SUTURE CLOSURE—ITS PROGRESS AND AGE RELATIONSHIP

PART IV.—ECTOCRANIAL CLOSURE IN ADULT MALES OF NEGRO STOCK

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INTRODUCTION

In former papers we have dealt with the problem of suture closure on both sides of the male White cranium (1, 2) and on the endocranial surface of the male Negro cranium (3). We have shown that the current conception of a closure tendency should be replaced by a definite modal age relationship in suture union. But we have also made it clear that there is a vast difference between a modal age relationship and individual uniformity. Although we have not yet had the opportunity of presenting our comparative data we have outlined the theory that the human cranium is distinctly aberrant from the mammalian type in its suture closure plan and that this aberration further resolves itself into great individual variation, despite which, nevertheless, a distinct human closure pattern may be discerned. In our discussion we have touched upon some of the influences bearing upon this individual variation. The modal closure pattern of a significant sample of a population is one thing and individual variability obscuring this pattern is quite another. It must be assumed then that the reader has already mastered the main features of the closure pattern before he attempts to understand the precise significance of the facts to be presented in this article.

Of our male Negro cranial 79 remain after discarding 41 irregular examples out of the 120 skulls of the sample. These 79 skulls were used in

the endocranial study and they are again used in the present work. Further additions which have accrued since the investigation started four years ago are not included although they bear out the conclusions presented. It is essential that exactly the same crania be utilized for ectocranial study as for endocranial examination so that the graphs of the two surfaces may be directly comparable. We divide cranial sutures into three categories: sutures of the vault, circum-meatal sutures, and accessory sutures. The reasons for this subdivision we have already presented (1). It remains therefore simply to present and discuss the facts relating to ectocranial closure in the male Negro.

By the term Negro we mean the American Negro. Originally the term Negro-hybrid was employed. This expression however may be and usually is taken to imply a greater admixture of White blood than the facts justify. Whatever the hybridization may have been in the distant past, unpublished studies made in this laboratory indicate that hybridization with Whites has occurred to a much less degree in recent generations than popular opinion takes for granted. This view has also been expressed by Herskovits in a very important recent paper (4). In the work on the endocranial sutures we have discussed the relation of the American Negro graph to that of the male White and we have shown that essentially they follow the same pattern but that variability is more characteristic of the Negro. It is this greater variability together with misinterpreted data upon delayed union (3. pp. 56, 6a) which has resulted in the apparently significant differences insisted upon by earlier authors who have based their conclusions upon entirely inadequate information.

SUTURES OF THE VAULT

1. The Sagittal Suture

(Fig. 1).

There is a single fundamental pattern for both endocranial and ectocranial aspects of the suture but, as in male Whites, ectocranial closure does not attain the degree of completion observed upon the endocranial surface.

Union is first begun on the ectocranial aspect at twenty years, two years earlier than on the inner face. It continues rather slowly in the main until about twenty-four and then takes on a more rapid character and reaches a stage in the early thirties beyond which it never really progresses. The graph swings about quite considerably after this date, oscillation resulting manifestly from the relative paucity of material and from the individual variability which has already been discussed. Na-

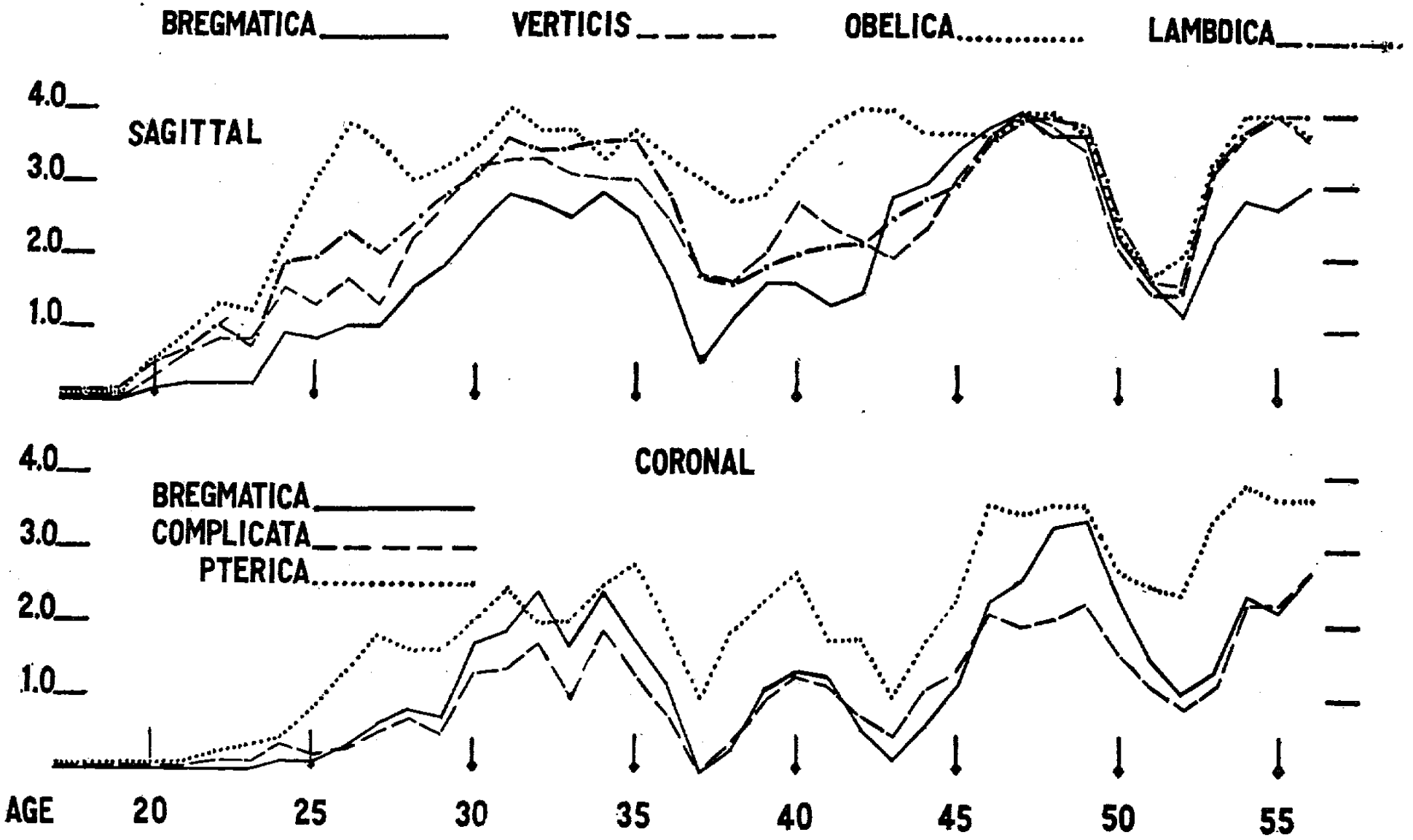
ture, it seems, demands a certain degree of conformity to pattern but, beyond this essential minimum, is not constrained to press uniformity. The degree of conformity is much less upon the outer than upon the inner surface of the cranium. This fact, taken in conjunction with our findings in the male White cranium, permits the important deduction that suture closure obtains its impetus from influences at work upon the inner face rather than from factors bearing upon the outer face. Perhaps the current and erroneous assertion that closure tends to be earlier and more rapid upon the endocranial aspect derives its origin in a hazy conception of the fact which we now emphasize.

Analysing the several parts of the suture as shown in the graph, one finds that the partes bregmatica and verticis hang more or less together, that the lambdica pursues a somewhat different course, and that the obelica is a law to itself.

The obelica commences to close at twenty years. This is two years earlier than on the endocranial surface but is precisely the same age as that for commencing closure on the ectocranial aspect of the male White. Thereafter its graph shows a rapid rise, reaching 3.8 at twenty-six and 4.0 at thirty-two years. These are the significant points; the oscillation after the early thirties is the expression of individual variability as already outlined. Now on the endocranial surface completion is attained at thirty-one and on the outer face in the male White at twenty-nine.

The lambdica also commences to close at twenty years and exhibits a steady continuous progress until thirty-two when union has reached the stage of 3.6. The age delimitation is therefore practically the same as for the endocranial aspect on which however union goes on to completion: it is not widely different from that in male Whites but the degree of closure is greater than upon the ectocranial face of the White skull.

Union in the verticis again appears first at twenty years. It progresses slowly to twenty-three when it has reached only 0.7. At twenty-four the graph stands at 1.5 and progress is rapid up to thirty-two when 3.3 is reached. Beyond this point no further real closure is attained. The slow progress as far as twenty-three is unrepresented on the endocranial face where union first appears at twenty-four but continues rapidly thereafter till complete closure is reached at thirty-one. On the ectocranial surface of the male White closure begins at twenty-one, continues slowly till twenty-five and rapidly from this age till the maximum of 2.7 is reached at twenty-nine.



MALE NEGRO ECTOCRANIAL

FIG. 1a. Ectocranial closure progress in the sutures of the vault. The years between twenty-six and thirty form the period of election for suture closure. The pars obelica of the sagittal has a pattern of its own. Coronal progress slightly precedes lambdoid. The coronal pattern differs somewhat from the endocranial pattern (Fig. 4).

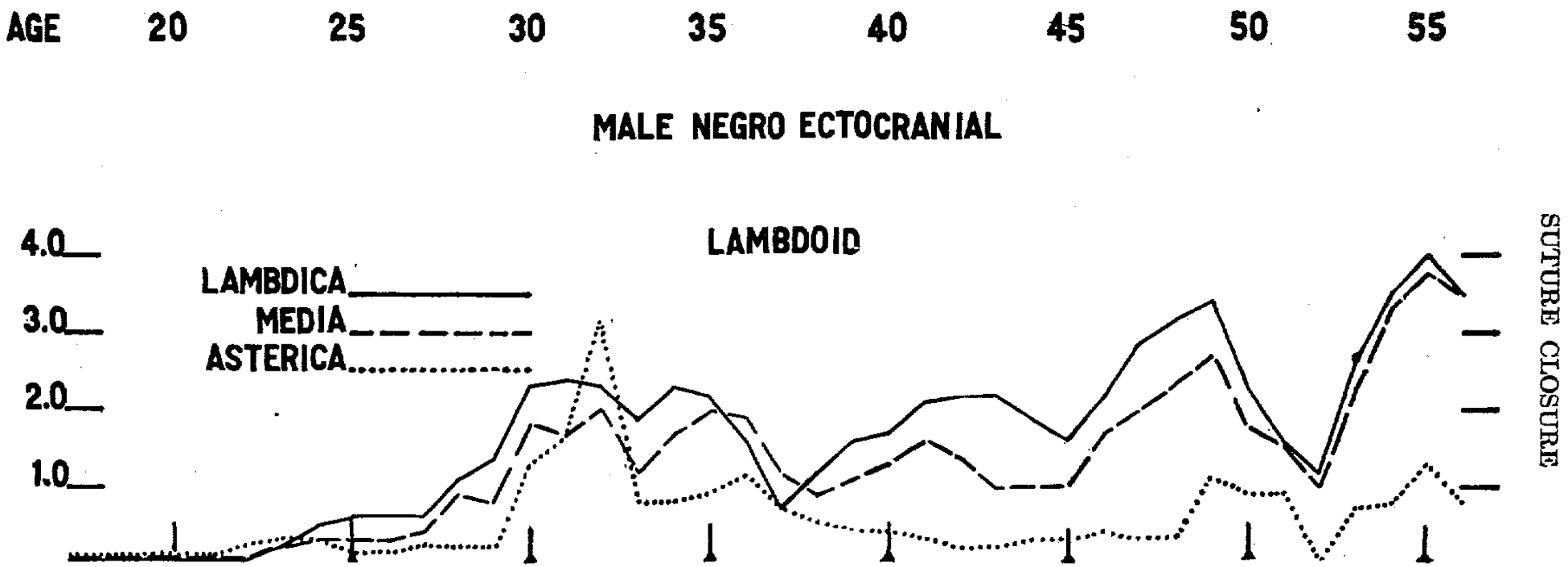


FIG. 1b. Ectocranial closure progress in the sutures of the vault. The years between twenty-six and thirty form the period of election for suture closure. The pars obelica of the sagittal has a pattern of its own Coronal progress slightly precedes lambdoid. The coronal pattern differs somewhat from the endocranial pattern (Fig. 4).

In the bregmatica as in the other parts union first occurs at twenty years. As in the verticis it is slow until twenty-three when the graph stands at 0.4. From twenty-four on to thirty-two closure continues more rapidly and reaches a maximum of 2.9 at the latter age. Here, as in the verticis, ectocranial closure commences earlier than endocranial union and reaches its phase of more rapid progress at a somewhat younger age. But whereas endocranial union is completed at thirty-one, ectocranial closure is never really complete, in spite of the fact that individual crania may exhibit absolute disappearance of the suture. In the male White skull ectocranial union of the bregmatica does not commence until twenty-six but the same maximum of 2.9 is attained already at twenty-nine.

Summing up all these observations we conclude that in the male Negro sagittal suture, closure commences earlier than on the endocranial aspect but that the maximum is attained about the same date in the early thirties. Closure is not so complete as on the endocranial surface. Comparing the ectocranial surfaces of White and Negro we find that union begins about the same age but that the maximum is lower for the White than for the Negro and is attained about three years earlier. Progress then is obviously about the same but is inhibited (or possibly prohibited) at an earlier stage in the White.

2. The Coronal Suture

(Fig. 1)

Endocranially we find that the coronal suture naturally divides itself into two parts, the pars pterica standing alone and the other two parts being associated together. No such distinction is to be found on the ectocranial aspect. In this respect ectocranial closure is strictly in accordance with the closure pattern discovered in the White. It has been held, largely upon the basis of closure in this suture, that complexity in appearance of a suture has a definite relation to age and speed of union. We have been unable to discern any difference in age or rate of closure dependant upon character of suture.

The bregmatica begins to unite at twenty-four, the complicata at twenty-two. In both union progresses with increasing speed until thirty-two when the former stands at 2.4 and the latter at 1.7. Thus both commencement and cessation of union on the ectocranial surface are somewhat in advance of corresponding stages on the endocranial face. It is true however that endocranial union progresses very little and quite slowly after thirty-two. In the White skull union starts in

both parts at twenty-six and the graph becomes oscillatory after twenty-nine, at which age the bregmatica stands at 2.3 and the complicata at 0.9. Union, therefore reaches about the same degree in the bregmatica of Whites and Negroes but the complicata progresses a little further in Negroes.

The pars pterica comences to unite at twenty-one and proceeds quite slowly until twenty-four when it reaches 0.4. Then the characteristic acceleration sets in and closure has reached 1.8 by twenty-seven. Slackening somewhat in pace it continues to 2.8 at thirty-five and becomes erratic thereafter. Commencement of union is distinctly earlier upon the ectocranial face and cessation is much earlier than on the endocranial aspect. Compared with the outer surface of the White however the start takes place about the same date and eventually union does not progress so far. There is then no very significant conclusion to be drawn from the fluctuant character of union in the coronal suture.

3. The Lambdoid Suture

(Fig. 1)

In the lambdoid suture there is again no distinction between the pars asterica on the one hand and the upper portion of the suture on the other. There is a distinct tendency in Negro skulls for this suture to exhibit lapsed union but these individuals have all been culled out together as aberrant. In the remaining series union commences in the lambdica and media at twenty-three and in the asterica at twenty-two. Progress is slow till twenty-seven in the lambdica and media. At this age it has reached 0.6 in the former and 0.4 in the latter. Closure is then more rapid and in the lambdica has attained 2.4 by thirty-one, in the media 2.0 by thirty-two years. In the asterica union is slow till twenty-nine when it has reached only 0.2. There is a spurious rise on the graph to 3.1 at thirty-two but closure never really gets beyond 1.0. Actually then the rise of the curve in the early twenties is sporadic and may be discounted: the real progress is in the later twenties and early thirties. Closure then is quite comparable in its development on both faces of the cranium but on the ectocranial aspect it is inhibited after thirty-two years.

If the ectocranial figures for the White skull be consulted it will be found that they are practically identical with those just set forth for the Negro. We find ourselves unable to confirm the assertion made by earlier workers to the effect that modal union in the lambdoid suture is really later in the Negro than in the White. We believe that such differences as may be perceived in an uncritical survey of samples of the two Stocks result entirely from individual variability.

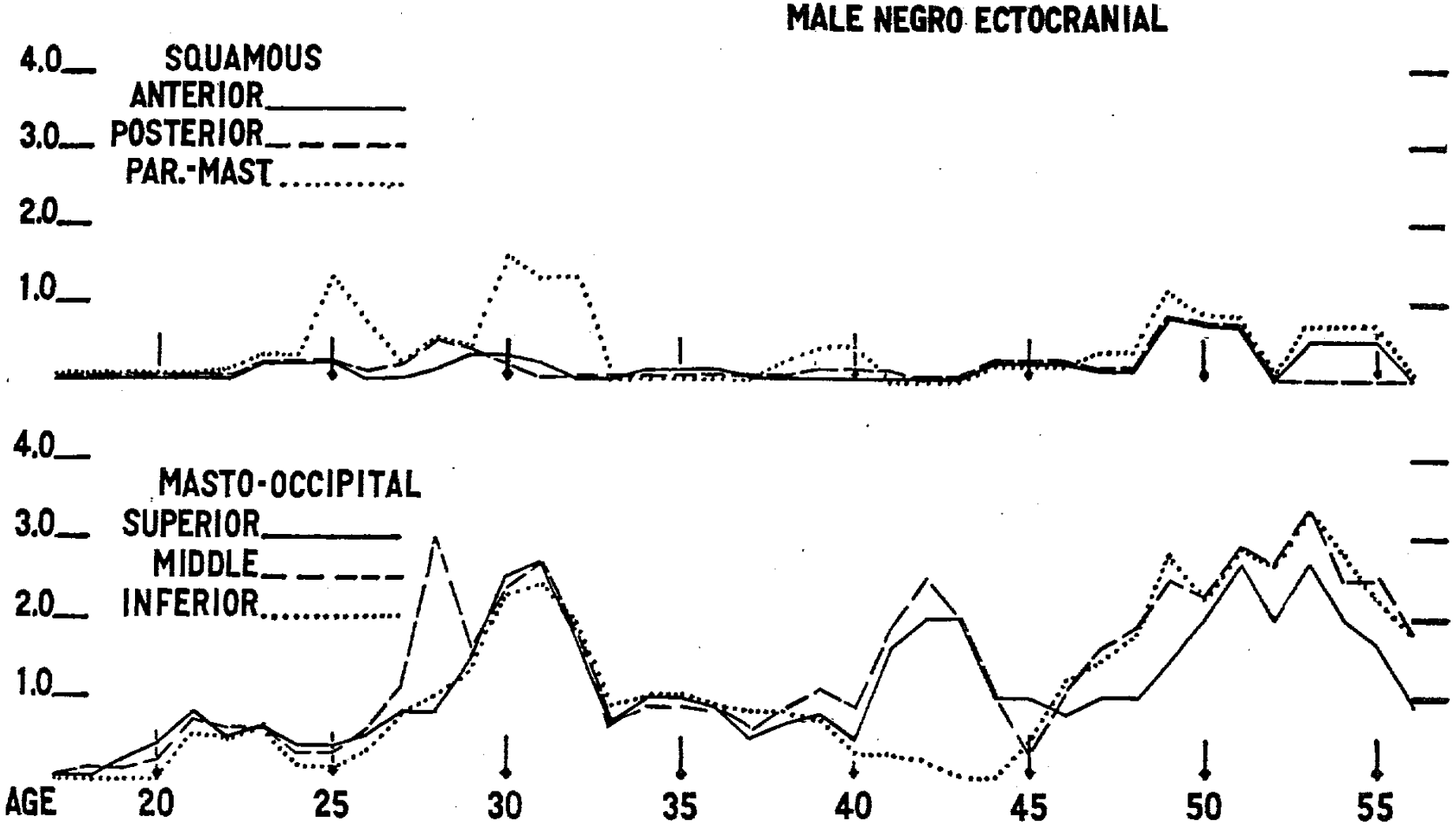


FIG. 2a. Ectocranial closure progress in the circum-meatal and accessory sutures. Progress in all these except the orbital spheno-frontal and masto-occipital is obviously different from that of the vault sutures. The patterns of the inferior masto-occipital and of the spheno-frontal differ from the corresponding endocranial patterns (Fig. 6, 7). Evidence of a subsidiary period of activity appears in these sutures about fifty. Lapsed union is characteristic of all ectocranial sutures.

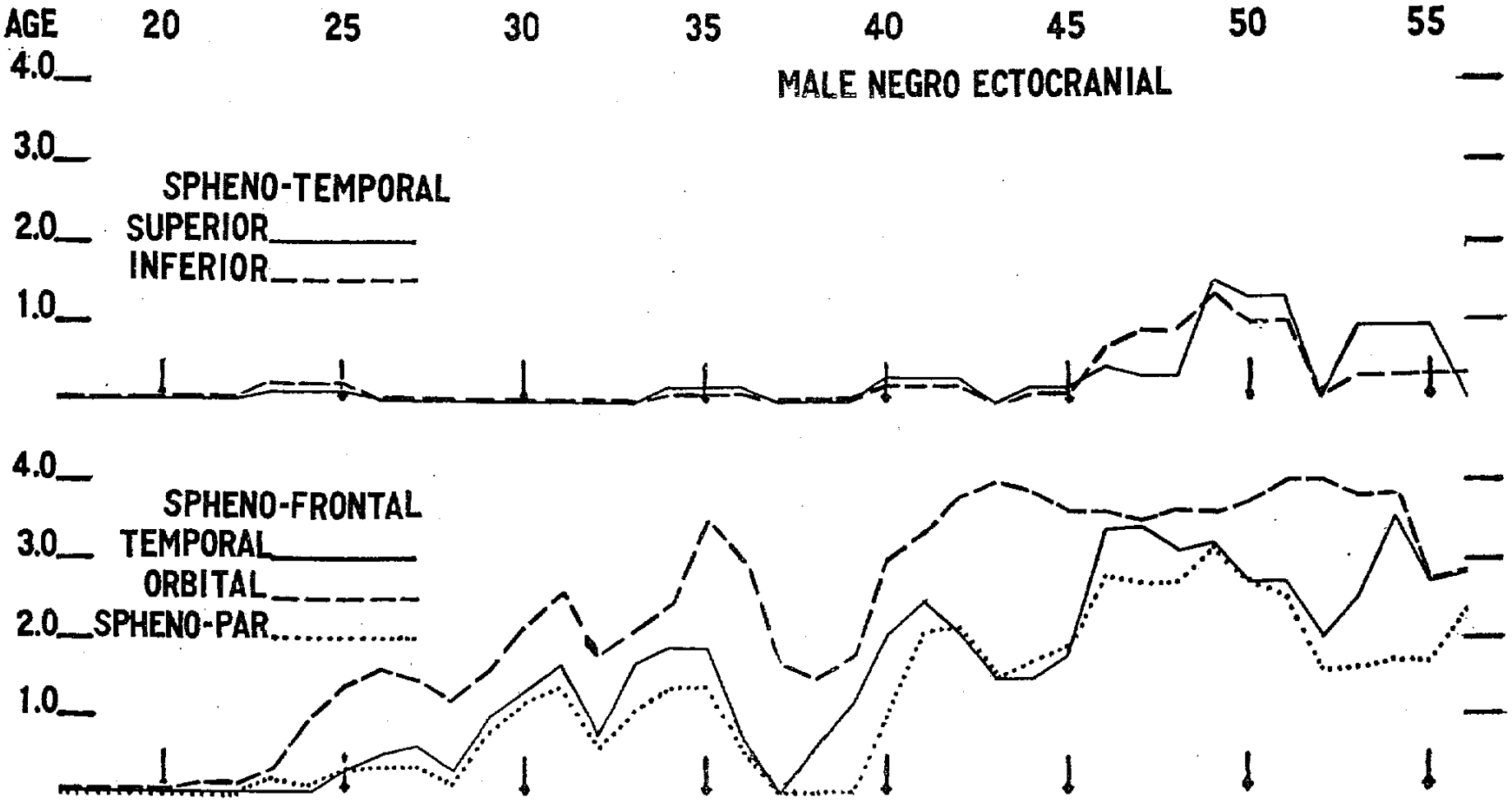


FIG. 2b. Ectocranial closure progress in the circum-meatal and accessory sutures. Progress in all these except the orbital spheno-frontal and masto-occipital is obviously different from that of the vault sutures. The patterns of the inferior masto-occipital and of the spheno-frontal differ from the corresponding endocranial patterns (Fig. 6, 7). Evidence of a subsidiary period of activity appears in these sutures about fifty. Lapsed union is characteristic of all ectocranial sutures.

THE CIRCUM-MEATAL SUTURES

In the White skull emancipation from the usual mammalian pattern of suture closure is clearly marked on the endocranial aspect and in more obscure fashion on the outer face. Ectocranial union in Whites commences in the masto-occipital suture alone during the supreme period of suture-closure activity, namely between twenty-six and thirty years.

This significant delay is not apparent upon superficial examination of either the ectocranial or endocranial surface of individual Negro skulls. A closer study of a sample shows that it is characteristic also of this Stock: it is masked by the determined effort at early union which however succeeds only in the masto-occipital suture. This successful attempt at closure in the masto-occipital precludes one from laying any stress upon the suggestion given by the lambdoid of many individuals that there is a real delay in union of the sutures in the occipital part of the Negro cranium. Were the Negro skull striving to open out in the occipital part some conformity might be confidently expected in the closure patterns of masto-occipital and lambdoid sutures. Critical examination proves that there is none. Of course the evident lapsed union in the lambdoid suture of so many Negroes calls for explanation. So far this has eluded us but the marked individual variation suggests some existing instability or change.

Apart from the masto-occipital other sutures of this group make merely a faint effort at closure before the secondary period of activity at about fifty years.

1. The Masto-Occipital Suture

(Fig. 2)

Extremely early commencement of union of the masto-occipital suture is characteristic of the outer face as it is of the endocranial aspect, but it is spurious in nature and real union only takes place in the later twenties.

In the pars superior closure starts at nineteen years but has reached no more than 0.8 at twenty-eight. From this age to thirty-one union is rapid and at the latter age stands at 2.7 beyond which no further real progress takes place.

In the pars media the first sign of union appears at eighteen and again proceeds very lethargically until twenty-six when it has reached 0.6. There is a spurious rise at twenty-eight but, as in the pars superior union reaches its maximum at thirty-one when it also attains the figure 2.7. In later years the graph shows merely oscillations.

In these two parts of the suture ectocranial closure follows closely the pattern of endocranial union but ceases earlier and does not progress so far.

Comparison with ectocranial union in the White skull reveals no really significant difference. Actually the similarity is quite striking but final union is greater in the Negro.

Our graphs for the Negro do not carry us with confidence beyond fifty-five years but there does seem to be indication in the masto-occipital suture of a secondary period of activity at about fifty years.

In the pars inferior union starts at twenty-one and proceeds slowly until twenty-six when the graph stands at 0.3. After this there is a steady rise to 2.5 at thirty-one beyond which once more progress is oscillatory except for the secondary activity at about fifty years. Commencement is several years later than on the endocranial aspect and there is no distinction between the closure pattern of this part and those of the other portions of the suture as there is on the inner face.

Compared with the White skull we find again a striking similarity of pattern. In both Stocks the graphs of all three parts of the suture follow a very uniform course. The acceleration and final greater degree of union of the inferior part so characteristic of the endocranial face of both Stocks is entirely absent on the outer face.

2. The Spheno-Temporal Suture

(Fig. 2)

Regarding closure of both superior and inferior parts of the spheno-temporal suture there is extremely little to say. Sporadic rises of the graph occur from time to time but there is no real activity until about fifty years and the actuality of activity even then is doubtful. Probably this suture does not close at all.

There is a pronounced attempt at closure on the endocranial aspect in the fifth decade, affecting the inferior portion more than the superior. In this suture the closure influence clearly operates from the inner surface.

In the White skull also there is very little attempt at union ectocranially and what there is scarcely makes its appearance until late in life. The endocranial aspect however resembles the inner face of the Negro skull in attaining a greater and earlier degree of closure.

3. The Squamous Suture

(Fig. 2)

The squamous suture resembles the spheno-temporal in exhibiting merely sporadic attempts at union. While efforts are made in both

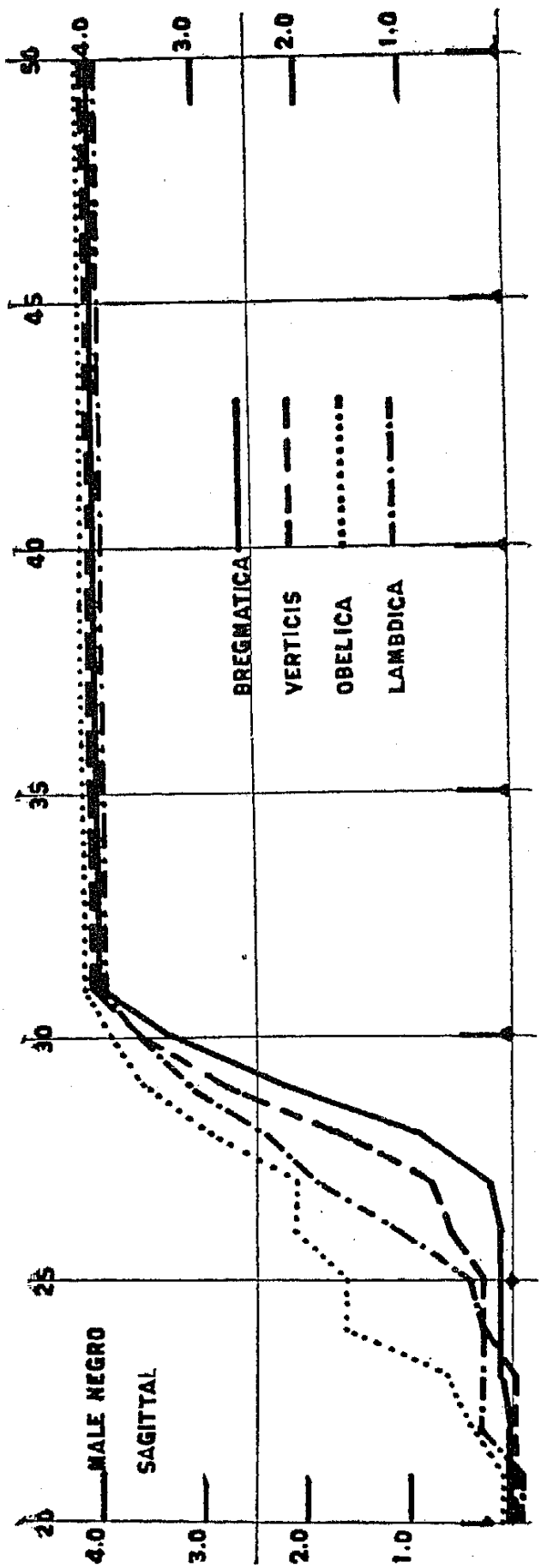


FIG. 3. This and the succeeding four figures of endocranial closure are inserted for comparison. Closure pattern on the endocranial aspect of the sagittal suture. Note the obelica.

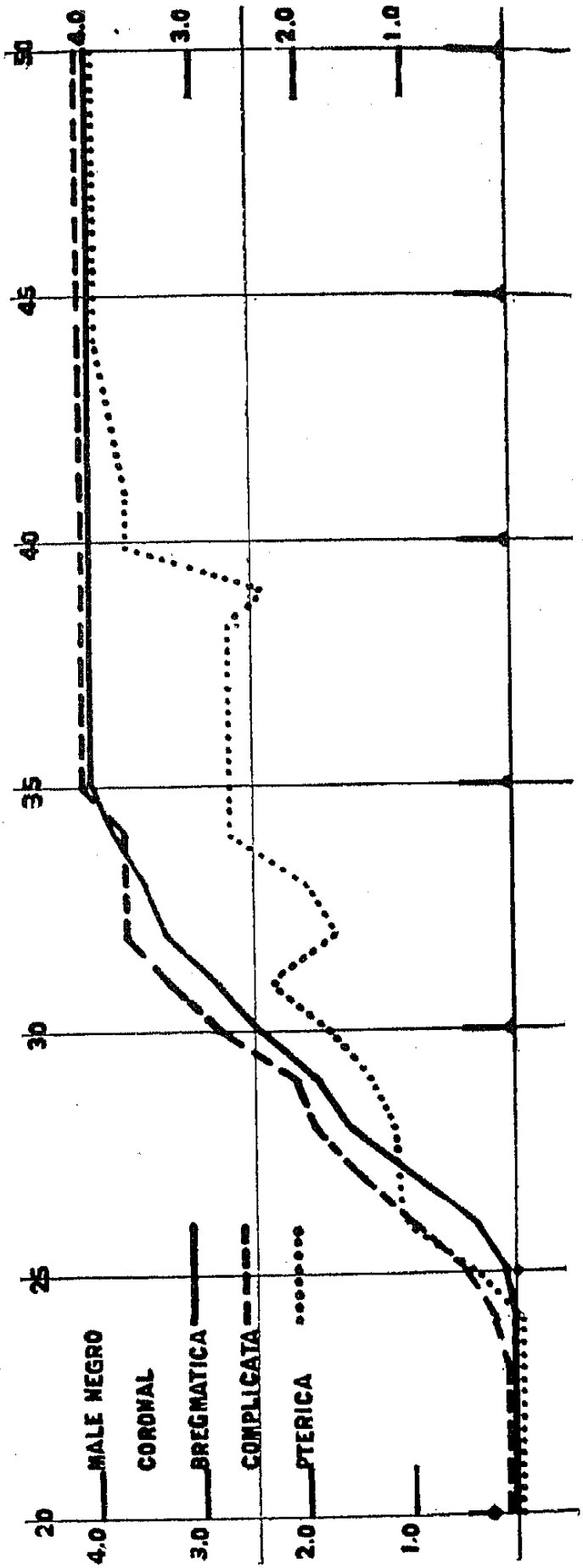


FIG. 4. Endocranial closure progress in the coronal suture.

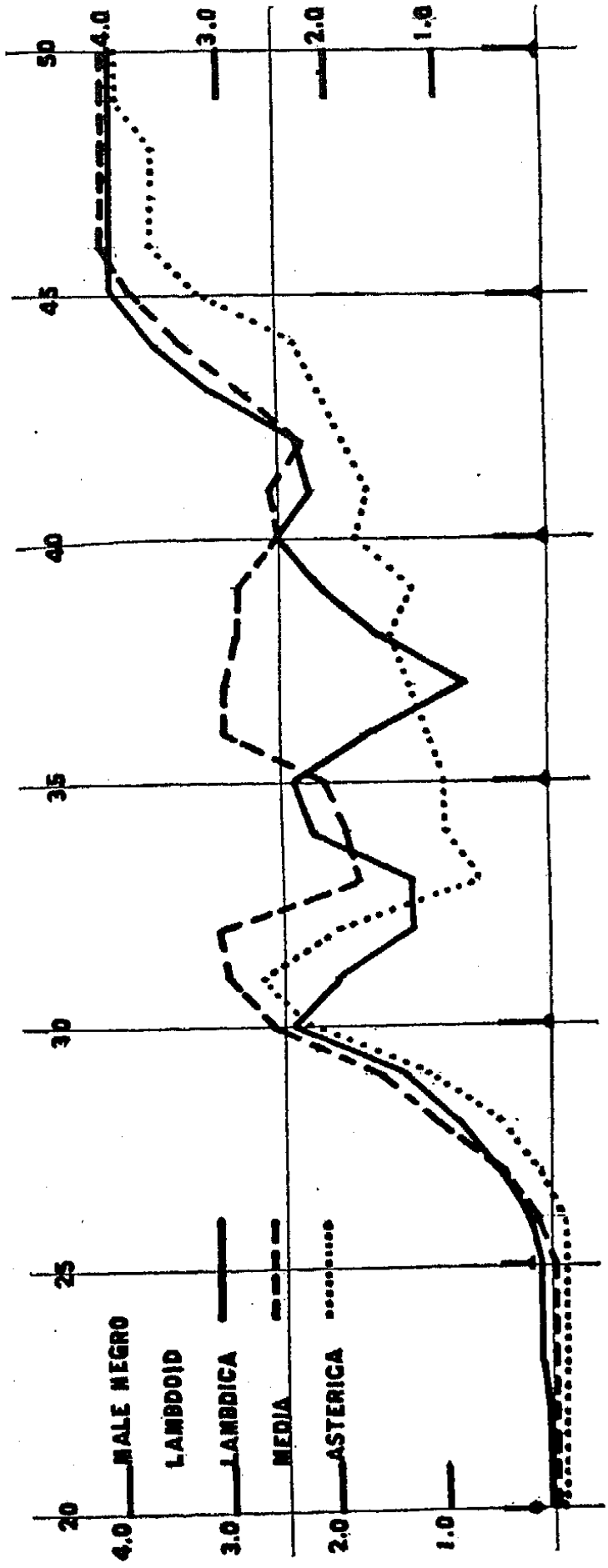


FIG. 5. Endocranial closure progress in the lambdoid suture.

sutures at the age of twenty-three there is nothing noteworthy until fifty years. In the squamous suture this late union is more than a little doubtful. Probably this suture also never closes. The early attempt accords well with the similar early attempt at the same age on the inner face but it is of no significance except to mark a survival of the typical mammalian date of closure. The squamous suture in the White skull presents a quite comparable ectocranial closure pattern.

4. The Parieto-Mastoid Suture
(Fig. 2)

The closure pattern of the parieto-mastoid suture closely resembles that of the squamous suture of which it is the continuation. The sporadic attempt at twenty-two is not kept up, despite the spurious rises at about twenty-five and thirty years. It never really closes much beyond 0.5. This is not nearly so great as on the endocranial aspect where however closure does not really amount to much until after fifty years. Any differences from the graph of the White skull are probably due merely to random sampling.

THE ACCESSORY SUTURES

As in the White skull the closure patterns of the spheno-parietal and the temporal part of the spheno-frontal sutures run a parallel course. The orbital part of the spheno-frontal pursues a course of its own. This scheme differs considerably from that presented by these sutures on the endocranial aspect of the skull. In both White and Negro series, on this face the two parts of the spheno-frontal suture follow a common closure pattern and the spheno-parietal has an independent course. The explanation is found in the fact that inner and outer aspects of the spheno-frontal suture are not at all comparable and should not therefore be contrasted at all. On the other hand we are justified in comparing the ectocranial patterns of White and Negro Stocks, and as we might expect, we find them strikingly similar.

1. THE SPHENO-PARIETAL SUTURE (FIG. 2)

Union in the spheno-parietal suture commences at twenty-three years and follows closely the pattern of the temporal part of the spheno-frontal. There is practically no progress until twenty-eight and then a rapid rise to 1.4 at thirty-one. Following the curve of the temporal spheno-frontal the stage of 2.8 is reached at forty-six but only after many oscillations and these oscillations continue during later life.

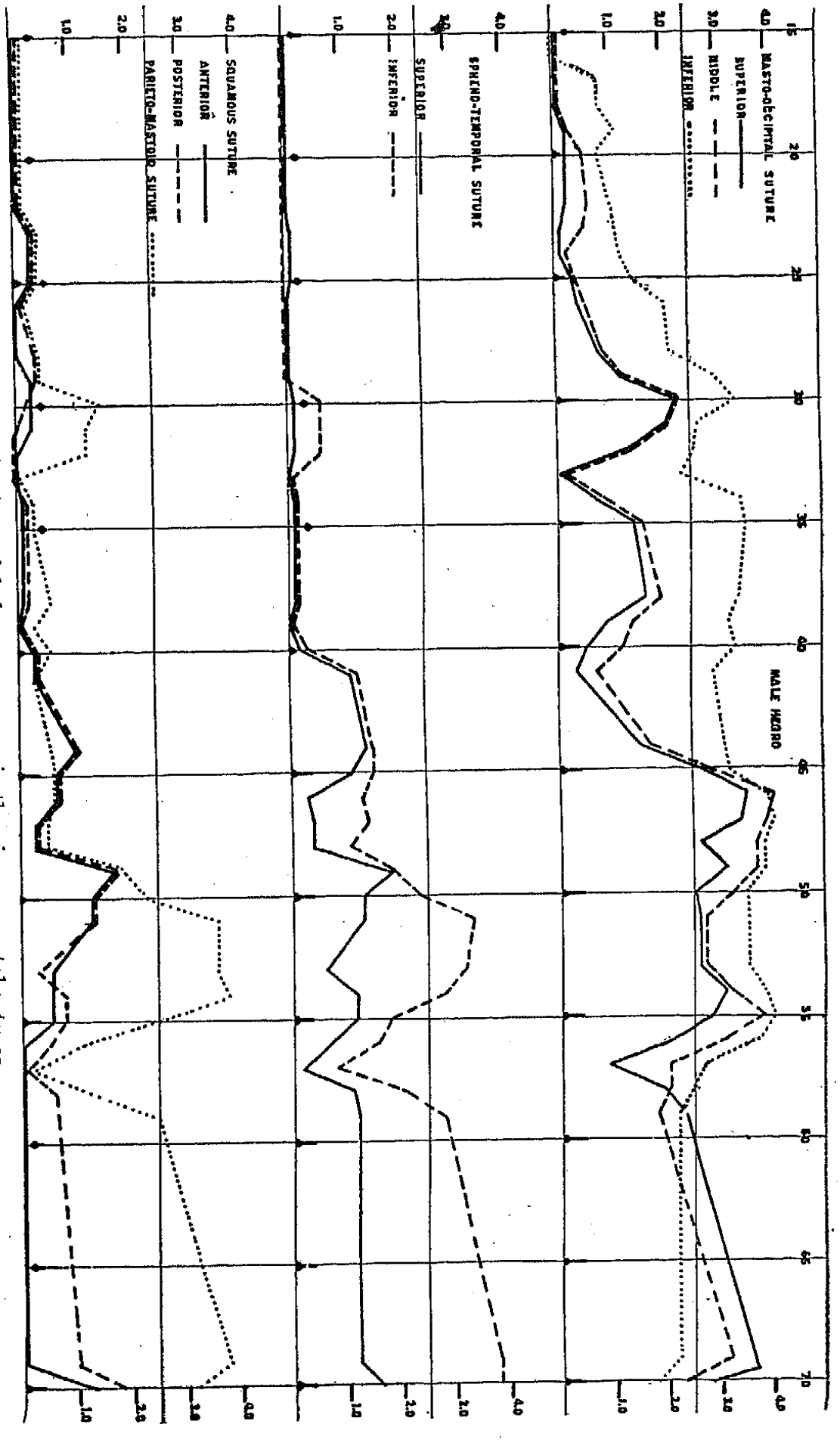


FIG. 6. Endocranial closure progress in the circum-meatal sutures.

2. THE SPHENO-FRONTAL SUTURE (FIG. 2)

The orbital part of the spheno-frontal pursues a course not greatly differing from that of a suture of the vault. This is probably due to the fact that, like the vault sutures, emancipation from the typical mammalian pattern is not so pronounced as in the other parts of the accessory sutures. The temporal part on the contrary, like the spheno-parietal suture, more closely resembles in its course the masto-occipital. As these sutures mark somewhat comparable extremes of the circummeatal complex this similarity in closure pattern is to be expected.

The orbital part commences to unite at twenty-one and there is a steady rise to 2.6 at thirty-one and to 3.5 at thirty-five. Complete closure is attained at forty-three and sporadically thereafter.

The pars temporalis shows union first at twenty-five and exhibits a steady rise to 1.9 at thirty-five. It reaches 3.4 at forty-six and beyond this it does not progress.

Both parts of the suture exhibit a markedly oscillatory course and in this they resemble the White pattern but are somewhat more erratic. The orbital part in the White skull rises to 2.3 at thirty-one and finally to 3.8 at forty-six years. The temporal part also commences to close at twenty-eight and though progress is slow at first the curve rises to 2.1 at thirty-eight with slow oscillatory progress thereafter. The similarity of pattern in White and Negro Stocks is therefore quite as striking as in other areas of the cranial suture complex

CONCLUSIONS

In discussion of the Negro endocranial sutures we have dealt fully with the method of combing our material. We have mentioned that minor variabilities, not great enough to cause exclusion of the skull from our series, but still large enough to produce marked irregularity in the graphs, are also more frequent in the Negro series. We have not considered it worth while to carry the graphs further than fifty-five years because of the relatively small number of skulls in our collection beyond sixty years of age.

When a comparison is made between Negro ectocranial closure and Negro endocranial union we find that the period of election from twenty-six to thirty years is marked on both surfaces of the cranium by vigorous progress in union of the vault sutures. Shortly after thirty years there is pronounced slowing of the pace on the endocranial aspect and an inhibition so effective on the outer face that little or no further progress takes place. As in the White the coronal suture exhibits an inversion of closure order, the pars pterica taking the lead on the outer face

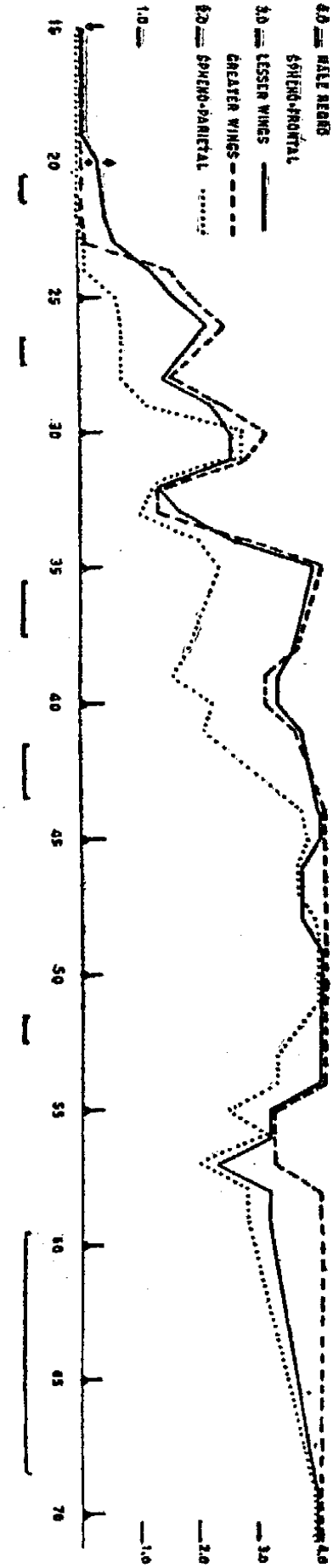


FIG. 7. Endocranial closure progress in the accessory sutures.

whereas it lags behind on the inner surface. The entire lambdoid on the ectocranial aspect is very lethargic in closing and its pars asterica has almost entirely lost the ability to close at all. This is of course a form of lapsed union and represents an extreme type of human emancipation from the mammalian time table of suture union. It is this peculiarity of the ectocranial lambdoid the superficial study of which uncorrected by investigation of the inner face, led Gratiolet and others into the extraordinary and thoroughly baseless view of a difference in closure order between Negroes and Whites. During the period of election the coronal maintains a slight lead over the lambdoid in its closure, precisely as in Whites.

In the circum-meatal and accessory sutures we find a fairly close resemblance to the vault pattern in the orbital part of the spheno-frontal and to a much less extent in the masto-occipital, the spheno-parietal and the temporal part of the spheno-frontal. On the other hand the squamous, parieto-mastoid and spheno-temporal sutures probably do not close at all on the ectocranial aspect. There are therefore the same stages in emancipation in the outer face of the Negro skull as on the inner face, most pronounced emancipation in the squamous suture and less complete emancipation the further one progresses away from this suture as a focus along the circum-meatal and accessory groups and the asterica of the lambdoid.

The significant difference between the ectocranial and endocranial patterns of the spheno-frontal suture has already been emphasized; they are not really comparable at all.

TABLE I. CRANIAL SUTURES—MALE NEGRO ECTOCRANIAL CLOSURE.

Suture	Commencement and course	Termination (or peak)	
Sagittal	20 slowly to 24	32	4.0 in obelica alone 2.9–3.6 in general
Spheno-frontal orbital	21	35 at 3.5	May reach 4.0 at 43
Spheno-frontal temporal	25	46 at 3.4	1.9 at 35
Coronal 1 and 2	22–24	32	Bregmatica at 2.4 Complicata at 1.7
Coronal 3	25	35 at 2.8	Spurious rise at 21
Lambdoid 1 and 2	23 (27)	31–32	Lambdica 2.4 Media 2.0
Lambdoid 3	22 (29)	?31	not more than 1.0
Masto-occipital 3	26	31 at 2.5	Spurious rise at 21 secondary activity ca 50
Spheno-parietal	28	46 at 2.8	1.4 at 31
Spheno-temporal 2	ca 50?	None	Probably never closes
Spheno-temporal 1	ca 50?	None	probably never closes
Masto-occipital 1 and 2.	26–28	31 at 2.7	Spurious rise ca 18 secondary activity ca 50
Parieto-mastoid	ca 50?	None	probably never closes
Squamous posterior	ca 50?	None	probably never closes
Squamous anterior	ca 50?	None	probably never closes

TABLE II. CRANIAL SUTURES—MALE WHITE ECTOCRANIAL CLOSURE

Suture	Commencement and course	Termination (or peak)	
Sagittal	20 slowly to 26	29	3.9 in obelica alone 2.4–2.9 in general
Spheno-frontal orbital	28	46 at 3.8	2.3 at 31
Spheno-frontal temporal	28	38 at 2.1	may reach 4.0 in old age
Coronal 1 and 2	26	29	Bregmatica at 2.3 Complicata at 0.9
Coronal 3	28	50 at 3.8	Spurious rise at 22
Lambdoid 1 and 2	26	30	Spurious rise at 21 Lambdica 2.3 Media 1.9
Lambdoid 3	26	?30	not more than 1.0
Masto-occipital 3	26	33 at 1.4	may reach 4.0 in old age
Spheno-parietal	28	38 at 2.0	0.5 at 31: continues to old age
Spheno-temporal 2	36	?65	probably never closes
Spheno-temporal 1	37	?65	probably never closes
Masto-occipital 1 and 2.	28	32 at 0.8–1.0	may reach 3.5 in old age
Parieto-mastoid	39	?64	probably never closes
Squamous posterior	38	?65	probably never closes
Squamous anterior	38	?65	probably never closes

In comparing Negro and White patterns on the ectocranial face we find that, in the vault sutures, when one has discounted the difference in total numbers, there is strikingly little discrepancy. In the Negro the graphs of the several parts of any suture tend to run more closely together than in the White and the same slight lead of the coronal over the lambdoid is maintained. The insignificant differences found on the endocranial surface between spheno-temporal, spheno-parietal and masto occipital of Whites and Negroes are not apparent on the outer face. Indeed one would have great difficulty in determining, did one not already know, to which Stock any particular graph refers.

SUMMARY

1. Suture closure in the Negro, as in the White, makes its appearance on both faces of the cranium at one and the same date. There is no significance in such slight differences as occur except in the coronal. The reason for accelerated progress in the pterica of the coronal on the outer surface and its lagging behind endocranially is not yet yet apparent.

2. Ectocranial closure is more erratic, slower and less complete than endocranial union.

3. Lapsed union is very characteristic of all ectocranial sutures though it does not present itself in all individuals.

4. The period of election for suture closure is twenty-six to thirty years just as on the endocranial face. There is evidence however of secondary periods of activity, one about fifty years.

5. Ectocranial closure patterns are the same for both faces of the cranium, allowing for the limitations mentioned above, except in the coronal suture and in the spheno-frontal suture. The appearances of the latter suture upon outer and inner faces of the cranium should not be compared.

6. We repeat that there is one modal of type of human suture closure upon outer and inner faces of the cranium, common to White and Negro Stocks, and that human emancipation from the mammalian type of closure is focussed upon the squamous and its subsidiary sutures and upon the lambdoid.

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