Genetic studies of hybrids between the Mexican killifishes, *Platypoecilus maculatus* and *Xiphophorus hellerii*, have shown that when the black-spotted varieties of *Platypoecilus* are crossed with *Xiphophorus*, melanosis appears in some of the hybrid offspring. The distinguishing feature of these black-spotted varieties of *Platypoecilus* is the presence in the skin of a large type of black chromatophores. These pigment cells have been called macro-melanophores and in normal fishes are confined to the cutaneous tissues of the body. Varieties of *Platypoecilus* possessing the small type of black chromatophores (micromelanophores), when crossed with *Xiphophorus*, do not produce hybrid offspring which become afflicted with melanosis in any degree. The two general types of hybrids are illustrated in Plate XV. Fig. 89 is a photograph of a melanotic individual possessing the macromelanophores arranged as black areas or blotches over the surface. Fig. 90 shows a specimen lacking melanophores of the large type but possessing the small melanophores (micromelanophores) condensed as a crescent about the base of the caudal fin and also scattered over the whole body. The two specimens shown in these figures were brood mates. It appears conclusive that the macromelanophores alone among black pigment cells are involved in melanosis and the melanotic over-growths under consideration.

1 The investigation upon which this article is based was supported in part by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University. This is the third of a series of three papers, the first of which appeared in the preceding issue of *The American Journal of Cancer* (15: 732, April 1930). The second immediately precedes this. Because of the close interrelationship of these papers, the figures are numbered consecutively throughout, so that there may be in this paper an occasional reference to figures appearing in the other two.

Through breeding experiments the junior author (Gordon, 1931a) was able to isolate sixteen fundamental color varieties in Platypoecilus, three of which stand out from the others by the possession of macromelanophores. They are the spotted-red platy (Fig. 85), the Rubra (spotted-red-stippled) (Fig. 86), and the black platy (black striped-stippled) (Fig. 87). In the two spotted varieties the macromelanophores are scattered irregularly over the body, while in the black variety they are arranged as dense sheets along the sides. The spotted platys throughout life appear to be normal in every respect. The black platy appears to be abnormal, but its breeding behavior and life history, so far as these are known, do not support such a view. Contrary to expectation, crosses involving the black platy (Platypoecilus) with the swordtail (Xiphophorus) do not produce hybrid fishes which show melanotic overgrowths as frequently as those in which the black-spotted varieties participate.

EXTERNAL FEATURES OF THE MELANOTIC FISHES

For the purposes of description, the advance of melanosis in hybrid killifishes will be mentioned as occurring in a system of
three magnitudes or states of intensity (Plate XIV). Intermediates between these states have been observed. In a cross (pedigree 123) of a Rubra female (spotted-stippled-red) with a Xiphophorus male forty-five hybrids were produced. Of these hybrids, thirty were recognized as exhibiting the first state of melanosis, illustrated by Fig. 88. Thirteen are recorded as exhibiting the second state, illustrated by Fig. 66, while three, because of characteristic neoplastic over-growths, are recognized as coming within the category here termed the third state of melanosis, shown in Fig. 68. For complete details and figures concerning the genetics of these hybrids, the reader is referred to the paper immediately preceding this (Gordon, 1931b).

First State: The initial stage appears as a densely pigmented blotch across the caudal peduncle, where it joins the caudal fin. About this area macromelanophores develop in every direction. The more extensive pigmented areas do not result as a spreading from the original blotch as a center, but come about by the increase in the size of isolated areas, at first scattered over the sides of the body. At the same time (Plate XIV, Fig. 88) the fins appear blotched. These isolated blotches on the fins increase in size and meet, thus forming larger areas, as they do upon the body. The fin invasion involves the caudal, dorsal, anal, and in rare cases the pelvic fins also. In this stage the entire surface of the body may be considered as having experienced an abnormal invasion of macromelanophores (Plate XV). Further observations of hybrid fishes showing the progress of melanosis reveal the continued coalition of distinct melanophore groups, and the advent of others, resulting eventually in the formation of a continuous sheet of macromelanophores. The consolidation of macromelanophore groups is the most characteristic feature in the initial stage of melanosis.

The initial stages of melanosis in hybrid fishes may be recognized as early as the day of their birth, and there is every reason to believe that they may be detected even during the period of larval development within the oviducts of gravid females. Many old melanotic hybrids indicate that the development of melanosis may not proceed beyond what is here regarded as the initial stage (Figs. 88, 91, 92, 93).

Second State: The second progressive state of melanosis, so far as the surface of the body is concerned, may be mentioned as that in which there is a further consolidation of isolated groups
of macromelanophores resulting in an extension of affected regions, accompanied by a deterioration of the structural elements themselves. The scales and fin rays are divested of their soft parts, and there is a noticeable loss of rays, especially in the dorsal and caudal fins (Plate XIV, Fig. 66). In well-developed cases the fins are completely lost. It is to be noted, also, that in advanced stages locomotion is seriously affected. The complete loss of caudal fin may be accompanied by a reduction or a complete loss of flexibility of this region of the body. The caudal peduncle is then awkwardly moved from side to side in such a manner that it appears to have lost all vital relation with the rest of the body. In a great many cases there is a noticeable impairment of the normal movements of the peduncle. An individual so impaired in its locomotion could not long survive in the feral state. There is no record known to the authors of these hybrids having been found in nature, but the overlapping ranges of Platypoecilus and Xiphophorus (Meek, 1904) offer an opportunity for the proper crosses to be made among the wild fishes.

Correlated with the loss of parts, as described for the second state of melanosis, is the occurrence in the subcutaneous tissues of macromelanophores which are also particularly active in the replacement of connective tissues associated with muscle and bone. For purposes of reference this stage in the progress of melanosis is here termed *general melanosis*. As in the first state, fishes so afflicted may exhibit no indication of advancing beyond this stage. In the first two states there are encountered many variations in the progress of melanotic invasion. What has been written above may be taken as expressing the process in general. Plate XV illustrates not only the range of variations but also some of the patterns which are found.

There should be mentioned a series of observations which seem significant, the details of which will be presented in another communication. In order to acquire materials for grafting experiments, the caudal fin of a melanotic hybrid (pedigree 123) was cut off with scissors. The specimen as it appeared prior to the operation is shown in Plate XVI, Fig. 101. A portion of the caudal fin had been lost due to the progress of melanosis. At the time the caudal fin was severed, only three fin rays remained, and these were in the mid region. The caudal fin of this specimen regenerated, producing eight rays, and, after a period of twenty-five days, appeared as shown in Plate XVI, Fig. 102. The depression
in the dorsal and ventral edges of the fin is space which had not been filled by the regenerating fin. The new fin was first without pigment but was soon invaded by macromelanophores from adjoining areas. Fifty-three days after the operation (that is, twenty-eight days after the stage shown as Fig. 102) this fish appeared as shown in Fig. 103. Two other specimens were operated upon in a similar manner. Figs. 104 and 106, Plate XVI, show these specimens before the amputation of the caudal fin. Figs. 105 and 107 show the same specimens after the caudal fin had regenerated.

**Third State:** This state is definitely characterized by a noticeable increase in the proportions of the affected parts of the body. Externally there may be only the general melanotic appearance, with no indication of loss of parts, but internally there is always, in the three cases studied, evidence of activity which results in the replacement of normal tissues.

In the breeding work of the junior author, four hybrids were found (culture numbers 56 and 123) afflicted with the third state of melanosis expressed in pronounced over-growths which are sharply demarcated from surrounding regions. These are discussed separately with respect to their external appearance and are referred to as the caudal (Fig. 108), the peduncular (Fig. 110), and the head (Figs. 68, 109) over-growths respectively according to their locations on the body.

The melanotic over-growth of the caudal fin occurred in one of a brood of fishes (pedigree number 56) whose female parent was a Rubra platy (Fig. 86) and the male parent a melanotic hybrid (first state), like the specimen shown in Fig. 92, Plate XV. The over-growth appeared shortly before sexual maturity, but reached its greatest development later. It appears that there were no hindrances, either in external or internal structure sufficient to prevent mating. This fish died in its fifteenth month from undetermined causes. It measured 40 mm. in length (including caudal fin), while the over-growth measured 11 mm. in its greater dimension. The over-growth appeared on the ventral edge of the caudal peduncle and fin and extended a little less than half way to the dorsal edge of the latter. Its transverse dimension measured 2 mm. The greater part was on the left side of the meson (Fig. 108). Its surface appearance is decidedly irregular and has eruptive features (Plate XVII, Fig. 114). The scales stand out at right angles and many seem to have lost their position, due to
an increase of pressure from the interior. Häussler (1928) calls attention to the pigmentation of the mid-ventral line of the caudal peduncle and fin in Xiphophorus. In the male this line runs continuously from the region of the anus to the tip of the sword-like extension of the caudal fin (Fig. 112). Häussler has expressed the belief that this pigmented area gives rise to melanosis among

![Figures 108-110](image)

**Figures 108-110**

The over-growths shown in these figures represent what is mentioned in the text as the *third state* of melanosis.

**Fig. 108.** Melanotic Hybrid (Culture Number 56), Showing Over-growth in Tail Region

**Fig. 109.** Melanotic Hybrid (Culture Number 123), Showing Over-growth in Head Region

**Fig. 110.** Melanotic Hybrid (Culture Number 123), Showing Over-growth in Peduncle Region

the Platypoecilus-Xiphophorus hybrids, when the spotted variety of the former is used. It should be noted in this connection, that in two cases, to be described presently, the over-growth occurred in the head region. Kosswig (1929) has described lateral over-growths, also. It appears to the authors that the mid-ventral pigmented area of Xiphophorus is not necessarily the seat of melanosis.
The largest of the over-growths is found in the caudal peduncle (Fig. 110 and Plate XV, Fig. 94) of a first generation hybrid of a Rubra female and a swordtail male (pedigree number 123). It appeared in a male 45 mm. long. The affected area extended from the caudal fin to the region of the anus, a distance of 20 mm. The melanotic over-growth in this fish appeared soon after sexual maturity and progressed very rapidly until even the modified anal fin (the intromittent organ) was invaded and malformed by macromelanophores (Plate XV, Fig. 94). Fig. 110 is a drawing of the peduncular over-growth from the dorsal side and shows an enormous increase in the proportions of the region, which is jet black in color. The scales, instead of lying closely imbricated, are elevated along their free margin as though responding to pressure from within. This fish was observed to exhibit difficulty in swimming during the last stages of melanosis. The caudal half of the body seemed to lack flexibility and hung lower than the head region, as if the caudal half were heavier. This fish was killed in a fixing fluid, but at the time it appeared evident that it could have lived for a short time only.

The third place in which an over-growth has been found is the occiput, just behind the eye (Fig. 109). The hybrid in which this head over-growth developed was a female with the same genetic history as the male fish (pedigree number 123) in which the peduncular over-growth appeared. It was 34 mm. long, and the melanotic over-growth measured about 5 mm. in diameter. The bulk of the over-growth was on the left side of the body. It must have developed rapidly, for it was not detected among the members of the same brood until a week before the fish died, when it was in its fourteenth month. The general appearance may be appreciated by referring to Fig. 68 which is a photograph of another hybrid of the same brood, showing the early stages of a melanotic over-growth in approximately the same position. This individual is now (Oct. 25, 1930) in its twentieth month. The swelling on the head was detected about the nineteenth month. Apparently the progress of the head over-growth in this hybrid is much slower than in the other specimen. The fish appears to be very active and in no way exhibits impairment of normal movements. This fish will be kept under close observation.¹

¹ Since this has been written, the melanotic fish under discussion developed another over-growth on the side of the body and died suddenly. Its morphology will be treated in another paper.
INTERNAL STRUCTURE OF THE OVER-GROWTHS

In many cases the structure of the melanotic deposits has been studied from sections in two planes, and from specimens or portions of the body which have been cleared in an essential oil. The progress of melanin deposits in the deeper tissues is in general similar in method to that outlined above as occurring at the surface.

The first depositions of black pigment in macromelanophores occur in the corium, directly under the epidermis, and the corium lining the pockets in which the scales are lodged. The epidermis itself is invaded by melanophores at an early stage (soon after birth), but not extensively. In older (mature) individuals extended stretches of the epidermis become fully pigmented. The normal epidermal cells appear to be elevated at first, and finally dislodged at the surface, as occurs regularly and normally in the naked-skinned catfishes. Large melanophores are thus brought to the surface, where they disrupt, liberating the pigment granules. Such cells appear the same in both paraffin and celloidin sections. In some fishes, at least, similar phenomena appear normally. The corium and subcutaneous tissue, inward as far as the muscles, become a dense black; that is, form continuous chains of macromelanophores, as the earlier isolated areas extend so as to meet. Muscular areas and deeper myosepta are invaded slowly at first. The invasion progresses from the subcutaneous tissues inward. The connective tissue about muscle bundles and fibers in a given area may show a single melanophore with extensive and irregular processes completely surrounding several muscle bundles. A second melanin cell appears in the same region, expands, and meets the first one, establishing a small pigmented area which enlarges and becomes more and more dense. In a similar fashion areas join, so that there results eventually a general and more or less continuous invasion of the connective tissue from the superficial corium inward to the connective tissue at the very center of the body mass (Plate XVII, Fig. 111). Here the periosteum of the vertebrae and other skeletal parts becomes fully populated with black cells. Up to the present time we have not observed bone and definitive cartilage to be affected, but pro-cartilage is found to be invaded as readily as other tissues which fall prey to the melanophores. In one specimen at least, the meninges of the spinal cord were invaded, and there were some indications that the
nervous tissue itself might be giving away to the onslaught of the black cells.

Connective tissue, as such, appears to be destroyed as the result of melanophore invasion. As a result, parts normally bound together are found to separate easily. An extreme of this situation is exhibited by the fin rays and scales, from which all soft parts fall away. In this naked state they exist for a time, but eventually drop from the body, producing the deteriorated appearance of the fins shown in the figures referred to above. In this manner a complete loss of the fin, usually the caudal, occurs. During the progress of such ravages in the fins, a thick mass of black pigment envelops them, obscuring or completely masking the fin rays, which fall away in groups of several rays each. The end result is shown in many of the figures to which reference has already been made. In this state all semblance of a fin is lost.

Following the more or less complete invasion of the connective tissue, the melanophores send their processes into the muscle bundles. The relation of the black cells and muscle fibers is well shown in dissociated and teased material, mounted in balsam without staining. There is every appearance of pseudopodia-like processes being sent from the black cell directly into a bundle of fibers. In many cases the muscle fibers disappear, leaving the space occupied only by processes of melanophores. In others the fibers appear to undergo degeneration, breaking up into large numbers of fragments before complete disappearance. Muscles cut through the proper longitudinal plane frequently show the large melanophores wrapped about the fibers as an enveloping tissue. In other cases enormous melanophores are found to extend transversely across a muscle mass with pseudopodia-like processes extending from the main mass of the cell among the fibers. The series of these processes on a given pigment cell correspond in number and position to the underlying muscle fibers, among which they extend.

Deterioration of connective tissue and the destruction of muscular tissue is the state reached by most melanotic individuals inflicted with general melanosis (state two). In parts showing the completed stage of melanosis, all tissue excepting bone and cartilage appear to have been replaced entirely by black cells (Plate XVII, Fig. 111). The endothelium of capillaries disappears, leaving the blood cells crowded together in extensive places, bounded only by
dense masses of melanophores. The affected regions are extensive. The whole caudal peduncle is usually affected, and from here melanosis may extend, so as to include most of the body and fins. Loss of scales and fin rays may or may not follow.

What is referred to above as general melanosis (that is the second state) involves the structural aspects which have just been described. This general melanotic condition is accompanied by an increase in the proportions of the regions seriously affected. The movements of the fish are indicative of the extent of the destruction which has come to the muscles. When the caudal peduncle and fin give no evidence of flexibility, structural study shows the muscle fibers to have largely disappeared. The increased proportions of affected regions is due in a minor part to the increase in the number of cells showing melanin inclusions. It appears, however, that the region increase in size is due to the enormous increase in the size of the melanophores. The largest measured was 300 microns in its greater dimension, and in this case probably not more than three-quarters of the cell was included, since processes became indistinguishably mingled with those of neighboring cells. Our observations lead us to believe that the melanophores increase much beyond this size. Measuring cells which are so irregular and so inextricably mingled is scarcely satisfactory.

The third state of melanosis is that mentioned under the discussion of external features as a pronounced over-growth within somewhat restricted limits. These have been found in the three regions mentioned above. The surface of these over-growths suggests for them more of a tumor-like nature than does any stage in a general melanotic affection. All three of these sharply outlined over-growths present certain features in common: (1) melanophores within the over-growth appear smaller than in the corium of fishes showing general melanosis. They are numerous enough, however, to impart a jet black color at the surface, which sharply marks the over-growth. (2) The over-growth is due to the increase of a tissue (or state of a tissue) not so evident in a generally affected region. (3) The surface of these swellings appears to be in a state of eruption at certain points.

The peduncular over-growth presents a few superficial and structural peculiarities which might be interpreted as representing an intermediate state between general melanotic areas on the one
hand and the tumor-like enlargements on the other. Among these three over-growths there are found certain differences of detail, but fundamentally the over-growths appear to be identical.

Because of outstanding similarities recognized among these over-growths, that of the caudal fin only will be described in detail. The particular specimen studied offers many advantages. It was not so extensive but that serial sections could be made, thus making possible continuous observations from adjacent unaffected areas, through all transitional grades, into the over-growth itself. Then, too, throughout a large part of its extent this over-growth was on the left side of the tail. Cross-sections offered, therefore, the further advantage of a direct comparison of the over-growth with the less affected parts of the opposite side. Large melanophores are numerous in the corium; their behavior and distribution are the same, so far as can be judged from structural studies, as in regions affected with general melanotic invasion. In all melanotic hybrids a large number of large melanin cells may be regarded as "normal." The macromelanophores do not appear to be associated with abnormal conditions except in hybrid fishes showing general melanosis and over-growths.

Outside the over-growth region macromelanophores are scattered in the connective tissue of the skin, in the regions of areolar tissue, about the muscles, and between muscle bundles. Connective-tissue fibers are everywhere conspicuous. At the edges of the over-growth the connective tissue areas become thickened, the fibers become less conspicuous and finally disappear. The looseness of the normal connective tissue is lost; the whole mass of this metamorphosing tissue becomes more compact and leathery in structural appearance. The over-growth is due to the increase of such transformed tissue at all levels, particularly between the epidermis and muscle segments, and between the muscle segments and the middle plane of the body. The paired elements of the fin rays become widely separated for the same reason. The muscle bundles which normally lie close together become so widely separated and reduced in bulk that they lose all semblance to muscle masses. A comparison of the two sides of Fig. 120 illustrates all of these features. In the stage shown in Figs. 108 and 114 surface excrescences were evident in the caudal over-growth. Over such surface the swelling appeared to be in a state of eruption. The epidermis and scales had been lost, leaving the metamorphosed
MORPHOLOGY OF MELANOTIC OVER-GROWTHS

(or new) tissue exposed (Fig. 120). The microscopic structure of such surfaces indicates that here single cells or cell groups of varying sizes, and even masses of tissue, were sloughed off as a part of the over-growth process.

At points somewhat remote from the caudal over-growth, where the connective tissue is not noticeably affected, there are irregular (that is, stellate) granular cells. The nucleus is single and relatively large, and readily takes the basic dyes. These cells appear to be uniformly granular, but not densely so. The granules are of a deep amber color in both stained and unstained preparations. The melanophores, found side by side with the lighter cells, are larger, possessing granules which are of the same size and color, especially when viewed through the thinner parts of the cell. In the thicker portions of the melanophore the granules impart almost a black color, but not the jet black of the macromelanophores found in general melanotic areas.

Between the larger and darker cells, and the lighter ones, there appears to be every conceivable gradation. The significance of this has not yet been definitely determined. There is the possibility that the smaller dark cells are the large ones "growing up." In that event one should view the lighter cells as a distinct type (distinct physiologic type, at least). In some preparations, especially of the head over-growth, this appears to be the case. The question must be studied further. Whatever may be the situation in this respect, the two apparent kinds are always present, and the lighter, smaller, granular cells are more abundant.

The light cells assume a number of different shapes, which seem to follow an orderly sequence in their changes, which appear to become permanent according to the progress of the over-growth. In regions adjacent to the margins of the over-growth these light granular cells are irregularly star-shaped. As the tissue forming the over-growth increases in amount, the light cells gradually assume a more even surface and become more slender and elongate. In the extreme they become very slender, and sometimes sharply pointed at opposite ends. That is, they become slender spindles. Further study may reveal the behavior of these and of the larger cells to be significant.

Early in this study it was recognized that some of the larger dark cells and the majority of the light cells lie with their long axes parallel. This is a striking feature of each of the over-
growths. The cells as a mass appear as if streaming in the same direction. It is in such situations that they become more regularly spindle-like in form. Serial sections reveal the fact that this "streaming" appears to be directed toward the surface of the overgrowth. Near the middle plane of the body the cells are frequently found to be irregular in form and in their relations to one another. In early stages of the over-growth, as, for instance, about the margins of the base, the light cells are irregular and mixed among connective tissue fibrils, some of which appear as relatively broad bands but much reduced in quantity as compared with the normal state. Many light cells appear to be stretched along and in contact with these fibrils. Connective tissue and muscle fibers disappear as the over-growth advances in development. In regions where the over-growth is well established, the two kinds of granular cells mentioned above are the only structural elements which were found. The true over-growth appears, therefore, to be due to a new tissue which not only replaces the normal tissues but increases in amount, thus causing the over-growth.

The head and peduncular over-growths exhibit essentially the same features as those of the caudal fin.

**Summary and Conclusions**

The above preliminary review is descriptive and not intended to serve as a basis for detailed interpretations and broad generalizations. There are certain points which appear to be clear:

1. As a result of macromelanophore invasion there results a state of general melanosis in which there is a deterioration and final complete replacement of normal tissues by the invading cells. This may or may not be accompanied by noticeable over-growth.

2. A state is reached where there occur sharply delineated over-growths in which a new tissue replaces the normal tissue and produces the over-growth.

3. In both general melanosis and tumor-like over-growths, the final tissue of the affected parts is clearly a true neoplasm.

4. However different the several neoplastic cells may appear to be, they are regarded as expressing different states of the same metabolic disturbance in the organism.
The Three States of Melanosis Observed in Adult Hybrids of the Same Brood. (Figures 1.5 Times Life Size)

Fig. 68. Melanotic Hybrid, First State of Melanosis (Culture Number 123)

Fig. 66. Melanotic Hybrid, Second State of Melanosis (Culture Number 123), Showing Loss of Part of the Caudal and Dorsal Fins

Fig. 68. Melanotic Hybrid, Third State of Melanosis (Culture Number 123), Showing Early Stage of Overgrowth in Occiput Behind the Eye

For dorsal view of another head over-growth, see Fig. 109.

Water colors by Wilhelmina Brown
References


PLATE XV

The figures of this plate exhibit the wide range of melanosis among hybrids of Platypoecilus and Xiphophorus, the three states of melanosis, and the appearance of non-melanotic hybrids. The figures are all life size. (The photographs in this and succeeding plates are by Myron Gordon, unless otherwise stated.)

Fig. 89. Melanotic Hybrid (first state) of Culture Number 167
Fig. 90. Non-melanotic Hybrid of Culture 167, Showing Crescent Pattern in Tail

The micromelanophores are present in all parts of the body

Figs. 91, 92, 93. Melanotic Hybrids (first state) of Culture Number 123

Fig. 94. Melanotic Hybrid with Melanotic Over-growth in the Peduncle Region (third state); Culture Number 123

Figs. 95, 96, 97. Melanotic Hybrids Showing Second State of Melanosis (general melanosis)

Figs. 98, 99, 100. Melanotic Hybrids of Varying Sizes to Show Early Development of Melanosis
PLATE XV
(Figures 89–100)
PLATE XVI

Fig. 101. Melanotic Hybrid (second state), Showing Loss of Part of Caudal Fin
Later, when the caudal fin was reduced to only three rays, it was amputated. Culture number 123.

Fig. 102. Same Melanotic Hybrid as Fig. 101, Showing the Caudal Fin Regenerated and Reinvented by Macromelanophores

Fig. 103. Same Melanotic Hybrid as 101 and 102, Showing Further Invasion of New Tissue by Macromelanophores and the Deterioration of the Regenerated Tissue

Fig. 104. Melanotic Hybrid (second state), Showing Loss of Part of Caudal Fin due to Melanosisis (Culture Number 123)

Fig. 105. Same Melanotic Hybrid as Fig. 104, Showing Regeneration of Caudal Fin Following Its Amputation
Melanotic invasion of the new tissue is just begun.

Fig. 106. Melanotic Hybrid (second state), Showing Loss of Tissue about the Rays of the Caudal Fin (Culture number 123).

Fig. 107. Same Melanotic Hybrid as 106, Showing Regeneration of Caudal Fin and Reinvasion of New Tissue by Macromelanophores
**PLATE XVII**

**Fig. 111. Sagittal Section through Caudal Region of a Melanotic Hybrid (Culture Number 167), Showing in the Second State of Melanosis the Replacement of Normal Tissues by Melanotic Cells**

**Fig. 112. Tail of a Cleared Specimen of Xiphophorus, Showing the Extent of the Internal and External Pigmentation by Micromelanophores**

Note the mid-ventral black stripe (M).

**Fig. 113. Cleared Specimen of Xiphophorus, Showing a Variety Characterized by the Presence of the Crescent (C').**

The crescent is formed by micromelanophores.

**Fig. 114. Cleared Melanotic Hybrid (Culture Number 56), Showing Melanotic Overgrowth in the Caudal Fin**

For a drawing from the dorsal aspect see Fig. 108.

**Fig. 115. Cross-section through the Caudal Overgrowth of the Melanotic Hybrid Shown in Fig. 114.**

Note the overgrowth on the ventral edge and compare with approximately normal features shown in the dorsal (D) part.
PLATE XVIII

INTERNAL FEATURES OF MELANOTIC HYBRIDS SHOWING THE THIRD STATE OF MELANOSIS

Fig. 116. Cross-section through the caudal peduncle of melanotic hybrid (Culture Number 123), showing complete envelopment of this region by melanotic tissues.

Mn. Meningeal tissues invaded by melanotic cells. Me. Melanotic cells in the dermis. M. Invasion of muscles by melanotic cells. E. Area shown enlarged in Fig. 117.

Fig. 117. That portion of Fig. 116 within the black circle, enlarged to show the location of melanotic cells in the dermis.

Me. Melanotic cells. Sc. Scale.

Fig. 118. Sagittal section through the head region of a melanotic hybrid (Culture Number 123), showing extent of the head over-growth and regions affected.

S. Surface of over-growth with epidermis destroyed. Sc. Scale forced out of place. E. Area enlarged as Fig. 119. Ey. Caudal part of eye. G. Gills.

Fig. 119. That area of Fig. 118 enclosed by the black circle, enlarged to show the invasion of muscles by melanotic cells.


Sections prepared by Miss Esther R. Lashley, Cornell University, Ithaca, N. Y.
PLATE XIX

Fig. 120. Cross-section through the caudal over-growth of a melanotic hybrid (culture number 56), showing the replacement of normal tissues by melanotic types.

Ma. Macromelanophores in the corium between scales.
P. Periosteum still present around this fin ray.
Pd. Periosteum destroyed by melanotic cells. Note those below, also.
Ms. Muscle bundles completely separated by melanotic tissues.
M. Muscle bundles on the opposite side of the fish which are nearly normal.
Sc. Scale.
Ep. Surface from which the epidermis and corium have disappeared.

Photograph by Mr. Dunn, Cornell University Medical School, New York, N. Y. Courtesy of Professor James Ewing.
Fig. 121. Transection through the posterior end of the peduncle of a 33 mm. male melanotic hybrid in the second state of melanosis, showing areas of complete replacement of normal tissue by macromelanophores.

A view of the type of melanotic hybrid from which this section is made is given in Plate XIV, Fig. 66. Stained with hematoxylin and eosin. Series 15, slide 197, section 16. Cornell collection.
PLATE XXI

FIG. 122. TRANSECTION OF A MELANOTIC TUMOR IN THE TAIL REGION OF A 44 MM. MALE MELANOTIC HYBRID, SHOWING AN ADVANCED STAGE IN THE REPLACEMENT OF NORMAL TISSUES BY NEOPLASM.

The elements of the bony fin-rays alone persist in a normal state. A view of the melanotic hybrid from which this section is made is given in Plate XVII, Fig. 114 (see also Fig. 108). Stained with picro-carmine. Series 3, slide 17, Cornell Collection.
FIG. 123. SAGITTAL SECTION THROUGH THE HEAD TUMOR OF A 34 MM. FEMALE MELANOTIC HYBRID, SHOWING NORMAL AND NEOPLASTIC TISSUE WITH THE GROWTH OF THE LATTER INTO THE MORE NORMAL AREAS.

A view of the hybrid from which this section is made is given in Fig. 109 (see also Plate XIV, Fig. 68). Stained with hematoxylin and eosin. Series 778, slide 63, section 4, Cornell Collection.