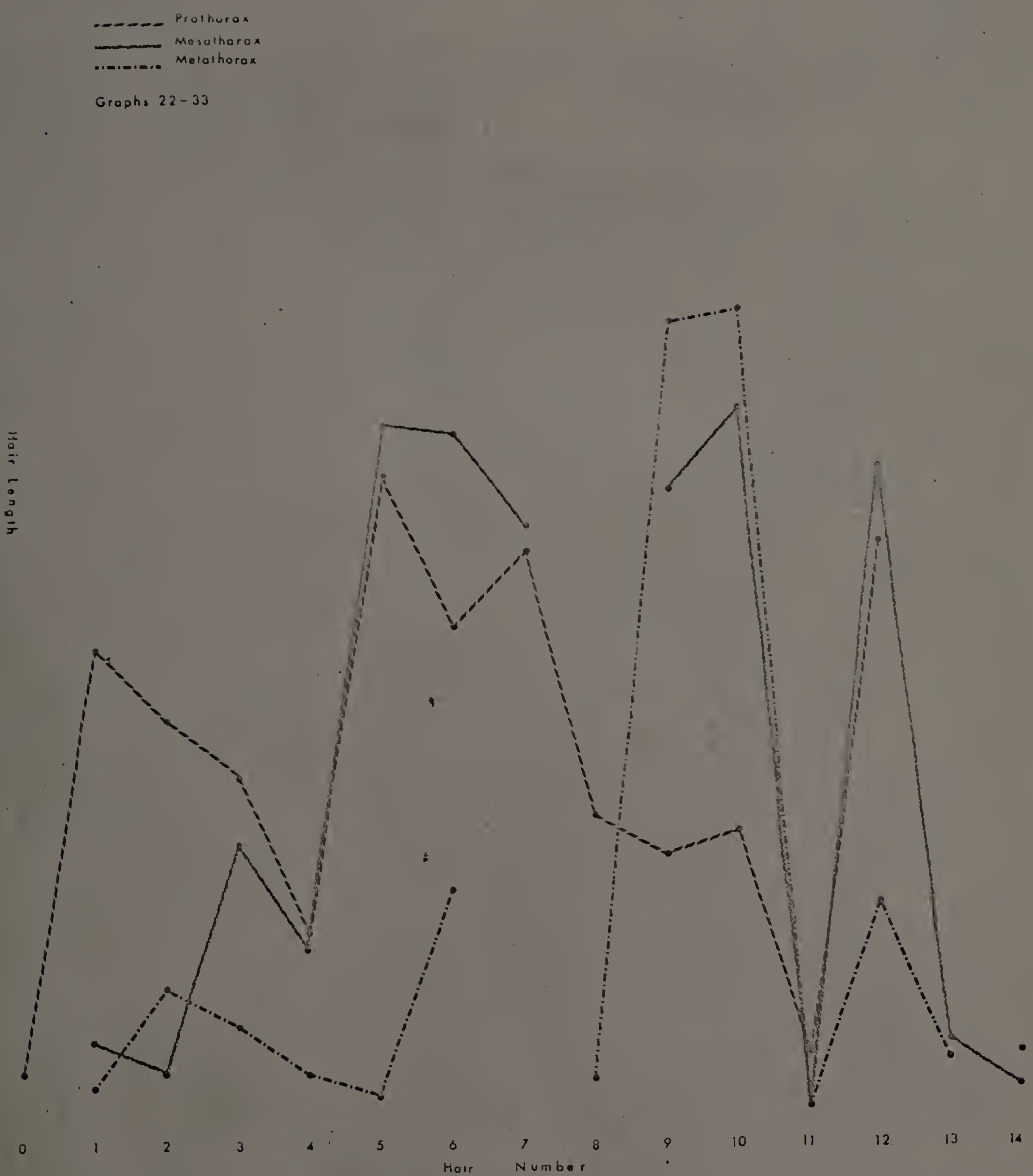


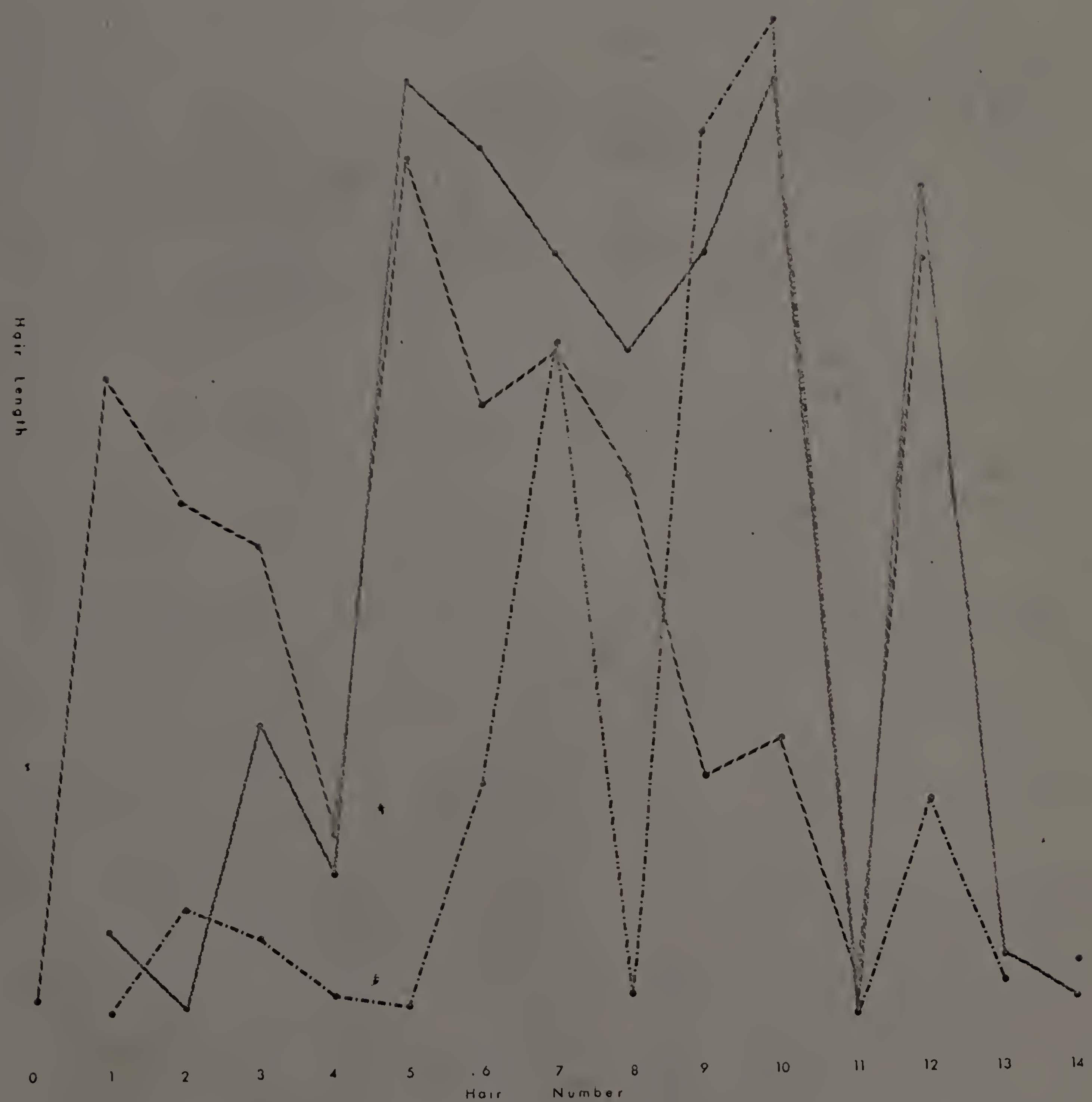
Graph 19



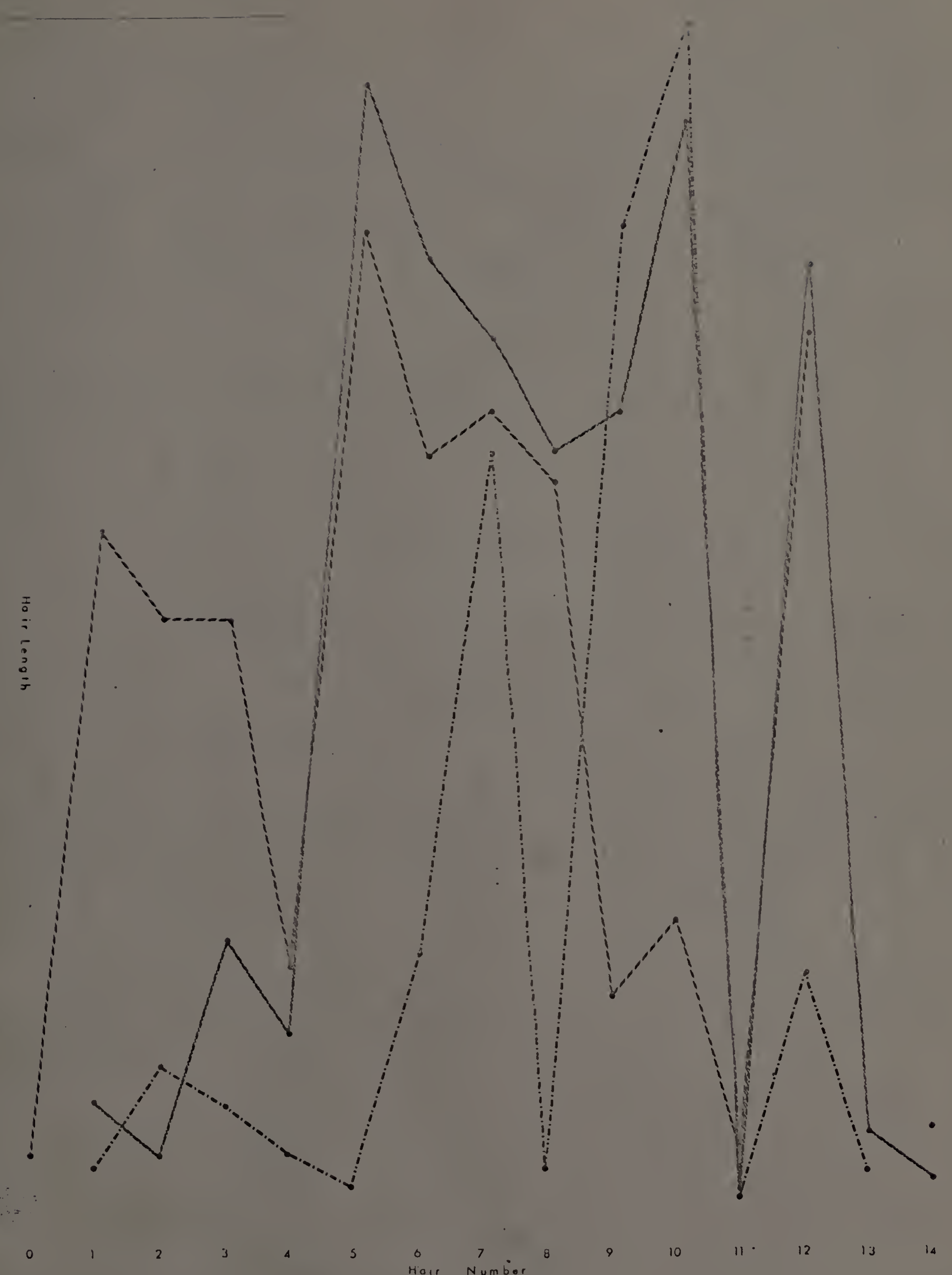
Graph 20

Graph 21

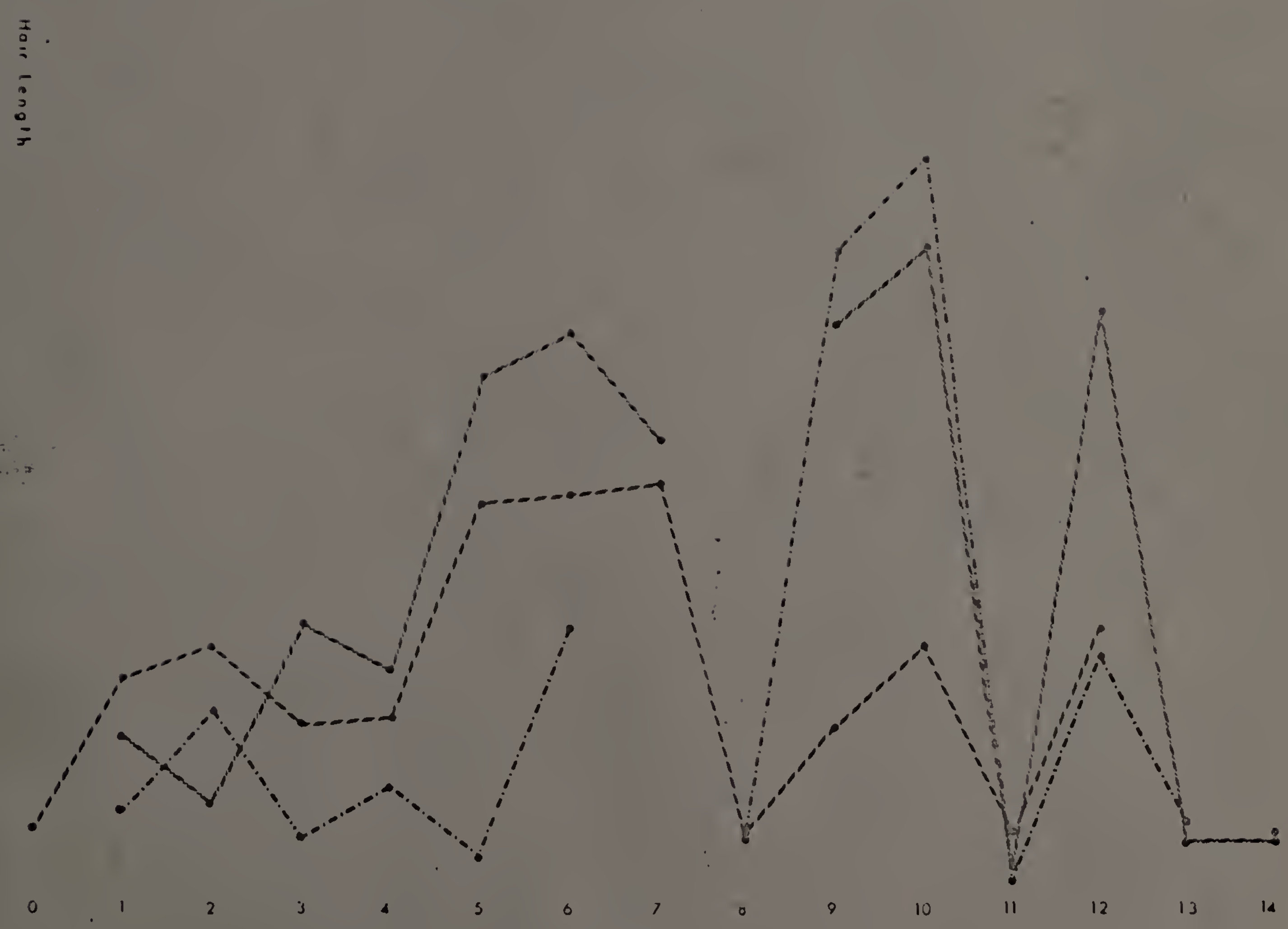

Prothorax
Mesothorax
Metathorax
Graphs 22 - 33
Hair Length
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Hair Number
Graph 22



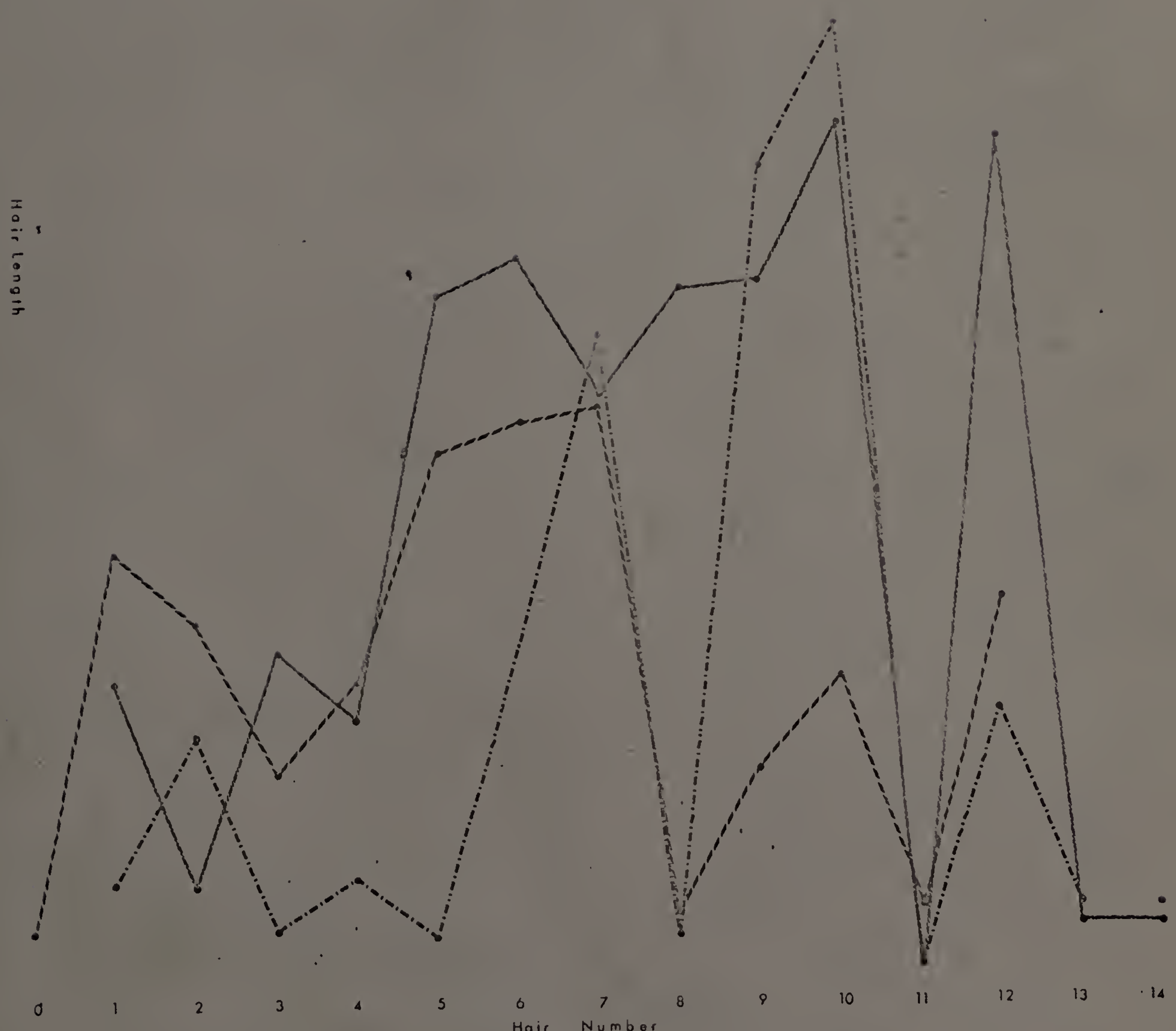
Graph 23



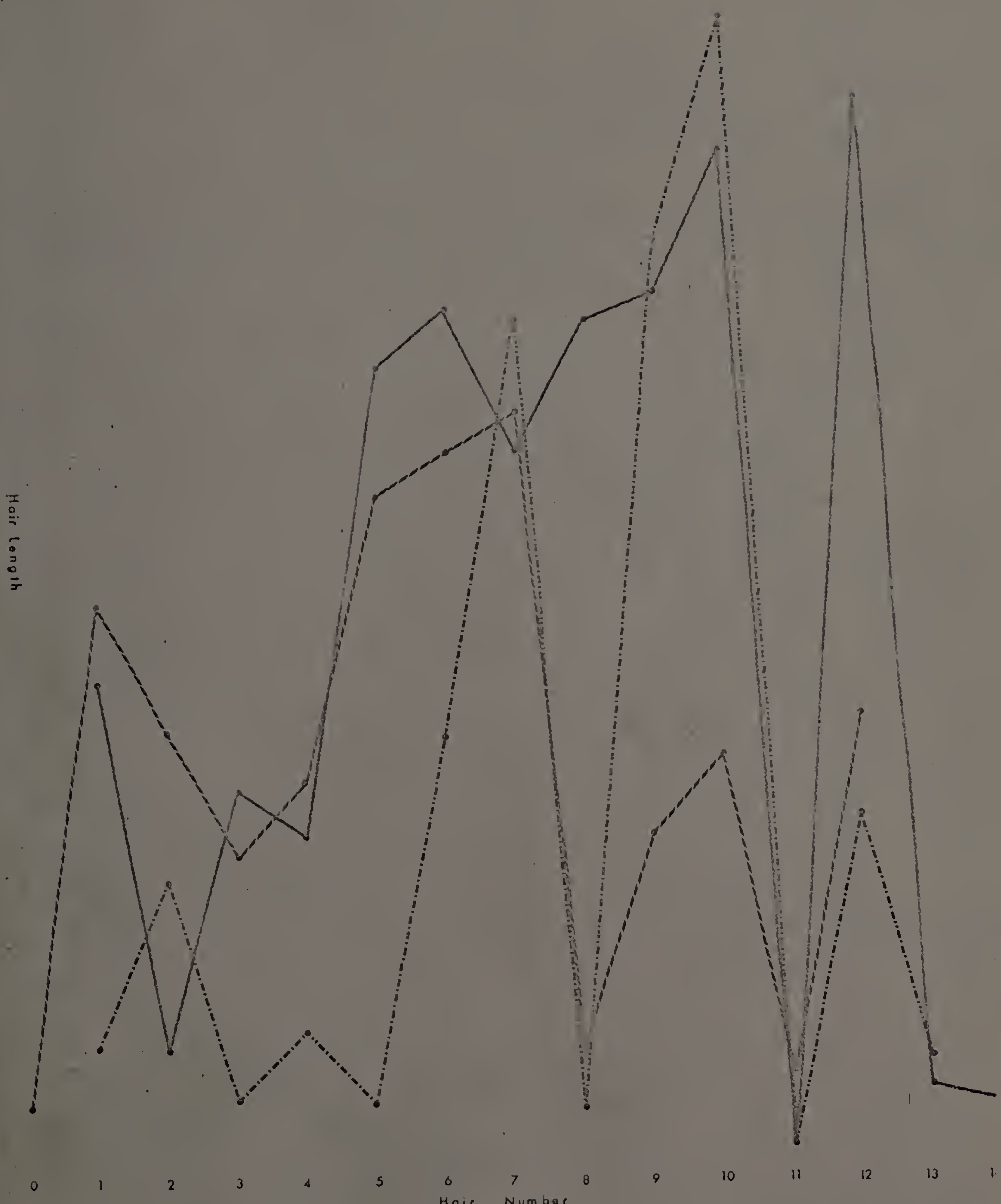
Graph 24



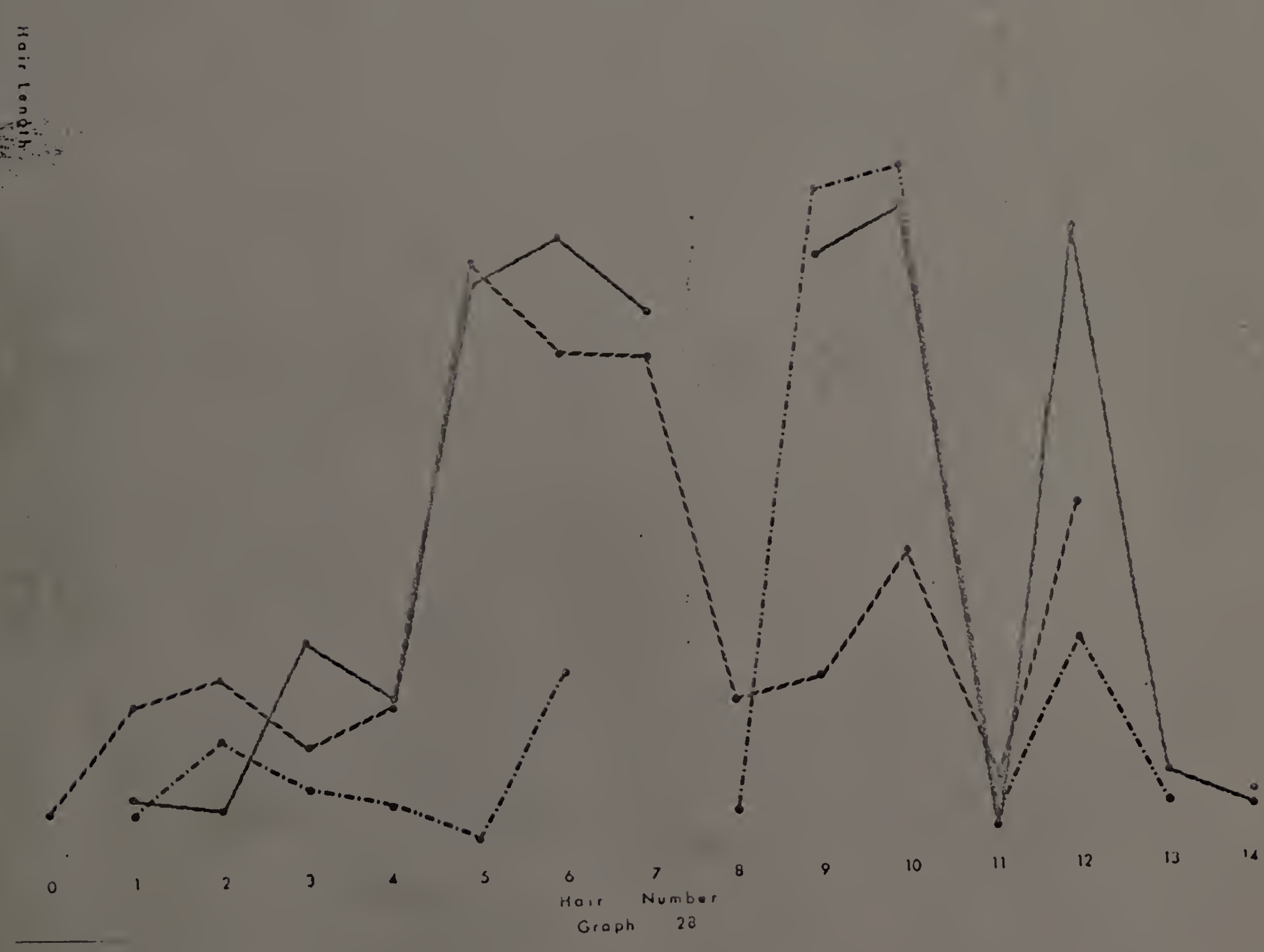
Graph 25



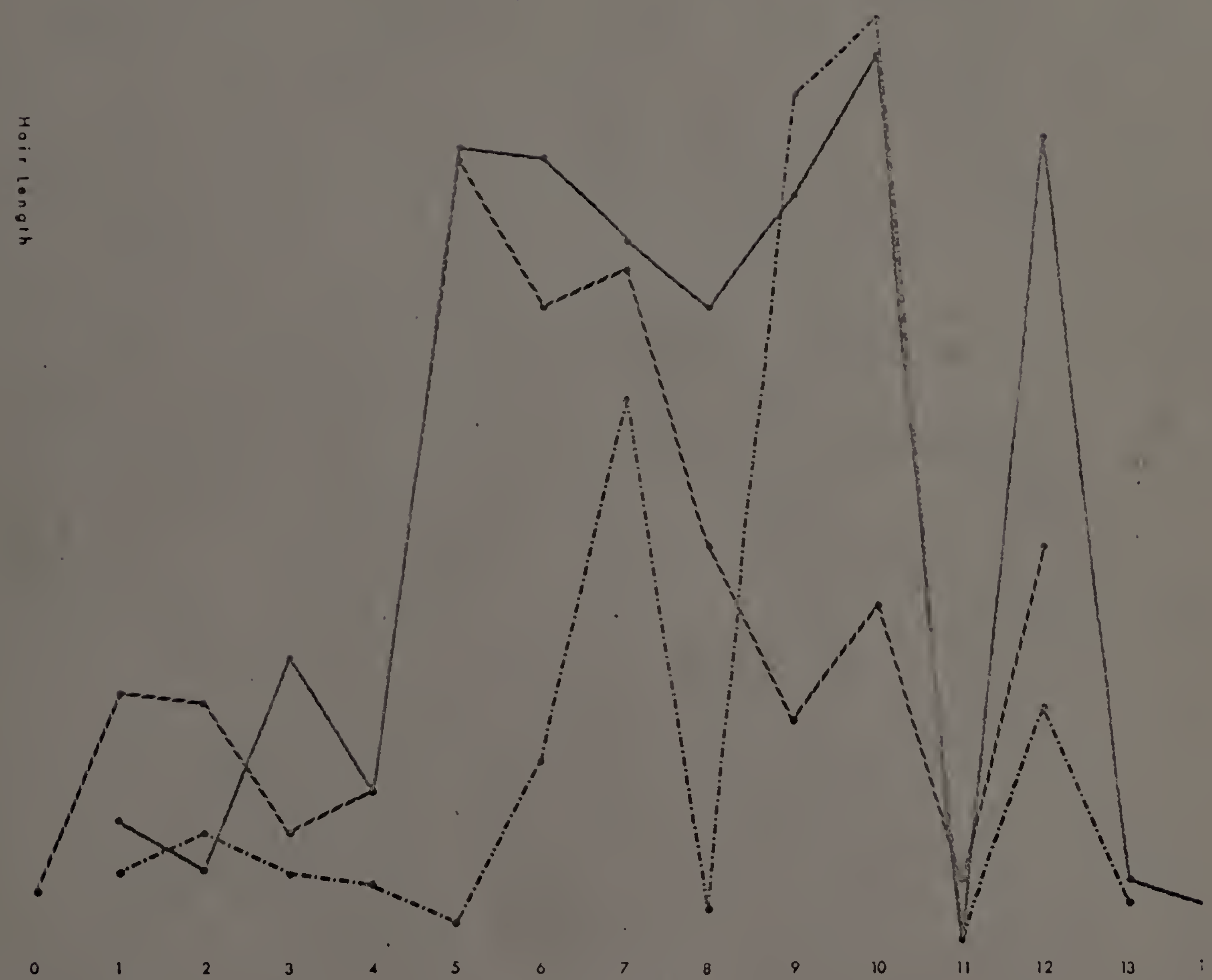
Graph 26



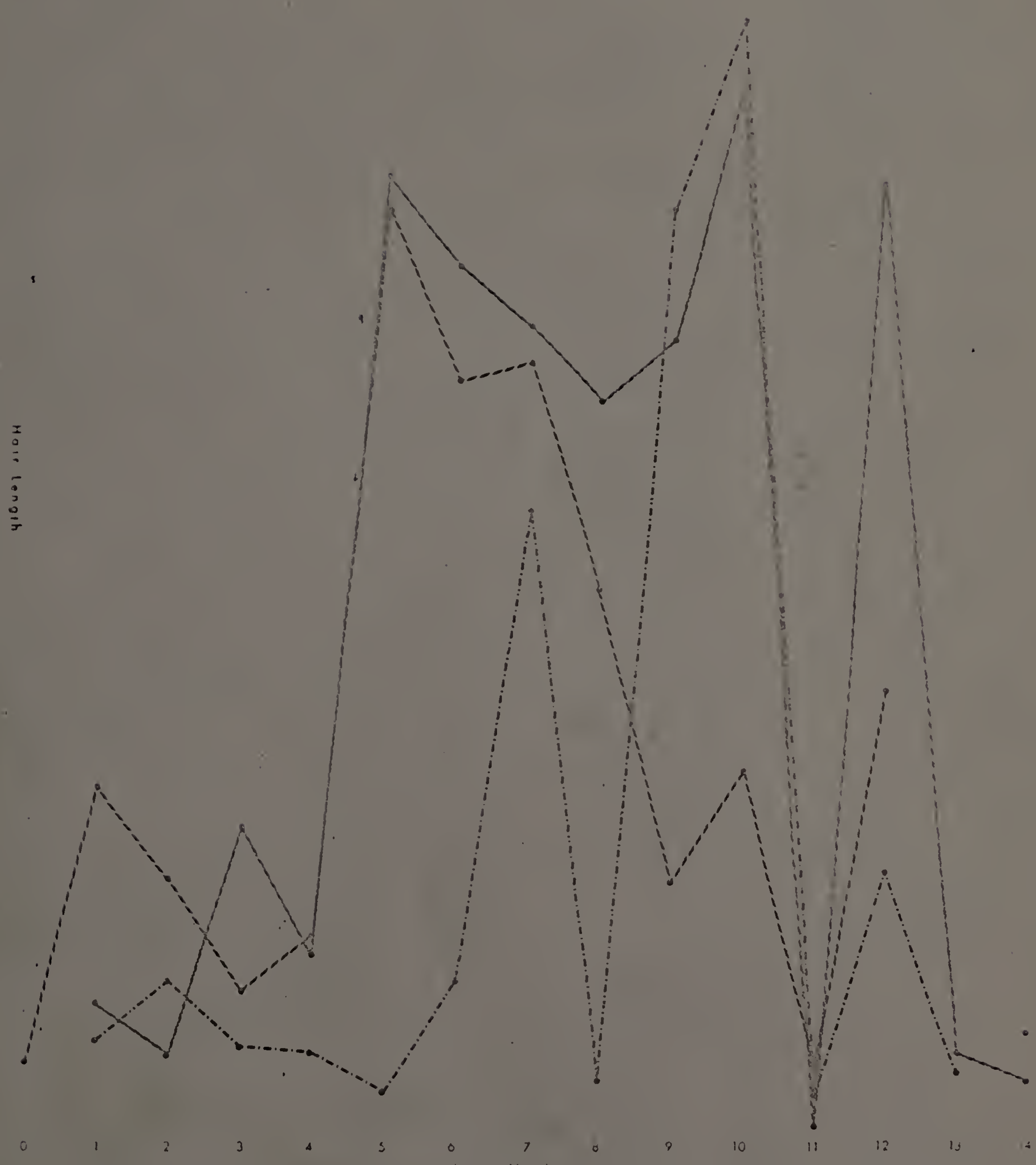
Graph 27



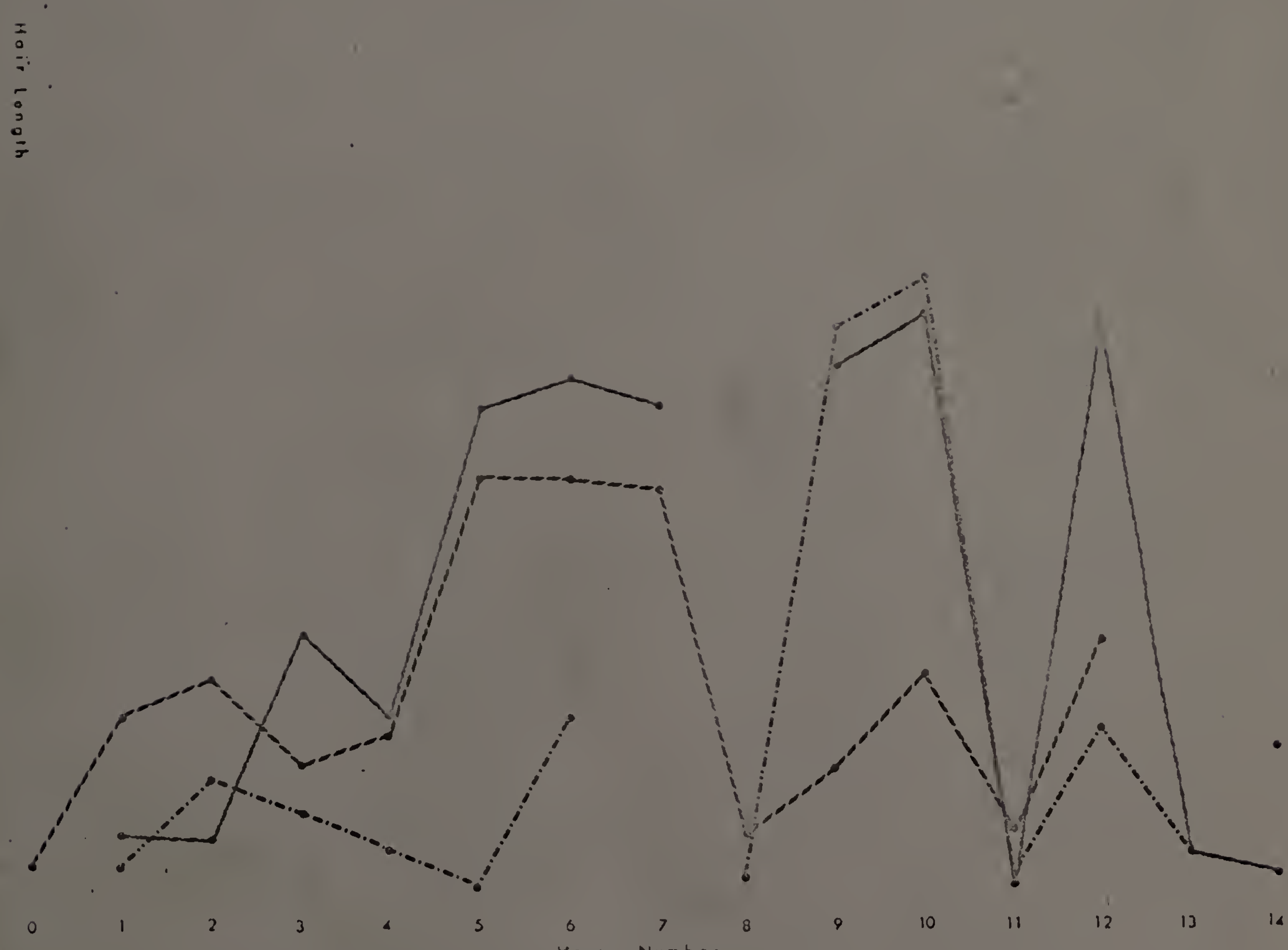
Graph 28



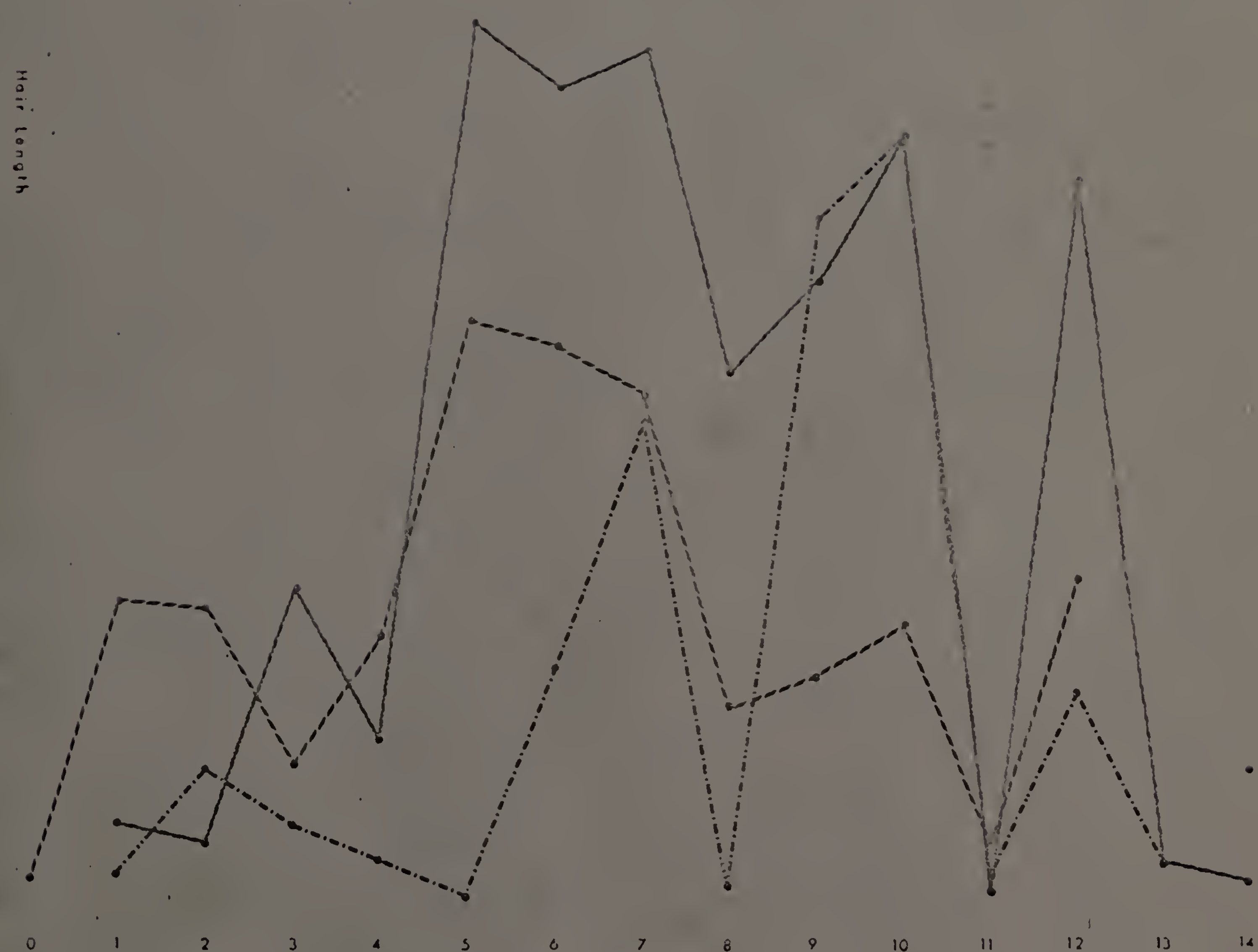
Graph 29



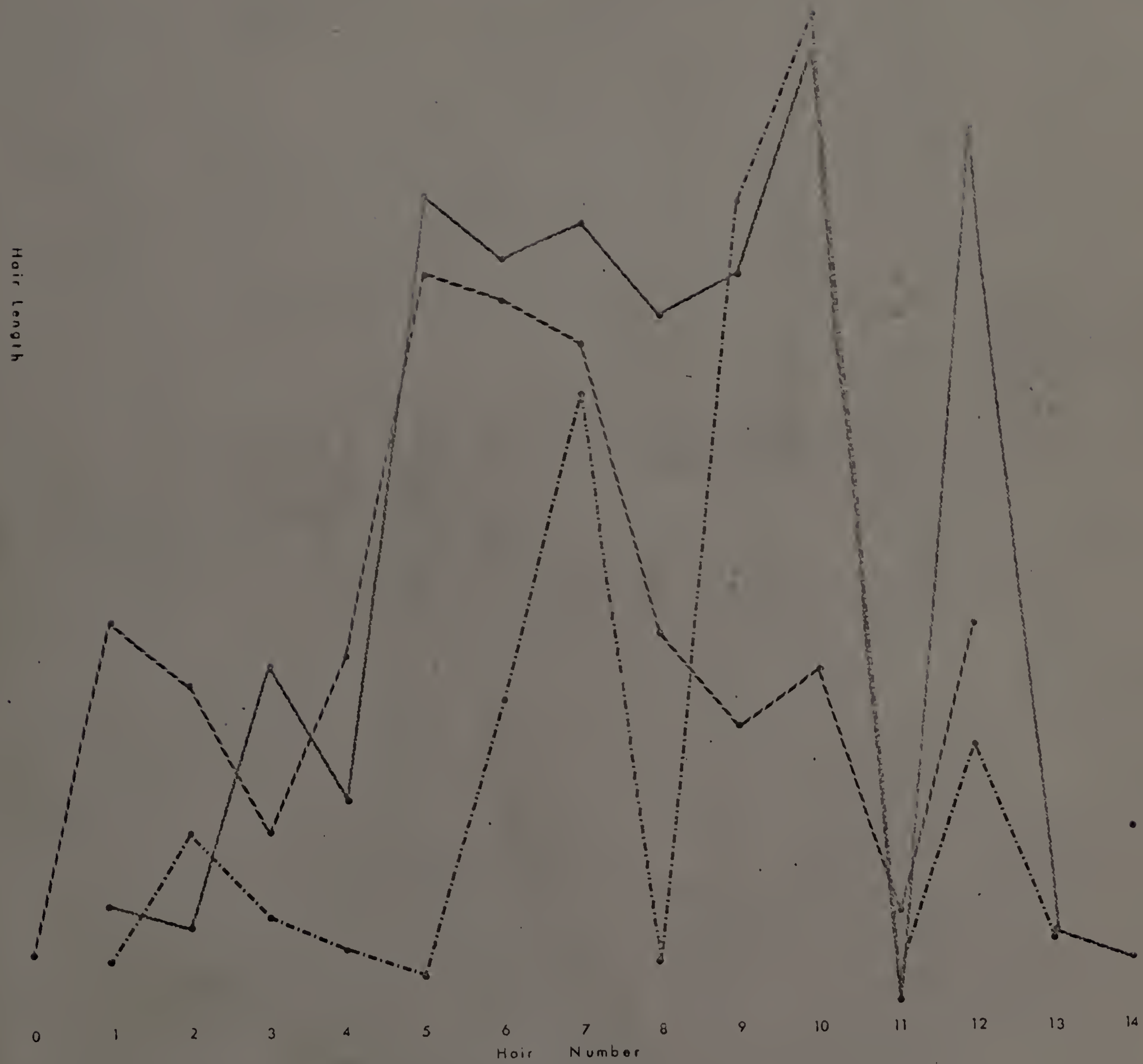
Graph 30



Graph 31



Graph 32



Graph 33

TABLE I

Identification of hairs to type and those with barbs

Hair	abserratus II	abserratus III	abserratus IV	atropalpus II	atropalpus III	atropalpus IV	cinereus II	cinereus III	cinereus IV	vexans II	vexans III	vexans IV
P0												
P1	+%	+%	+%	+%	+%	+%		%	%	+	+	+
P2	+%	+%	+%		%	%						
P3	+%	+%	+%	%	%	%						
P4					%	%						
P5	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
P6	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
P7	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
P8	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
P9				%	%	%						
P10					%	%	%	%	%			
P11												
P12	+%	+%	+%	%	%	%	%	%	%			
P14												
MS1				+%	+%	+%						
MS2												
MS3					%	%			%			
MS4						%						
MS5	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MS6	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MS7	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MS8		+%	+%		+%	+%		+%	+%		+%	+%
MS9	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MS10	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MS11												
MS12	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MS13												
MS14												
MT1												
MT2												
MT3												
MT4												
MT5												
MT6						%						
MT7		+%	+%		+%	+%		+%	+%		+%	+%
MT8												
MT9	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MT10	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%	+%
MT11												
MT12												
MT13												

+ Hair belongs to type 1. All other hairs are type 2.

% Hair has barbs in at least some specimens.

TABLE II

Statistics pertaining to hair length for _Aeaes abserratus_ @

Hair	Mean			Range			Standaed deviation		
	II	III	IV	II	III	IV	II	III	IV
P0	61	58	86						
P1	560	754	899	451-616	671-836	836-1012	54.8	50.0	46.2
P2	479	615	788	396-561	495-671	704-880	50.4	57.9	52.5
P3	410	569	784	352-484	495-649	715-836	42.8	44.8	34.2
P4	224	263	338						
P5	767	1003	1299	726-803	891-1078	1232-1397	21.0	56.1	45.3
P6	589	724	1004	550-649	671-770	968-1045	31.3	34.1	34.2
P7	677	787	1066	649-726	737-968	990-1111	27.1	64.1	38.8
P8	365	642	976	275-451	539-693	902-1023	60.2	51.2	35.8
P9	315	309	308						
P10	328	361	401						
P11	88	83	105						
P12	690	885	1179	660-726	803-979	1089-1276	27.0	56.0	60.4
P14	83	105	134						
MS1	96	137	159						
MS2	69	73	87						
MS3	327	369	370						
MS4	206	202	251						
MS5	825	1093	1482	737-901	968-1177	1331-1694	42.2	75.2	83.5
MS6	815	1018	1267	726-902	913-1166	1155-1375	57.1	77.0	72.3
MS7	666	929	1304	660-792	792-990	1100-1254	36.9	67.2	46.5
MS8		785	1015		715-858	946-1078		43.3	39.8
MS9	579	750	919	495-671	693-792	836-990	57.3	52.5	29.6
MS10	620	880	1220	539-671	814-946	1133-1309	38.1	47.0	79.9
MS11	27	44	52						
MS12	597	808	1104	484-638	759-858	1012-1199	49.2	57.7	45.6
MS13	102	102	130						
MS14	49	58	73						
MT1	42	45	73						
MT2	158	167	208						
MT3	117	126	156						
MT4	60	68	97						
MT5	32	46	54						
MT6	279	300	358						
MT7		540	719		517-572	671-770		70.4	60.8
MT8	51	61	80						
MT9	638	851	1075	605-693	792-902	979-1199	57.3	52.5	29.6
MT10	666	929	1304	627-693	869-1012	1210-1375	43.7	56.8	74.2
MT11	25	36	47						
MT12	261	279	335						
MT13	74	74	104						

@ Range and standard deviation are presented only for type 1 hairs. All numbers are in microns.

TABLE III

Statistics pertaining to hair length for *Aedes atropalpus*

	Mean			Range			Standard deviation		
Hair	II	III	IV	II	III	IV	II	III	IV
P0	41	51	70						
P1	182	439	670	159-205	396-484	583-759	18.6	28.3	62.1
P2	220	368	516						
P3	146	215	362						
P4	157	308	453						
P5	355	544	805	317-416	473-605	693-869	28.4	47.9	51.1
P6	365	579	853	341-382	539-638	781-946	15.1	28.7	43.9
P7	379	594	909	341-424	517-660	814-1012	24.4	39.2	64.7
P8	46	69	132	39-52	60-81	81-296	05.1	06.7	05.9
P9	141	220	391						
P10	227	312	484						
P11	44	74	107						
P12	231	385	534						
P14	46	72	94						
MS1	135	309	577	114-156	220-385	396-638	13.6	48.4	82.5
MS2	75	95	134						
MS3	239	336	447						
MS4	199	280	383						
MS5	474	707	959	440-528	638-759	869-1122	25.9	41.5	82.3
MS6	511	745	1029	462-550	660-825	946-1089	32.7	48.5	39.4
MS7	413	607	857	385-462	561-649	781-935	24.6	26.9	58.3
MS8		717	1015		638-770	924-1100		32.1	50.3
MS9	523	723	1044	473-572	660-825	968-1122	33.6	41.7	52.3
MS10	603	884	1223	539-649	825-946	1122-1298	31.1	36.1	56.3
MS11	-	-	-						
MS12	540	875	1284	484-594	803-946	1177-1386	39.9	49.3	61.4
MS13	39	58	90						
MS14	40	56	71						
MT1	68	95	136						
MT2	160	250	330						
MT3	37	51	75						
MT4	87	109	156						
MT5	24	43	69						
MT6	236	342	510						
MT7		668	1012		561-726	946-1089		40.9	51.9
MT8	35	47	63						
MT9	596	843	1113	539-649	748-891	1045-1188	31.4	34.6	68.7
MT10	681	990	1381	627-759	913-1034	1265-1474	35.2	40.3	61.2
MT11	-	-	-						
MT12	217	275	418						
MT13	53	74	121						

TABLE IV

Statistics pertaining to hair length for <u>Aedes cinereus</u>

Hair	Mean			Range			Standard deviation		
	II	III	IV	II	III	IV	II	III	IV
P0	50	52	76						
P1	148	252	398						
P2	172	248	282						
P3	108	114	157						
P4	140	154	224						
P5	573	785	1075	517-638	737-847	1001-1166	38.2	37.0	57.3
P6	480	637	876	451-495	561-715	825-924	14.3	40.7	41.0
P7	479	675	894	440-528	605-781	803-957	32.0	59.4	51.8
P8	144	392	626	75-182	341-550	550-693	26.7	59.6	41.8
P9	168	222	287						
P10	280	335	415						
P11	62	65	80						
P12	323	397	511						
P14	49	70	113						
MS1	61	127	140						
MS2	45	76	81						
MS3	217	285	348						
MS4	151	151	199						
MS5	551	796	1112	484-594	748-858	979-1232	29.1	36.7	71.8
MS6	597	782	1008	506-660	693-957	957-1078	46.0	43.6	36.1
MS7	523	707	934	429-583	649-759	891-968	41.3	38.7	23.7
MS8		631	846		583-682	803-924		29.0	40.0
MS9	579	750	919	495-671	693-792	836-990	44.6	32.4	39.7
MS10	620	880	1220	539-671	814-946	1133-1309	35.2	36.0	54.2
MS11	-	-	-						
MS12	597	808	1104	484-638	759-858	1012-1199	43.0	32.3	57.5
MS13	63	65	86						
MS14	29	40	56						
MT1	41	77	100						
MT2	113	115	170						
MT3	68	79	89						
MT4	49	61	81						
MT5	14	27	43						
MT6	171	185	271						
MT7		540	719		517-572	671-770		15.2	29.0
MT8	33	39	61						
MT9	638	851	1075	605-693	792-902	979-1199	27.7	33.6	61.0
MT10	666	929	1304	627-693	869-1012	1210-1375	19.6	41.3	57.5
MT11	-	-	-						
MT12	198	233	305						
MT13	38	48	61						

TABLE V

Statistics pertaining to hair length for *Aedes vexans*

Hair	Mean			Range			Standard deviation		
	II	III	IV	II	III	IV	II	III	IV
P0	37	41	63						
P1	174	306	412	156-200	265-351	367-478	13.3	23.0	40.0
P2	206	295	338						
P3	[illegible]	146	185						
P4	159	270	378						
P5	393	578	786	359-442	539-616	726-891	22.7	22.2	45.6
P6	395	553	752	369-424	495-594	693-803	16.3	39.8	46.3
P7	382	501	709	364-408	462-550	605-803	15.4	26.7	56.6
P8	64	201	397	44-91	143-252	308-528	13.7	32.4	65.7
P9	169	235	295						
P10	217	280	356						
P11	63	72	99						
P12	244	324	406						
P14	95	143	190						
MS1	64	88	110						
MS2	58	73	87						
MS3	249	319	363						
MS4	170	175	224						
MS5	460	622	866	429-495	550-660	803-924	18.1	36.8	37.8
MS6	486	615	796	451-517	550-660	737-836	17.4	42.3	31.9
MS7	462	630	835	440-495	539-671	737-902	15.6	37.0	47.9
MS8		521	736		473-550	671-792		23.6	40.5
MS9	495	611	781	473-539	561-638	726-858	18.2	21.2	42.2
MS10	552	750	1021	517-594	704-803	913-1089	21.4	28.1	56.3
MS11	-	-	-						
MS12	540	716	934	495-583	649-759	858-979	22.2	29.5	37.1
MS13	42	56	78						
MS14	28	37	47						
MT1	33	43	59						
MT2	113	142	186						
MT3	80	89	96						
MT4	50	57	60						
MT5	15	27	38						
MT6	171	243	326						
MT7		472	654		440-528	594-704		23.2	43.6
MT8	28	37	50						
MT9	540	673	859	484-583	583-770	781-891	25.9	52.8	28.3
MT10	581	759	1052	539-605	671-814	935-1133	25.2	44.7	60.3
MT11	-	-	-						
MT12	169	220	272						
MT13	44	56	73						

TABLE VI

Statistics pertaining to hair diameter for *Aedes abserratus*[@]

Hair	Mean			Range			Standard deviation		
	II	III	IV	II	III	IV	II	III	IV
P1	5.1	8.7	10.1	3.9-5.2	7.8-9.1	9.1-10.4	0.4	0.6	0.6
P2	3.8	5.9	8.8	2.6-3.9	5.2-6.5	7.8-9.1	0.4	0.7	0.6
P3	3.8	5.9	9.8	2.6-3.9	5.2-6.5	9.1-10.4	0.4	0.7	0.7
P5	3.8	5.9	9.8	5.2-6.5	7.8-9.1	11.7-13.0	0.6	0.6	0.9
P6	4.6	5.6	9.2	3.9-5.2	5.2-6.5	9.1-10.4	0.7	0.6	0.4
P7	5.7	6.8	10.1	5.2-6.5	6.5-7.8	9.1-10.4	0.7	0.8	0.8
P8	2.9	5.5	9.5	2.6-3.9	5.2-6.5	9.1-10.4	0.6	0.6	0.6
P12	6.0	8.6	12.1	5.2-6.5	7.8-10.4	10.4-13.0	0.7	0.9	1.0
MS5	5.2	7.9	12.9	5.2	7.8-9.1	10.4-14.3	0.0	0.4	1.2
MS6	5.1	6.9	10.4	3.9-6.5	6.5-7.8	9.1-11.7	0.7	0.6	0.8
MS7	4.4	6.3	8.9	3.9-5.2	5.2-6.5	7.8-9.1	0.7	0.5	0.5
MS8		5.3	8.3		5.2-6.5	7.8-9.1		0.4	0.7
MS9	5.3	7.5	9.0	5.2-6.5	6.5-9.1	7.8-10.4	0.4	0.8	1.0
MS10	6.7	9.1	12.9	6.5-7.8	7.8-10.4	11.7-14.3	0.5	1.0	0.7
MS12	5.3	7.8	10.8	5.2-6.5	7.8	10.4-11.7	0.4	0.0	0.6
MT7		5.3	8.6		5.2-6.5	7.8-9.1		0.4	0.7
MT9	6.1	7.7	10.4	5.2-6.5	6.5-9.1	9.1-13.0	0.6	0.7	1.2
MT10	6.2	8.5	11.5	5.2-6.4	7.8-9.1	10.4-13.0	0.6	0.7	0.9

@ All numbers are in microns.

TABLE VII

Statistics pertaining to hair diameter for *Aedes atropalpus*

Hair	Mean			Range			Standard deviation		
	II	III	IV	II	III	IV	II	III	IV
P1		2.7	4.2		2.6-3.9	3.9-5.2		0.4	0.8
P5		2.9	4.9		2.6-3.9	3.9-6.5		0.6	0.8
P6		2.7	4.4		2.6-3.9	3.9-5.2		0.4	0.7
P7		3.5	5.0		2.6-3.9	3.9-5.2		0.6	0.5
MS5	2.9	4.6	6.5	2.6-3.9	3.9-5.2	5.2-7.8	0.6	0.7	0.8
MS6	3.0	4.6	6.1	2.6-3.9	3.9-5.2	5.2-7.8	0.6	0.7	0.8
MS7		3.1	4.1		2.6-3.9	3.9-5.2		0.7	0.6
MS8		3.9	5.0		3.9-5.2	5.2-7.8		0.6	0.9
MS9	3.3	5.0	6.1	2.6-3-9	3.9-5.2	5.2-6.5	0.7	0.5	0.6
MS10	4.1	6.3	9.9	3.9-5.2	5.2-6.5	9.1-10.4	0.5	0.5	0.7
MS12	3.3	5.0	6.8	2.6-3.9	3.9-5.2	6.5-7.8	0.7	0.5	0.6
MT7		4.1	6.1		3.9-5.2	5.2-6.5		0.5	0.6
MT9	3.3	4.8	6.3	2.6-3.9	2.6-6.5	5.2-6.5	0.7	0.1	0.5
MT10	3.9	5.3	8.7	3.9	5.2-6.5	7.8-9.1	0.0	0.4	0.6

TABLE VIII

Statistics pertaining to hair diameter for *Aedes cinereus*

Hair	Mean			Range			Standard deviation		
	II	III	IV	II	III	IV	II	III	IV
P5	4.2	6.5	9.3	3.9-5.2	5.2-7.8	7.8-10.4	0.6	0.6	0.8
P6	3.9	5.2	7.8	2.6-3.9	5.2	7.8	1.0	0.0	0.0
P7	4.0	5.3	7.4	3.9-5.2	3.9-6.5	6.5-9.1	0.4	0.1	0.8
MS5	4.1	6.3	9.5	3.9-5.2	5.2-6.5	9.1-10.4	0.5	0.5	0.1
MS6	4.4	5.4	8.1	3.9-5.2	5.2-6.5	7.8-9.1	0.7	0.5	0.6
MS7	3.8	5.2	7.3	2.6-3.9	5.2	6.5-7.8	0.4	0.0	0.7
MS8		4.9	6.8		3.9-5.2	5.2-7.8		0.6	0.8
MS9	5.2	5.6	7.6	5.2	5.2-6.5	6.5-7.8	0.0	0.6	0.5
MS10	5.1	6.6	9.5	3.9-5.2	6.5-7.8	9.1-10.4	0.4	0.4	0.6
MS12	3.9	5.4	7.7	3.9	5.2-6.5	6.5-7.8	0.0	0.5	0.4
MT7		4.1	5.4		3.9-5.2	5.2-6.5		0.5	0.5
MT9	4.3	6.4	7.6	3.9-5.2	5.2-7.8	6.5-7.8	0.6	0.7	0.5
MT10	4.9	6.3	8.7	3.9-5.2	5.2-6.5	7.8-9.1	0.6	0.5	0.6

TABLE IX

Statistics pertaining to hair diameter for *Aedes vexans*

Hair	Mean			Range			Standard deviation		
	II	III	IV	II	III	IV	II	III	IV
P5	3.1	4.9	7.5	2.6-3.9	3.9-5.2	5.2-7.8	0.7	0.6	0.8
P6	2.7	4.6	6.6	2.6-3.9	2.6-5.2	6.5-7.8	0.4	0.9	0.4
P7	3.4	4.1	5.5	2.6-3.9	2.6-5.2	5.2-6.5	0.7	0.9	0.6
MS5	3.8	5.2	7.7	2.6-3.9	5.2	6.5-7.8	0.4	0.0	0.4
MS6	3.8	4.9	6.7	2.6-3.9	3.9-5.2	6.5-7.8	0.4	0.6	0.5
MS7	3.0	5.0	7.3	2.6-3.9	3.9-5.2	6.5-7.8	0.6	0.5	0.9
MS8		4.2	5.6		3.9-5.2	5.2-6.5		0.6	0.6
MS9	4.1	5.2	6.6	3.9-5.2	5.2-6.5	5.2-7.8	0.5	0.5	0.7
MS10	5.1	6.7	9.8	3.9-5.2	6.5-7.8	9.1-10.4	0.4	0.5	0.7
MS12	4.0	5.6	8.0	3.9-5.2	5.2-6.5	7.8-9.1	0.4	0.6	0.5
MT7		3.7	5.6		2.6-3.9	5.2-6.5		0.5	0.6
MT9	4.1	5.2	6.6	3.9-5.2	5.2-6.5	5.2-7.8	0.5	0.6	0.7
MT10	4.6	6.2	9.1	3.9-5.2	5.2-6.5	9.1-10.4	0.7	0.6	0.6

TABLE X

Frequency distribution of the number of branches per hair for *Aedes abserratus*

Hair	Instar	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
		Number of branches per hair												
P0		see Table XIV												
P1	II	20											1.00	0.00
	III	18	2										1.10	0.31
	IV	3	17										1.85	0.37
P4	II	10	10										1.50	0.51
	III	7	13										1.65	0.49
	IV	2	12	5									2.10	0.64
P5	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	19	1										1.05	0.22
P7	II	20											1.00	0.00
	III	3	17										1.85	0.37
	IV		17	3									2.15	0.37
P9	II	19	1										1.05	0.22
	III	11	8	1									1.50	0.61
	IV	9	6	4	1								1.81	0.93
P10	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	19	1										1.05	0.22
P11	II	7	13										1.65	0.49
	III	2	8	9	1								2.45	0.76
	IV		3	4	9	4							3.70	0.98
P14	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	19	1										1.05	0.22
MS1	II	1	11										1.92	0.29
	III		4	8									2.67	0.49
MS2	II	7	12	1									1.70	0.57
	III	3	12	5									2.10	0.64
	IV		4	9	6	1							3.20	0.83

TABLE X (Cont.)

Hair	Instar	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
		Number of branches per hair												
MS3	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	15	5										1.25	0.00
MS4	II		13	6	0	1							2.45	0.76
	III		1	9	8	2							3.55	0.76
	IV			5	9	5	1						4.10	0.85
MS6	II			15	5								3.25	0.44
	III		1	17	2								3.05	0.39
	IV			8	9	3							3.75	0.72
MS8	II													
	III			1	9	1	1						4.17	0.42
	IV					2	7	2	1				6.17	0.49
MS9	II		1	19									2.95	0.22
	III			2	13	3	2						4.25	0.79
	IV					3	6	8	2	1			6.60	1.04
MS11@	II		7	5									2.42	
	III	1	7	3	4								2.33	
	IV			6	6								3.50	
MS13		see Table XIV												
MS14		see Table XIV												
MT1	II	8	9	3									1.75	0.72
	III	6	11	3									1.85	0.67
	IV		7	3	5	5							3.40	1.23
MT2	II		4	11	5								3.05	0.69
	III			14	6								3.30	0.47
	IV			6	9	4	1						4.00	0.86
MT3	II		2	9	7	2							3.45	0.83
	III				3	9	3	2	1	2			5.75	1.52
	IV						4	4	6	3	2	1	7.90	1.45
MT4	II		6	4	1	1							2.17	0.97
	III		1	4	6	1							3.58	0.79
	IV				6	3	3						4.75	0.87
MT6	II	20											1.00	0.00
	III	18	2										1.10	0.31
	IV	19	1										1.05	0.22

TABLE X (Cont.)

Hair	Instar	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
				Number of branches per hair										
MT7	II													
	III			1	9	2							4.00	0.52
	IV					6	5	1					5.58	0.67
MT8					see Table XIV									
MT9	II		15	5									2.25	0.44
	III			16	4								3.20	0.41
	IV			1	14	3	2						4.30	0.73
MT11@	II		9	3									2.25	
	III		11		1								2.17	
	IV		5	4	2		1						3.00	
MT12	II	18	2										1.10	0.31
	III	19	1										1.05	0.22
	IV	19	1										1.05	0.22
MT13					see Table XIV									

@ Number of branches per hair could only be estimated.

TABLE XI

Frequency distribution of the number of branches per hair for *Aedes atropalpus*

Hair	Instar	Number of branches per hair: 1	2	3	4	5	6	7	8	9	10	11	Mean	SD
P0	II		3	5	4								3.08	0.79
	III				8	4							4.33	0.49
	IV				1		4	5	2				6.58	1.08
P1	II	20											1.00	0.00
	III	18	2										1.10	0.31
	IV	1	16	3									2.10	0.45
P3	II	27	3										1.10	0.31
	III	11	19										1.63	0.49
	IV	6	21	3									1.90	0.55
P4	II	20											1.00	0.00
	III	19	1										1.05	0.22
	IV	20											1.00	0.00
P5	II	11	1										1.08	0.29
	III	1	11										1.92	0.29
	IV		5	7									2.58	0.52
P6	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	19	1										1.05	0.22
P7	II	10	2										1.17	0.39
	III		11	1									2.08	0.29
	IV			8	4								3.33	0.49
P8	II	15	5										1.25	0.44
	III	6	13	1									1.75	0.55
	IV	1	16	2	1								2.15	0.59
P11	II	17	3										1.15	0.37
	III	8	10	2									1.70	0.66
	IV	4	9	7									2.15	0.75
P14	II	20											1.00	0.00
	III	3	15	2									1.95	0.51
	IV	1	6	13									2.60	0.60
MS1	II	29	1										1.03	0.18
	III	22	8										1.27	0.45
	IV	5	14	11									2.20	0.71

TABLE XI (Cont.)

Hair	Instar	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
		Number of branches per hair												
MS2	II	15	5										1.25	0.44
	III	11	9										1.45	0.51
	IV	9	8	3									1.70	0.73
MS4	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	19	1										1.05	0.22
MS5	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	12	8										1.40	0.50
MS6	II			14	6								3.30	0.47
	III			5	10	4	1						4.05	0.83
	IV					2	7	11					6.45	0.69
MS8	II													
	III				7	5							4.42	0.52
	IV							4	7	1			7.74	0.62
MS9	II			8	4								3.33	0.49
	III				5	5	2						4.75	0.75
	IV						1	8	3				7.17	0.58
MS11[@]	II	8											1.00	
	III	9	3										1.25	
	IV	10	1	1									1.25	
MS13	II		7	3	2								2.58	0.79
	III		1		6	5							4.25	0.87
	IV					2	4	5	1				6.42	0.90
MS14	II	1	4	6	1								2.58	0.79
	III			4	5	3							3.92	0.79
	IV				1	5	4	2					5.58	0.90
MT1	II	1	10	1									2.00	0.43
	III		2	9	1								2.92	0.52
	IV			3	5	3		1					4.25	1.14
MT3	II	6	13	1									1.75	0.55
	III	5	10	5									2.00	0.73
	IV		8	10	1	1							2.75	0.79
MT4	II	4	15	1									1.85	0.49
	III		7	13									2.65	0.49
	IV		1	10	8	1							3.45	0.69

TABLE XI (Cont.)

Hair	Instar	Number of branches per hair: 1	2	3	4	5	6	7	8	9	10	11	Mean	SD
MT5	II	16	4										1.20	0.41
	III	17	3										1.15	0.37
	IV	20											1.00	0.00
MT7	II													
	III			1	3	7	1						4.67	0.78
	IV							7	1	3	1		7.83	0.35
MT8	II	4	10	4	1								2.05	0.83
	III	1	8	7	4								2.70	0.86
	IV		1	5	9	2	3						4.05	1.10
MT9	II		4	8									2.67	0.49
	III				10	2							4.17	0.39
	IV					3	7	1	1				6.00	0.85
MT11@	II	7	1										1.13	
	III	10	2										1.17	
	IV	10	1	1									1.25	
MT13	II	2	14	4									2.10	0.55
	III		1	8	9	2							3.60	0.75
	IV			3	8	6	1	1	1				4.60	1.27

@ Number of branches per hair could only be estimated.

TABLE XII

Frequency distribution for the number of branches per hair for *Aedes cinereus*

Hair	Instar	Number of branches per hair: 1	2	3	4	5	6	7	8	9	10	11	Mean	SD
P0		see Table XV												
P2	II	10	10										1.50	0.51
	III	10	10										1.50	0.51
	IV	3	15	2									1.95	0.51
P3	II		5	11	4								2.95	0.69
	III		1	5	10	4							3.85	0.81
	IV			3	5	7	5						4.70	1.03
P4	II		13	6	1								2.40	0.60
	III		5	12	3								2.90	0.64
	IV		2	9	7	2							3.45	0.83
P7	II	20											1.00	0.00
	III	8	12										1.60	0.50
	IV		15	5									2.25	0.44
P8	II	20											1.00	0.00
	III	19	1										1.05	0.00
	IV		18	2									1.90	0.31
P9	II	5	15										1.75	0.44
	III	3	17										1.85	0.37
	IV	4	15	1									1.85	0.49
P11	II	4	8										1.67	0.49
	III	1	4	6	1								2.58	0.79
	IV		3	4	3	2							3.33	1.07
P14	II	2	18										1.90	0.31
	III		15	5									2.25	0.44
	IV		14	6									2.30	0.47
MS1	II		10	7	3								2.65	0.75
	III			4	10	5	1						4.15	0.81
	IV				8	5	5	2					5.05	1.05
MS2	II	1	10	9									2.40	0.60
	III		3	14	3								3.00	0.56
	IV		1	4	15								3.70	0.57

TABLE XII (Cont.)

				Number of branches per hair										
Hair	Instar	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
MS3	II	20											1.00	0.00
	III	19	1										1.05	0.22
	IV	20											1.00	0.00
MS4	II		13	7									2.35	0.49
	III		1	8	9	2							3.60	0.75
	IV			3	14	3							4.00	0.56
MS6	II		12										2.00	0.00
	III		3	9									2.75	0.45
	IV			2	8	2							4.00	0.60
MS8	II													
	III			12									3.00	0.00
	IV				1	6	3	2					5.50	0.90
MS9	II		12										2.00	0.00
	III		1	9	2								3.08	0.52
	IV					7	4	1					5.50	0.68
MS11[@]	II	11		1									1.08	
	III		2	1									2.33	
	IV		3	3	1								2.71	
MS13					see TABLE XV									
MS14					see Table XV									
MT1	II	9	10	1									1.60	0.60
	III		5	10	5								3.00	0.73
	IV			3	7	9							4.40	0.82
MT2	II		1	10	8	1							3.45	0.69
	III			3	9	7	1						4.30	0.80
MT3					see Table XV									
MT4	II		6	13	1								2.75	0.55
	III		1	6	11	2							3.70	0.73
	IV		1	2	3	6	2	3	2	1			5.40	1.85
MT5	II	19	1										1.05	0.22
	III	19	1										1.05	0.22
	IV	20											1.00	0.00

TABLE XII (Cont.)

Hair	Instar	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
		Number of branches per hair												
MT6	II	7	12	1									1.70	0.57
	III	2	16	2									2.00	0.46
	IV	2	18										1.90	0.31
MT7	II													
	III		1	7	4								3.25	0.62
	IV					4	5	2	1				6.00	0.95
MT8		see Table XV												
MT9	II		20										2.00	0.00
	III		17	3									2.11	0.37
	IV			18	2								3.10	0.31
MT11@	II	5	7										1.58	
	III		7	1									2.11	
	IV	1	4	6	1								2.58	
MT13		see Table XV												

@ Number of branches per hair could only be estimated.

TABLE XIII

Frequency distribution of the number of branches per hair for <u>*Aedes vexans*</u>

Hair	Instar	Number of branches per hair: 1	2	3	4	5	6	7	8	9	10	11	Mean	SD
P0		see Table XVI												
P3	II	14	6										1.30	0.47
	III	2	13	5									2.15	0.59
	IV		11	7	2								2.55	0.69
P4	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	16	4										1.20	0.41
P5	II	12											1.00	0.00
	III	12											1.00	0.00
	IV	11	1										1.08	0.29
P7	II	12											1.00	0.00
	III		10	2									2.17	0.39
	IV		1	8	3								3.17	0.58
P8	II	12											1.00	0.00
	III	4	7	1									1.75	0.62
	IV		3	6	2	1							3.08	0.90
P9	II	20											1.00	0.00
	III	20											1.00	0.00
	IV	15	5										1.25	0.44
P11	II	1	10	11	7	1							2.90	0.92
	III		6	10	10	3	1						3.43	1.04
	IV		2	1	9	12	4	1	1				4.73	1.26
MS1	II	2	13	5									2.15	0.59
	III		4	10	4	2							3.20	0.89
	IV			8	9	2	1						3.80	0.83
MS2	II		14	6									2.30	0.47
	III		4	12	4								3.00	0.65
	IV		3	7	6	3	1						3.60	1.10
MS4	II	1	29										1.97	0.18
	III		20	10									2.33	0.48
	IV		13	17									2.57	0.50

TABLE XIII (Cont.)

Hair	Instar	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
		Number of branches per hair												
MS6	II			10	2								3.17	0.39
	III			4	5	3							3.92	0.79
	IV			1	0	5	5	1					5.42	1.00
MS8	II													
	III			1	5	6							4.42	0.67
	IV					1	2	7	2				6.83	0.84
MS9	II		1	10	1								3.00	0.43
	III				9	3							4.25	0.45
	IV					1	3	8					6.58	0.67
MS11@	II	8	4										1.33	
	III		6	6									2.50	
	IV		5	4	1	1							2.82	
MS13		see Table XVI												
MS14		see Table XVI												
MT1	II	15	13	2									1.57	0.63
	III		16	13	1								2.50	0.57
	IV	1	10	14	5								2.77	0.77
MT2	II	1	22	6	1								2.23	0.57
	III	1	5	18	6								2.97	0.72
	IV		3	18	9								3.20	0.61
MT3	II		1	3	5	2	1						3.92	1.08
	III			1	2	6	2	1					5.00	1.04
	IV					1	4	1	2	3	1		7.42	1.62
MT4	II	2	4	6									2.33	0.78
	III				4	5	1	1		1			5.28	1.48
	IV					4		4	4				6.67	1.30
MT5	II	20											1.00	0.00
	III	18	2										1.10	0.31
	IV	19	1										1.05	0.22
MT7	II													
	III				2	6	4						5.17	0.72
	IV						1	1	4	4		2	8.58	1.69
MT8		see Table XVI												

TABLE XIII (Cont.)

Hair	Instar	Number of branches per hair 1	2	3	4	5	6	7	8	9	10	11	Mean	SD
MT9	II		12										2.00	0.00
	III			9	1	2							3.42	0.79
	IV				3	6	3						5.00	0.74
MT11@	II	8	3	1									1.42	
	III	1	3	5	3								2.83	
	IV		2	7	2		1						3.25	
MT13	see Table XVI													

@ Number of branches per hair could only be estimated.

TABLE XIV

Frequency distribution of the number of branches per hair for *Aedes abserratus*

Hair	Instar	Number of branches per hair													Mean
		3	4	5	6	7	8	9	10	11	12	13	14	15	
PO	II	1	5	3	3										4.67
	III				3	3	2	1							7.11
	IV					3	1	1	1	1	1	1		1	9.38

Hair	Instar	Number of branches per hair												Mean
		6	7	8	9	10	11	12	13	14	15	16	17	
MS13	II	4	3	4	1									7.17
	III				1			1	2	2	3		3	11.42
	IV#													
MS14	II	3	3	5	1									7.33
	III			1		4	1	3	2			1		11.41
	IV#													

Hair	Instar	Number of branches per hair												Mean
		3	4	5	6	7	8	9	10	11	12	13	14	
MT8	II	1	1	1	8		1							5.67
	III							3	3	3	2		1	10.67
	IV#													
MT13	II		8	4										4.33
	III			1		2	2	2	4		1			8.75
	IV					1	1	3	3	1	1			9.50

@ All figures are estimates.

\# The number of branches in instar IV are too numerous to estimate.

TABLE XV

Frequency distribution of the number of branches per hair for *Aedes cinereus*[@]

PROTHORACIC HAIR 0

Instar	Number of branches per hair							Mean
	4	5	6	7	8	9	10	
II	1	1	4	4	1		1	6.58

Instar	Number of branches per hair									Mean
	9	10	11	12	13	14	15	16	17	
III	1	1	2	1	2	1		1	1	12.60

Instar	Number of branches per hair											Mean
	13	17	18	19	20	21	22	23	24	25	30	
IV	1	2		1	1	2		1	2	1	1	21.17

MESOTHORACIC HAIR 13

Instar	Number of branches per hair												Mean
	7	8	9	10	11	12	13	14	15	16	17	18	
II	2		3	1									8.29
III								1	2	2		1	15.67

Instar	Number of branches per hair										Mean
	17	18	19	20	21	22	23	24	25	26	
IV	1	1	1	1				2		1	21.14

MESOTHORACIC HAIR 14

Instar	Number of branches per hair													Mean
	5	6	7	8	9	10	11	12	13	14	15	16	17	
II	1	1	2	1										6.60
III						4	1		1					10.67
IV										2	1	1	1	15.20

METATHORACIC HAIR 3

Instar	Number of branches per hair														Mean
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
II	1	7	4												5.25
III			1		7	2	2								8.75
IV						1	1	2	3	1	2	1		1	12.50

TABLE XV (Cont.)

Instar	Standard deviation
II	0.62
III	1.71
IV	2.24

METATHORACIC HAIR 8

Instar	Number of branches per hair: 3	4	5	6	7	8	9	10	Mean
II	1		3	1					4.80
III						3		2	8.80

Instar	Number of branches per hair: 11	12	13	14	15	16	17	18	19	Mean
IV	2	2	1	1	3			1	1	14.42

METATHORACIC HAIR 13

Instar	Number of branches per hair: 4	5	6	7	8	9	10	11	12	Mean
II	2	3								4.60
III				1	3	1	2	1	1	9.22

Instar	Number of branches per hair: 11	12	13	14	15	16	17	18	19	Mean
IV	1	1	2	2			1	1	1	14.56

@ All figures are estimates except for metathoracic hair 3.

TABLE XVI

Frequency distribution of the number of branches per hair for *Aedes vexans*

PROTHORACIC HAIR 0

Instar	4	5	6	7	8	9	10	11	12	Mean	SD
	Number of branches per hair										
II	4	4	2	2						5.17	1.12
III			4	1	3		2		2	8.25	2.26

Instar	8	9	10	11	12	13	14	15	16	17	Mean	SD
	Number of branches per hair											
IV@	1	1	3	2			3		1	1	12.00	

MESOTHORACIC HAIR 13

Instar	4	5	6	7	8	9	10	11	12	Mean	SD
	Number of branches per hair										
II		3	3	1	3		1	1		7.08	1.97
III	1			1	3	3		3	1	8.92	2.19

Instar	14	15	16	17	18	19	Mean	SD
	Number of branches per hair							
IV@	1		1	1	1	1	16.80	

MESOTHORACIC HAIR 14#

Instar	5	6	7	8	9	10	11	12	13	14	15	16	Mean	SD
	Number of branches per hair													
II	1	1	1	1	1								6.83	
III		1		2		2							8.40	
IV										2	2	1	13.67	

METATHORACIC HAIR 8

Instar	2	3	4	5	6	7	8	9	10	11	12	13	Mean	SD
	Number of branches per hair													
II	1	1	7	2	1								4.08	1.00
III			1	3	4	2	1					1	6.50	2.32

Instar	8	9	10	11	12	13	14	15	Mean	SD
	Number of branches per hair									
IV@	1		2		1			1	11.00	

TABLE XVI (Cont.)

METATHORACIC HAIR 13

Instar	Number of branches per hair: 3	4	5	6	7	8	9	10	11	12	13	14	Mean	SD
II	2	3	5	2									4.58	1.00
III					1	3		4		1	1	2	10.33	2.42

Instar	Number of branches per hair: 9	10	11	12	13	14	15	16	17	Mean	SD
IV	3	1	1	2	1	1	1	1	1	12.25	2.80

Number of branches per hair were only estimated for all three instars.

@ Number of branches were only estimated for instar IV.

TABLE XVII

Frequency distribution of the number of branches per hair for prothoracic hair 4 of Aedes cinereus

Instar	2	3	4	5
		Twelve specimen sample		
II	8	3	1	
III	3	7	2	
IV	1	4	5	2
		Twenty specimen sample		
II	13	6	1	
III	5	12	3	
IV	2	9	7	2

TABLE XVIII

Patterns of development for thoracic hairs

Hair	abserratus	atropalpus	cinereus	vexans
P0	(4)@	4	(4)@	(4)+
P1	3	3	UB¢	UB
P2	UB	UB	3	UB
P3	UB*	4	4	4
P4	(4)	UB	4	3
P5	UB	4	UB	UB
P6	UB	UB	UB	UB
P7	4	4	4	4
P8	UB	4	3	4
P9	(4)*	UB	1	3
P10	UB	UB	UB	UB*
P11	4	4	4	(4)
P12	UB	UB	UB	UB
P14	UB	4	2	UB
MS1	4 *	(4)*	4	4
MS2	(4)	(4)	4	4
MS3	3	UB	UB	UB
MS4	4	UB	4	4
MS5	UB	3	UB	UB
MS6	3	4	4	4
MS7	UB	UB	UB	UB
MS8	3	3	3	3
MS9	4	4	4	4
MS10	UB	UB	UB	UB
MS11	-	-	-	-
MS12	UB#	UB	UB@	UB+
MS13	(4)#	4	(4)@	(4)@
MS14	(4)	4	(4)	(4)*
MT1	3 *	4	4 *	(4)*
MT2	(4)	UB*	(4)	(4)
MT3	4	(4)	4	4
MT4	4	4	4	4
MT5	UB	1	UB	UB
MT6	UB	UB	2	UB
MT7	3 #	3	3 @	3 +
MT8	(4)	4	(4)*	(4)
MT9	4	4	(4)	4
MT10	UB	UB	UB	UB
MT11	-	-	-	-
MT12	UB	UB	UB	UB
MT13	(4)@	4	(4)@	4

@ The number of branches per hair could only be estimated in all instars.

+ The mean number of branches per hair for instar III is statistically higher than that of instar II but the number of branches per hair could only be estimated for instar IV.

¢ UB means the hair is unbranches.

* The frequency distribution is suggestive of developmental pattern 4 but this was not confirmed by observations on additional specimens.

The number of branches per hair could only be estimated in instars II and III and were too numerous for estimation in instar IV.

TABLE XIX

Hair branching and size of cervical hairs in instars III and IV of *abserratus*, *atropalpus*, *cinereus* and *vexans*

	abserratus		atropalpus		cinereus		vexans	
	III	IV	III	IV	III	IV	III	IV
Number of specimens examined	5	14	12	12	12	15	12	12
Number of two-branched hairs	0	@	#	1	0	0	0	0
length in micrometers	*	*	19.00	15.00	9.00	9.00	14.00	19.00

@ On two specimens one hair appeared to have two branches.

* Hairs were not measured but appeared similar in length to those of *atropalpus* and *vexans*.

One specimen had an unusually large hair with three branches but this appeared to be an anomaly.