
The Scheel Letters, No. 50

West African Rivulins: *Epiplatys sheljuzhkoi* Poll 1953; Draft (Aquarium Journal)

In the previous article on *Epiplatys dageti* we tried to encircle the West African Rivulins that could be considered to be identical with *Haplochilus chaperi* as described by Sauvage in 1882. We attempted to prove that *Epiplatys dageti* Poll 1953 and in particular the variant known as Epiplatys "chaperi" had to be acquitted of being identical with Sauvage's species. We also expressed some suspicion that *Epiplatys sheljuzhkoi* Poll 1953 maybe could be the one that we were searching for.

There are reasons, however, also to acquit *E. sheljuzhkoi*, at least provisionally. The best defense that *E. sheljuzkhoi* is able to lay out is its number of dorsal rays. Whereas Sauvage's species, according to the description, has D 7/A 15, *E. sheljukhoi* has D 11/ A 16, according to the description, and D 11-12/A 15-18, according to our measurements. This means that for the present we are not able to identify any Rivulin known from southern Ivory Coast and Ghana with Sauvage's species. The type material first should be inspected.

Even though *E. sheljuzkhoi* was not described as a zoological species until 1953, preserved individuals belonging to this species had been present in the collections of museums. The British Museum in London, for instance, possesses a big collection of specimens collected at various localities in Ghana. We have examined all these individuals and found that they all belong to Poll's species and not to Epiplatys sexfasciatus Gill as was hitherto supposed. *E. sexfasciatus*, from all appearances, does not extend its distribution to the west of the rainforests bordering the frontier between Dahomey and Nigeria. It was unable to pass through the dry landscape which extends southwards from the northern savannas of West Africa and which reaches the coast in Dahomey and Togo.

The similarity of these two Epiplatys is very pronounced so we had to prepare crossings to clear up the affinities. The hybrids were more or less viable, but as they also were functionally sterile, we might consider *E. sheljuzhkoi* and *E. sexfasciatus* as two distinct species.

It is, however, very easy to distinguish between these species when microscopical examination is directed towards the side line pores of the head. This method will soon be published in a zoological paper by Stenholt Clausen, and, as it is not suited for aquarist use, we will try to define the species from other points of view.

Towards the east, *E. sheljuzhkoi* probably extends its range as far as the forests, that is, to the mountains at the frontier between Togo and Ghana. We recently had preserved material from that part of Ghana. To the north, it seems as if the extension follows the border of the forest. In the central part of Ivory Coast, the forest line steeply turns off towards the south because a wedge of savanna pushes forward deep into the forest. Centered in the northern part of this wedge, the city of Bouake is situated. From this locality, in 1960, Arnoult described his Epiplatys spillmanni which at some localities lived in swamps with acidic and very brown water. On the basis of the description we are unable to separate this species from neither Epiplatys sheljuzhkoi Poll nor from Epiplatys dageti Poll. We consider it to be most likely that this species represents one of the many variations inside *E. sheljuzhkoi*.

The extension of *E. sheljuzhkoi* towards the west is not known at present. Reliable reports west of Abidjan do not exist. There are however several reports of the occurrrence of both *E. sexfasciatus* and *E. ansorgei* in western Ivory Coast and in the forest more westwards. As we do not believe that neither *E. sexfasciatus* nor *E. ansorgei* exist west of Dahomey, these reports may cover other Epiplatys or Aphyosemion, known to exist in the western part of the Guinean rainforest. The preserved material on which these reports have been based have to be examined first. At present, we are only able to control one report. In 1936, E. Roloff from Karlsruhe collected specimens of a Rivulin at Kissy, near Freetown in Sierra Leone. These specimens were described as Epiplatys sexfasciatus leonensis by Ahl in 1937. During his stay in Sierra Leone in 1962 Roloff again collected specimens of this form near the type locality and kindly sent us live and preserved material. Ahl's subspecies was soon found to be identical with the true Epiplatys fasciolatus Guenther.

The material on which Poll based his description of Epiplatys sheljuzhkoi in 1953 was collected by Dr. L. Sheljuzhko. This was the same expedition where he also collected the material on which the description of *E. dageti* was based. The collector wrote that, in his collection area, *E. sheljuzhkoi* was abundant and was discovered in most localities. From Abidjan, which is the type locality, and up to a distance of approximately 50 miles north of this city, the species was found to live under various ecological conditions. The live material, when distributed in Germany first was named *E. macrostigma*. Roloff however sent individuals to Dr. M. Poll who in 1953 described the form as *E. sheljuzhkoi*. For our research on this species Dr. Poll kindly lend us preserved specimens.

Our material of live specimens originated from 4 populations from SW Ghana collected by H.S. Clausen in 1962 and one population from Central Ghana collected by Ulf Hannerz in 1963. The westernmost population derived from a locality near Tikawbo near the coast. The next population was found approximately midway between Cape Three Points and Half Assinie at a place called Aiyenasi, approximately 4 miles from the coast. One population lived in the rainforest (80-85 inches of rain) on tertiary sediments, in clear brown water with electrical conductivity of 23 rec. megohms (very much like distilled water) with soap hardness of only 0.5 German degrees and a pH approximately at 5. The water of the second population measured 27 reciprocal megohms. Both localities are situated within a part of the SW Ghana rainforest which most probably has supported tropical rainforest during the last one million years. The soil of this area is highly leaked and belongs to the type of soil named oxysols. The surface layer of this soil is very acidic and has a pH of 4.0-4.5, however on the tertiary sediments the pH of 3.5-4.0 is more common. The pH increases when one analyses the deeper layer of soil and reaches approximately pH 5.2 at a depth of six feet. Together with the specimens of *E. sheljuzhkoi*, also

specimens of Afronandus sheljuzhkoi and a Micropanchax were collected. These two populations of Epiplatys sheljuzhkoi apparently are very close to Poll's types in every visible respect.

Further towards the east, individuals from two populations were collected around Angona, some 10 miles north of Cape Three Points. These specimens are very much like the type material from Abidjan when the counts and measurements are compared, but they differ markedly in coloration and in color patterns. Both populations were taken in rainforest (approximately 75 inches of rain per year), on parent rock covered by a soil belonging to the oxysol-ochrsol type that is less acidic and less leached than the pure oxysol. The water measured 80-100 rec. megohms, soap hardness was 1.5 German degrees and the pH approximately 6.1. Epiplatys sheljuzhkoi lived in brooks and small swamps at these localities. Here and there precipitations of iron at the bottom could be seen.

Ulf collected his live material near Kumasi approximately 100 miles from the coast and inside the Ashanti forests. This forest is called the moist semi-deciduous forest type and stands on a soil of the ochrosol type. This soil has a pH of 5.5-7.0 and at the surface but at a depth of 6 feet the pH measures approximately 5.2, approaching the same pH which also was measured at that depth inside oxysols. The annual rainfall is approximately 60 inches in this area and the length of the dry season is greater. This area probably is not able to support a tropical rainforest during the arid periods which are known to occur in this part of Africa in connection with the glacial and interglacial periods of Europe. The Kumasi population differs in coloration and in color patterns from the populations previously mentioned.

A fourth form we only know from color and black/white photos sent to us by Dr. W. Foersch in 1960. This strain was imported into Germany in 1960 together with Epiplatys bifasciatus and Fundulosoma walkeri and derived from Ghana. A few notes on this importation were published in the DATZ 1960 by Meinken. As we do not know the locality of this form here we call it "1960" strain.

These six populations of *E. sheljzhkoi* divide into four variations of the *E. sheljuzhkoi* phenotype that may or may not represent geographical units or subspecies. The differences between the four strains however are only found in the coloration and in the pattern of dark crossbars on body sides.

Juveniles of *E. sheljuhkoi* all develop black crossbars on body sides. The number of such bars differs somewhat from one population to another but it is rather constant in a certain population, apart from the Kumasi population which is variable in this respect. The females retain these dark crossbars also after maturing. When frightened or sometimes also during spawnings the bars may disappear more or less. The males normally loose their crossbars after maturing. This feature is often seen within Epiplatys more or less markedly, but in *E. sheljuzhkoi* we find perhaps the most complete loss of male's crossbars. No wonder that Poll, in the description of this species, wrote that the male had no dark crossbars at all. If two ripe males are placed together in a tank we soon will realize that the crossbars still are present. These males very soon will fight each other and during the fight the crossbars are very conspicuous indeed and just as marked as those of the females. During spawning the male does not show its crossbars at all. Females as usual in this genus tend to double their black crossbars. The tendency to double crossbars is very much as within *E. sexfasciatus* and far below that of some populations of *E. dageti*.

A dark longitudinal band, from the gill covers to the root of the caudal fin, may develop on both sexes, in

particular if the individual is suddenly taken from one tank and placed into another. Such bands may occur also on spawning females that however normally do not loose their crossbars when the longitudinal band is visible. It seems as if the common system of spawning signals (crossbars contra longitudinal band) is less developed within this species if we compare it with such species as *E. senegalensis* and *E. longiventralis*.

Individuals of *E. sexfasciatus* may show what may be called a "reversed system of crossbars". When colored like this, the individual shows light crossbars on a dark background of body colors. This color system is linked to the night coloring and appears when one suddenly puts light on a dark tank containing these fishes. After a few minutes this color pattern fades away and may reverse into the normal system of dark crossbars on a light background of body colors. This odd color pattern also has been seen on a single individual of *E. sheljuzhkoi*. The dark ground color of this male reached the gill covers and covered the hindmost part of this.

More dark pigmentations are seen on the throat and it is likely that these patterns represent "signals of approach". Very small juveniles of this species develop a narrow red line just behind the lower lip and following the line of small side-line pores. This red line is seen on all juvenile individuals of West African Rivulins so far inspected. Behind this red line very often red pigments are seen on the throat back to a line between the corners of the mouth. This pigmentation tends to concentrate to a narrow red line from one corner of the mouth to the other. On juvenile *E. sheljuzhkoi* these red pigmentations however are weakly developed. During maturing the red pigmentations are replaced or covered by black pigments. Primarily the dark pigmentation takes place on the area between the lower lip and the line between the corners of the mouth. On males, however, the area more backwards develops melanophores covering the whole throat and lower parts of the gill covers. The dark pigmentation of the anterior part of the throat often tends to split up into two dark bars across the throat, one behind the lower lip, the other one between the corners of the mouth. When the individual is not activated, there is no conspicuous difference between the throat pattern of the two sexes. During fight and spawning however the male changes its throat pattern by the way that the whole throat back to the posterior edge of the gill covers develops a uniform bluish black color, just the same "pattern" as mentioned for Aphyosemion cinnamomeum and which also is used by male Epiplatys senegalensis, *E. fasciolatus* and *Aphyosemion australe*. During spawning the female to some extend transforms its throat pattern by the way that the whole area in front of the line between the corners of the mouth develops a more or less uniform very dark color, whereas the posterior part of the throat remains nearly uniformly white. Such temporary throat pattern signals seem to be very common among Old World Rivulins. Beside the species mentioned above, Aphyosemion roloffi and Aplocheilus dayi also use throat signals of this type. Fundamentally such signal patterns differ markedly from those developed by species like Epiplatys dageti, Aphyosemion nigerianum, etc. The systems of these species are permanent, they do not change their nature during fights and spawnings, and they permanently provide a conspicuous difference between the two sexes when seen from ahead.

We consider such color patterns not only to be of a certain interest to the aquarist, but also to possess a certain systematic value because probably several genes of inheritability are responsible for the development and the deciphering of such signals.

Mature specimens of *E. sheljuzhkoi* do not show any red pigmentation on the throat, however under the microscope one may or may not find traces of red pigments.

The dark crossbars on the body side seem to belong to just the same system which we find in Epiplatys sexfasciatus. The latter develop six dark crossbars normally, at least on juveniles and on young males. There are also one or two such bars on the head, but these are not considered here. The anterior bar develops just behind the pectorals and for this reason we use to call it the "P bar". The next bar sits over the root of the ventrals (more or less replaced) and is called the "V bar". The other four bars normally develop at equal intervals on the area between the first ray of the anal fin and the root of the caudal fin. These we call the "A bar". The P bar is present on the type female, on all individuals of the Tikawbo-Aiyenasi populations and is not present (normally) on individuals from the Abra-Angona, the Kumasi and the "1960" populations. However, among approximately 100 individuals of the Abra-Angona strain we have seen one individual (a male) that developed such bars on one side only. Among the offspring of this male no individual had such bars however. Also among individuals from the Kumasi population very rarely the P bar may develop on one side of the body. The V bar was present on one of the females that Poll lent us. It is normally present on individuals from the Kumasi population. In the first generations and the imported individuals from the Tikawbo-Aiyenasi populations not a single individual developed this bar, however in one strain from the offspring several individuals developed this bar. The Abra-Angona (and "1960") populations normally have neither a P nor a V bar on the body sides. Among the numerous offspring from the populations first mentioned there was a single male which developed one V bar. This male belongs to the offspring of the "single P bar male".

As we mentioned before, the females from the Kumasi strain tend to double their dark crossbars. The extra bars normally are A bars and they normally are not permanent but come and go according to the temper of the fish. Doubling of the crossbars rarely occurs on the females of the other populations. It does not seem that the doubling of crossbars has any meaning as signals exchanged between individuals of this species.

Dark pigments may develop along the free edges of males' fins. These pigmentations normally are not at all conspicuous as on many strains of *E. sexfasciatus* and in particular on male *E. dageti*. The pectorals also may develop a dark edge.

The metallic brilliance of the male differs markedly when different populations are considered. Males from the Abidjan populations and those from the Tikawbo-Aiyenasi populations develop a very strong brilliance not only on the whole area of the sides but also on the unpaired fins. Also the edge of the pectorals develops much brilliance. The color is bluish green when the fish is seen in incident light from above.

The "yellow" males of the Abra-Angona populations also may develop a strong brilliance that is lemon, probably caused by the strong development of yellow pigments within this strain. Males of the Kumasi, the "1960" and the "red" males of the Abra-Angona populations develop a very reduced brilliance probably because the various red and black pigments dominate and transform the color of the body and the fins into a red, or brown of very dark tinge. The Kumasi males have also an odd violet tinge on body and fins. The "1960" male has a weak brilliance on body sides whereas the fins are colored like the

Abidjan males.

The reason why the 1952-53 aquarium strain imported from Abidjan was named Epiplatys macrostigma seems to be based mostly on the development of red dots along male's body sides. The development of these red dots differs markedly from one population to another. The Abidjan, Tikawbo and Aiyenasi populations develop big rather rounded red dots on male's body sides. Towards the back the dots however tend to form red edges of the scales. The Abra-Angona males develop red dots that are less conspicuous and the tendency to form red scale edges on the back appears to be stronger. The red dots on males from Kumasi and the "1960" male are rather big and conspicuous, however the tendency for the development of red scale edges is much stronger than inside the other populations. The red dots are vertically oblong and the red reticulated pattern on the back is more perfect. These strains take in a position somewhat in between the Epiplatys that develop perfectly rounded red dots on body sides and those that develop a complete reticulated pattern produced by red scale edges. Such variations, but by far less developed, also exist in the populations of *E. sexfasciatus* from Nigeria.

The very conspicuous differences of the colors of the fins of males from different populations probably depend on the interaction of brilliance versus pigmentation. The strong brilliance of the Tikawbo-Aiyenasi males seems to be linked with the marked concentration of the pigment colors. On the body sides these pigments are concentrated mostly inside the big red dots that may or may not possess a black edge. In the fins the pigments seem to concentrate as narrow reddish black lines situated on the membrane between the fin rays. This concentration of pigments leaves open a large unpigmented area for the development of brilliance. However, these narrow red lines often break up into lines of red dots in particular in the dorsal fin (all populations) and inside the upper part of the caudal fin, or more rarely also in the lower part of this fin (Angona-Abra and "1960"). Only in the Tikawbo-Aiyenasi (and Abidjan) populations the red lines of the anal fin break up into red points and mostly only near the fin root and in the most posterior part of the fin. This breaking up of the red lines produces a marked effect as the rows of red dots are much more conspicuous than the unbroken red lines. Thus the pattern of the fins is changed markedly but the basis for this transformation only seems to be a minor change of the development of red pigments.

The fins of the Abra-Angona males look very yellow, orange or even red. This change of the fin color is produced by a dispersing of the red (and yellow) pigments out from the narrow red line centered in between the fin rays. In the anal fin this dispersion produces an almost uniform red color on red males. In the caudal fin the dispersion normally is not complete and the fin rays are uncolored. Also in this case a minor change of the red pigmentations produces a marked effect on the color of the fins. The same effects are produced on the body sides when the red (and black) pigments disperse and cover the brilliant areas.

We have used the terms "yellow" and "red" males for males of the Abra-Angona populations. It seems as if at least some males are able to change their general coloration from a brilliant lemon yellow into a deep orange red color of the whole body and the fins. Young males normally are yellow only. Old males may look lemon or deep orange. We do not know if an orange male may change its color back to lemon. One nature caught male was orange when imported and it remained unchanged for its whole life. Orange and yellow males are very handsome aquarium fishes indeed.

The upper edge of the dorsal fin is provided with a brilliant white edge on males of the Kumasi and "1960" strains. This edge contrasts markedly with the dark body color of Kumasi males. All strains have more or less developed milky white edges of the upper part of the caudal fin.

The females have very little metallic brilliance, as only the lower edge of the anal fin develops some bluish shine. The red dots on the body sides are smaller than on males and the reticulated pattern of dark scale edges is more marked. The shape of the body and the fins is seen on photos.

A remarkable feature is the prolongation of some of the lower rays of the caudal fin that takes on a shape not unlike that of male *E. dageti*. The development of this "sword" varies somewhat from one population to another and also in a certain population. Normally such prolongations do not develop on male *E. sexfasciatus*, however now and then very old aquarium kept males may develop a very short sword indeed.

In order to prove if the variations of natural populations as mentioned above were linked also to differences in the reproduction we made some crossings. Some of these crossings only gave very few fry, as we had several difficulties to find a water type suited for safe development of eggs. All offspring from such crossings so far gave fertile individuals of both sexes and this indicates that all forms are very closely related.

Angona male (the one with a single P bar) to Aiyenasi female gave two fry which both were males. Both had a single P bar, but odd enough this bar developed not on the same side of the body as that of the father. A normal Angona male however gave a single fry which also was a male and which did not develop a P bar. These three mixture males in their coloration represented a compromise between the other colors and patterns. All had the very characteristic big red dots on the upper parts of the anal fin (originated from the Aiyenasi population) and a rather weakly developed overall yellow color on body and fins (Angona population).

The Kumasi female and the Aiyenasi male produced numerous offspring that also were fertile in both sexes. As the former normally has two V bars and two P bars, whereas the latter has just the opposite we were interested to see if the offspring would develop both P and V bars. Many individuals indeed developed this "sexfasciatus like" pattern either on one side or on both sides of the body. Some individuals developed neither P nor V bars.

This means that neither the typical pattern of Ayinasi nor that of the typical Kumasi strain developed. As the Kumasi strain itself is very variable, the results of this crossing are not easy to survey. In order to try to develop a handsome aquarium strain, the Angona/Ayinasi mixed male was crossed to the Kumasi female. The offspring developed a highly variable pattern of crossbars.

As mentioned under *E. dageti*, the hybrids between this species and the *E. sheljuzhkoi* species were not viable. Bruce's strain and the Kumasi strain however gave hatching of apparently viable fry which however could not be raised, whereas the Monrovia strain with the Angona strain gave embryos which died before they were fully grown in the eggs. The fry all died from a blocking up of the blood system.

With Aplocheilus lineatus we only had a single egg, but this developed a blastula, but then the development stopped and after a few days the egg died. The best result was obtained with Nigerian Epiplatys sexfasciatus. 26 fertile eggs developed and hatched normally. First hatching took place after only 10 days and that fry had no yolk left. If we compare Rivulins living west of the Dahomey gap with those living east of that barrier, the western species normally have a more rapid development inside their eggs. The male was a Benin City individual whereas the female belonged to the Aiyenasi strain. 16 juveniles died during the first weeks in spite of our best care of these hybrids. 10 individuals were raised to maturity, but only 5 of these were strong fishes that developed sexual characters. 2 males and 3 females reached a total length of some 50 mm. The two males differed as one lost its dark crossbars very early in life and never again was seen so colored, whereas the other male kept its black bars through its whole life. Females and the barred male all had four A bars, however one female was lacking the two midmost bars. This particular female also did not develop any black bars in front of the anal fin. The other females all developed a P bar on both sides. Only the biggest female and the barred male developed the complete *E. sexfasciatus* bar system. Females often developed the black longitudinal band from the gill covers to the root of the caudal fin. It was impossible to get a single egg from these females and the males gave sterile eggs in back crosses.

The crossing results indicate that *E. sheljuzhkoi* is somewhat closer related to *E. sexfasciatus* than *E. dageti*. This idea is supported by the results of the electrophoresis analysis which say that the *E. sheljuzhkoi* has the very same spectrum (6 lines type) as have the *E. sexfasciatus* and *E. longiventralis* which seem to represent a certain group inside the genus Epiplatys. Meinken has supposed (Aquarienfische in Wort und Bild) that Epiplatys chevalieri and *E. sheljuzhkoi* are subspecies of Boulenger's Epiplatys macrostigma. We are not able to support this idea as at present we consider each of these three species as belonging to its own group of species inside the genus. At present we are not able to link the "sexfasciatus-longiventralis-sheljuzhkoi group" to any other group of Epiplatys.

From the aquarist's point of view the Abra-Angona strains of *E. sheljuzhkoi* are very handsome fishes and may become popular aquarium fishes if it was not for the behavior of these fishes. Like all known strains of this species, the individual when matured is very stagnant. Also the adults rest nearly all day long at the surface of the water. Towards members of its own and related species it is very brutal and perhaps you will find it even more brutal than adults of *E. sexfasciatus*. On the other hand, this species is a very handy one and seems to live in all types of aquaria usually used by aquarists. Best breeding results however are obtained in soft, slightly acidic water loaded with extracts from peat. The eggs measure 1.2-1.35 mm. They are transparent without any color and have long slimy filaments. The surface of the membrane may or may not have a reticulated pattern, weakly developed.

If we compare the variation in morphology and color patterns found within populations of *E. sexfasciatus* from Nigeria-Northern Cameroon with the variation described here for a restricted number of populations of *E. sheljuzhkoi* originating from a rather restricted area of western Ghana, we certainly find that the variations of color and color patterns are much greater in the latter than in the former species. It may be so that these variations are linked to the ecological conditions of the various populations studied.

However, also other reasons may be found. We have studied the prehistoric development of climates for this part of Africa in order to discover some explanation for some differences in genetics discovered

among populations of Aphyosemion bivitattum and *A. nigerianum*. Also we found it somewhat difficult to understand that the Rivulin fauna of the rainforests of Ghana apparently was poor in species. This study in literature indicates that the extension of the western parts of the Guinean rainforest (west of the Cameroon Mts.) has varied strongly in connection with the changes of climates that were produced by the glacial and interglacial periods of Europe. The geological and pedeological research in this part of Africa shows rather convincingly that during Pleistocene there have been very marked periods of aridity and of higher rainfall than today. There are however different opinions on the coherence of the events in Europe and those of this part of Africa. In our opinion the theory that links the arid periods of this part of Africa to the climax of the glacial seems to be the best founded. This theory says that the icecap on northern Europe will displace the climatic zones to a more southernly position and in this way the arid zones advance towards the Guinean coast. During these arid periods the Guinean rainforest of this area will be forced against the coast and it is likely that the forest is subjected to fragmentation. The forest and freswater fishes linked to this biotope will survive here and there along the coast where favorable conditions for an increased rainfall exist. Such areas probably are found, in particular, on the southern and western slopes of the mountains. If this is true, the Rivulins of these forests are split up into isolated populations for some length of time. As such isolated relict forests most likely will support only a rather limited number of individuals inside each population, causal mutations may more easily establish themselves inside such populations, forcing that population to develop some traits which are not developed inside other populations. Our many crossing experiments in African Rivulins indicate that in this group of fish some mechanisms governing the development of the embryo and the reproduction of the species as a whole are likely to develop mutations more often than the genes which govern the general morphology of the species. When the ice retreats from Europe and the climate of that part of the world becomes warmer, the climatic zones of Western Africa again will move northwards. The rain will fall again and the relict forests will expand. The isolated populations of the rainforest Rivulins again will be able to exchange their genes if such an exchange still is possible. Such exchange seems to be rather difficult or even quite impossible between different populations of *A. bivittatum*, *A. nigerianum* and between *A. arnoldi* and *A. filamentosum*. In the known populations of *E. sheljuzhkoi* such exchange however still seems to be possible and also very easy if individuals from different populations are brought together.

It may be so that more than one population of *E. sheljuzhkoi* survived as an isolated unit after the last glacial period of Europe. During postglacial time the isolated populations reunited and exchanged genes more or less forming different combinations from which the present populations developed their different color patterns. As we said before, a rather small part of SW Ghana is covered by a particular type of soil which indicates that this part of Ghana and also some parts of eastern Ivory Coast have supported a forest also during the arid periods mentioned above. French botanists and soil scientists during recent time published detailed maps showing the various types of soils and forest types and pointed out that in Ivory Coast there is a marked connection to be found between these two factors. On the soils that represent the oxysols in this area the number of tree species is much higher than on other soil types, thus indicating that the oxysols or like soils represent the areas where relict forests survived during the arid periods. They also show that in the western part of Ivory Coast and some parts of eastern Liberia there is another area which probably supported forest during the arid times. Rather limited parts of the mountainous landscape of eastern Ghana (Togo Hills) are covered by types of soil that indicate that also in this area

some relict forest survived the last glacial period. Until more populations have been studied we are not able to deal with the probable history of development in *E. sheljuzhkoi*.