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The sexual specificness of the skin pigments of the fishes of the genus Crenilabrus colorimetrically investigated

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The sexual specificness of the skin pigments of the fishes of the genus *Crenilabrus* colorimetrically investigated.

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Introduction.

Continuing my researches on the body colour of fishes (1,2) I began in the spring of the year 1927 at the Zoological Station of Naples research on the sexual physiology of the genus *Crenilabrus*. This publication is to be regarded as a preliminary report and a part of a larger work on the same subject that will be finished in the near future.

For the fishes of the genus *Crenilabrus* are characteristic their great sex differences in the colour of the bodies. These differences were known already to *Cuvier* and *Valenciennes* (6). A detailed description of the features of separate species is given in the monography by *M. P. Gourret* (8). The work of *Lo Bianco* (4) is a very useful guide to the spawning time of the species meet with in the bay of Naples. The aim of my work was to investigate the changes in body colour of the fishes of the genus *Crenilabrus* in both sexes during the whole time of the sexual cycle, and to derive

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these changes from the general conditions of the organism during the different periods of this cycle. For this purpose I have examined a large number of individuals of both sexes in different seasons and have come to the following conclusions.

Morphological observations.

Generally, the blue pigment of the ♂ is regarded the chief difference between the sexes in the colour of the bodies of the typical species of the genus *Crenilabrus*. In certain places of the body of a mature male appear blue dots that fuse together into characteristically arranged squares and stripes. While the black, yellow and red pigments are localized in the cells, the blue pigment saturates diffusely the body of a fish, even the muscular system and the bones. The bright blue spots in the skin are places where the pigment precipitates among the cells. *Zeyneck* (13) has analyzed the chemical composition of the blue pigment and, as later *Verne* (11), regards it as a carotinoid derivate — carotinalbumin. A mature female has in its skin no blue colour or it is hardly visible.

Examining a large number of specimens of *Crenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk. and *Crenilabrus mediterraneus* L. of both sexes, I have come to the conclusion that the blue diffused pigment is only one of the both sexual specific pigments in this genus, and that the body colour of both sexes of the above mentioned species undergo periodically a regular change during the period of the sexual cycles. The fundamental colour of the body of a mature male of the species *Crenilabrus mediterraneus* L. is dark yellowish-brown; on the fins there is stretched what looks like an orange coloured ribbon. Certain places of the body are covered with the already mentioned blue ornament. A mature female of the same species is a vivid dark red, with fins of the same colour, though much paler, and without the blue pigment. A mature male of the species *Crenilabrus pavo* C. V. is of a golden-yellow fundamental colour, with an orange-coloured front-tip of the back-fin, a row of red spots stretching along the sides and with the blue ornament on the body and the fins. A female is greenish-brown, with fins of the same colour but much paler, and without the red squares and the blue pattern. In the colour of the body of a mature male of the species *Crenilabrus ocellatus* Forsk. (a very variable species as regards the body colour) the chief part is played by the orange colour combined with green and bluish green of different shades, along with the blue diffused pigment.

The female is coloured monotonously bluish-green. At the end of the spawning time, the colours of the bodies of both sexes of all these species become paler. Particularly quickly decrease and disappear the specific ♂ elements of the body colour: bright yellow, orange and bright red (*Crenilabrus pavo* C. V.) pigments, by and by also the blue pattern. This process of the travelling away of the blue pigment from the skin continues quite a long time after spawning, and during this period the pale male has a strongly blue ground colour (without the bright pattern) and a more bluish muscular system and skeleton than at the time of sexual activity. After depositing spawn the female also becomes paler, so the colours of the bodies of both sexes become considerably more alike after the spawning time. With the coming of autumn, together with the regeneration of gonads, the unspecific (brownish and greenish) pigments of the female type begin again to accumulate in the bodies of the individuals of both sexes. The colours of the bodies of ♂ and ♀ during this period almost completely coincide and often it is difficult to tell, from the exterior appearance only, the sex of a fish. Some months before spawning (in February, March) in the body of a male there appear again the specific bright yellow and orange pigments, and the blue pattern begins to be renewed. From the above considerations I come to the conclusion that the sexual cycle of the fishes of the genus *Crenilabrus*, with regard to the colour of the bodies, is to be divided into four periods: the spawning period or the time of the maximum development of the specific „nuptial hue“ of the male; the period after spawning — the time of the destruction of the specific „nuptial hue“ and the pigments in general; the period of rest — the renovation period of the unspecific (or ♀ type) pigments in the individuals of both sexes, and the preparatory period or the period of newformation of the specific „nuptial hue“ of the ♂. The principal difference in the body colour of both sexes is to be looked for in the typical bright yellow and orange pigments of ♂; the appearance of their blue pigment is to be associated with the accumulation of the yellow pigment during the preparatory period. Having come to the above expressed conclusions, a question arises as to the chemical nature of the pigments themselves and their quantity in the body.

*Colorimetical researches.*a. *Methods.*

The micro-chemical experiments with concentrated acids, that have been made before, show that here, evidently, we have to deal with the pigments of the carotinoid group. Therefore having beforehand accordingly treated the skin of animals and their muscles, I extracted them after the modified method of *Arnaud* (3) with benzine at indoor temperature. The modification of the method consisted in treating beforehand the tissues with alcohol, in which case I chose methylalcohol. At the end of the extraction I reduced the mass of extracts or filled it up with a solvent proportionally to the weight of the tissue to be extracted, taking as the coefficient for benzine extracts 10 ccm. of the solvent to 1 gr. of skin, and 1 ccm. of solvent to 1 gr. of muscles. Before that I compared the separate unfractionated extracts of benzine. In order to acquire the relative data I took, as a standard for each species of fishes, the extract from an individual with the greatest concentration of pigments. The concentrations of extracts of remaining individuals of the same species I annotated in percents of the *Autenrieth-Königsberger's* scale of colorimetre. The absolute calculation of the mass of carotinods to 1 gr. of the weight of the skin (muscles) I performed according to the modified method of *Hymans van der Bergh* and *Müller* (9) taking as the standard solution the solution of pottassium bichromate in water and the comparing carrying out with the help of the scale of concentrations of the standard solution in descending geometrical proportion.

This modification of the method, refusing to use colorimetre, I introduced in order to be able to utilize in my work the data obtained by *Connor* (5) about the relation of carotin and pottassium bichromate in isocolorimetical solutions. Having obtained the data of the relative and the absolute concentrations of the undivided benzine extracts, I fractionated benzine with methylalcohol, taking as the coefficient 5 ccm. of methyl alcohol to 1 gr. of the weight of skin, and 1 ccm. to 1 gr. of the weight of the muscles. The aim of the fractionation was to separate the pigments of the xanthophyll group from the joint benzine extract and remove them into the methyl alcohol (*R. Willstätter* and *H.H. Escher*, 12); *J. Verne*, 11). Also the fractions of the methylalcohol were colorimetrically compared after the addition of xanthophyll which was procured by treating the tissues beforehand.

It has been said already that the blue diffused pigment is a special carotinalbumin. In the tissues left over from the

extraction of alcohol and benzine, the blue pigment is very easily to be extracted with distilled water (*Zeyneck*, 13) which method was applied also by me, taking as the dissolving coefficient 2 ccm. of water to 1 gr. of the weight of the skin and 1 ccm. of water to 1 gr. of the weight of the muscles. After repeated extractions in the skin and fins of the animals there were left over and not closely examined only the typical melanic pigments.

b. Results.

Leaving the more detailed description of the experiments for the future, we can formulate the results of the colorimetric measurement as follows.

1. In the male of *Crenilabrus pavo* C. V. during the preparatory and spawning periods the concentration of the joint benzine extract of the pigments of the skin reaches 0.15—0.2% concentration of the solution of potassium bichromate, viz. according to *Connor* (5) ca. 0.00019—0.00027 gr. of the carotinoid pigments to 1 gr. of the weight of the skin. (The dissolving coefficient of the pigments—10). In the period after spawning the mass of carotinoids in the skin diminishes to 0.065—0.05% — or ca. 0.00007 gr. of carotinoids to 1 gr. of the weight of the skin. In the ♀ of the same species during the preparatory and the spawning periods the concentration of the joint benzine extract of the skin reaches ca. 0.1%, viz. ca. 0.00012 gr. of carotinoids to 1 gr. of the weight of the skin; also here after spawning the mass of carotinoids diminishes and sinks to 0.05 (even to 0.025)%⁰, viz. to ca. 0.00005 (0.000016) gr. to 1 gr. of the weight of the skin.

In the ♂ of *Crenilabrus ocellatus* *Forsk.* the respective figures during the spawning period and the time after it are: 0.4%⁰, viz. 0.00046 gr. of carotinoids and ca. 0.04%⁰, viz. 0.000033 gr. of carotinoids. In the ♀ of the same species: 0.12%⁰, viz. ca. 0.00014 gr. and 0.025%⁰, viz. 0.000016 gr. So, during the spawning time as well as after it, the quantity of the absolute mass of carotinoids in the skin of male individuals of both these species is larger than that of the females. After spawning the mass of carotinoids in the skin lessens in both sexes and in the ♂ on an average to a larger extent than in the ♀. This is conspicuous in *Crenilabrus ocellatus* *Forsk.*, where the mass of carotinoids in the ♂ falls to $\frac{1}{14}$ part of the mass before spawning, but in the ♀ only to $\frac{1}{9}$. The more rapidly diminished mass of carotinoids in the ♂ is after that more quickly renewed.

Similar relations in both sexes we find also in *Crenilabrus mediterraneus* L. Only *Crenilabrus massa* and *Crenilabrus Roissali*, where there are also morphologically no sexual differences to be observed, do not show any definite quantitative differences in the mass of carotinoids in either sex.

2. Fractionating the benzine extract with methylalcohol we separate the xanthophylls from the genuine carotins. The concentration of xanthophylls in the skin of the ♂ of *Crenilabrus pavo* C. V. during the preparatory and the spawning periods reaches ca. 0.025%, concentration of the solution of potassium bichromate (the dissolving coefficient — 5), viz. ca. 0.000008 gr. of xanthophyll to 1 gr. of the skin. In the period after spawning this figure falls to below 0.004% viz. ca. 0.000005 gr. of xanthophyll to 1 gr. of the skin, in other words soon after spawning xanthophyll disappear from the skin of animals almost entirely. In the skin of the ♀ *Crenilabrus pavo* C. V. the concentration of xanthophyll also during the spawning period reaches at the highest 0.01%, viz. ca. 0.000015 gr. of xanthophyll to 1 gr. of skin, but in many individuals it does not exceed 0.004%, viz. 0.000005 gr. In the period after spawning in the ♀ this minor mass of xanthophyll in the skin decreases only very little and falls below 0.004%. During the period of rest, in the autumn months, when the carotin begins again to increase in the skin of individuals of both sexes, there is no growth of xanthophyll also in the ♂ individuals, and it appears anew only in the preparatory period, some months before spawning. In *Crenilabrus mediterraneus* L. we obtain almost entirely identical figures. Also the mass of xanthophylls in the male individuals of *Crenilabrus ocellatus* Forsk, during the spawning time increases to 0.025%, viz. 0.000008 gr. to 1 gr. of skin, and after spawning drops to below 0.004%, viz. 0.000005 gr. In the ♀ individuals of the same species during the spawning time as well as after it the xanthophyll mass in the skin is under 0.004%, is practically equal to nought.

Thus, in the male individuals of *Crenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk. and *Crenilabrus mediterraneus* L. with the approach of spawning time and the growth of the general mass of carotinoids in the organism as a whole, the xanthophylls increase particularly rapidly. With the end of the spawning time and the decrease of the mass of pigments the xanthophylls are the first to disappear. In the skin of female individuals during the spawning time there appears only a little quantity of xanthophylls, and the

spawning time coming to an end it decreases also only a little. With regard to the composition of pigments in the time after spawning the ♂ individuals closely approach the ♀ ones.

Also in both sexes of *Crenilabrus Roissali*, during the spawning time and the time after it, the xanthophyll mass in the body fluctuates between 0.000008–0.0000005 gr., but in this species there is not to be observed any difference in either sex. In the skin of the ♂ *Crenilabrus massa*, as well as in the ♀, the xanthophyll mass practically amounts to nought.

3. In the muscles of ♀ individuals of *Crenilabrus pavo C. V.* and *Crenilabrus ocellatus Forsk.*, during the time of spawning, the joint concentration of carotinoids may reach 0.000027 gr. to 1 gr. of muscles, but on the average it equals ca. 0.000012 gr. to 1 gr. of muscles; a somewhat smaller figure we obtain for *Crenilabrus mediterraneus L.* Of this mass xanthophyll forms a very little part, practically nil. After spawning in all ♀ of the above mentioned species carotin (just as in the skin) diminishes and sinks to ca. 0.0000001 gr. to 1 gr. of the muscle, that is, practically completely disappears from the muscular system. The ♂ individuals of the same species have less carotin pigments in the muscular system than the female ones, and their concentration during the spawning time does not exceed ca. 0.000005 gr. of pigments to 1 gr. of muscles. Only in certain individuals of *Crenilabrus ocellatus Forsk.* (the bodies of which are on the whole relatively richer with pigments) the concentration of the pigments in the muscles reaches 0.000012 gr. to 1 gr. of muscles. The extracts of muscle pigments in male individuals also are more labil than the extracts of muscle pigments in ♀, and especially in *Crenilabrus pavo C. V.* In the presence of air and remnants of ground muscular tissues they very quickly oxidise, where the carotin changes into xanthophyll. On the contrary, normally, the concentration of xanthophyll in the muscular system also in ♂ individuals is practically nil. After spawning time the concentration of carotinoids in the muscular system of the ♂ falls to ca. 0.0000001 gr. of pigment to 1 gr. of muscles, viz. the pigments disappear entirely. During the periods of rest and preparation, when the pigments accumulate anew in the skin, they increase also in the muscular system. Together with it the fish which had become lean fatten up in the time after spawning.

Thus, while during the spawning period the joint mass of carotinoids in the skin of ♂ individuals is much larger than in the skin of ♀, in muscular system it is just the opposit—the ♀ have more pigments than the ♂. In other words, in the ♂ the carotinoids are distributed over different parts of

the body very unequally and nearly all of them are concentrated in the skin; but in females they are divided more equally and are found also in the muscular system (and gonads) to a relatively considerable extent. Besides the carotins of the muscular system of the ♂ of *Crenilabrus pavo* C. V. in the presence of ground tissues show great tendency to oxidation. After spawning the mass of carotinoids in the muscular system of both sexes falls nearly to nought and becomes similar. The relations of the carotin and the xanthophyll masses in the skin and muscles of the ♂ and the ♀ of *Crenilabrus pavo* C. V. is shown in the following diagrams.

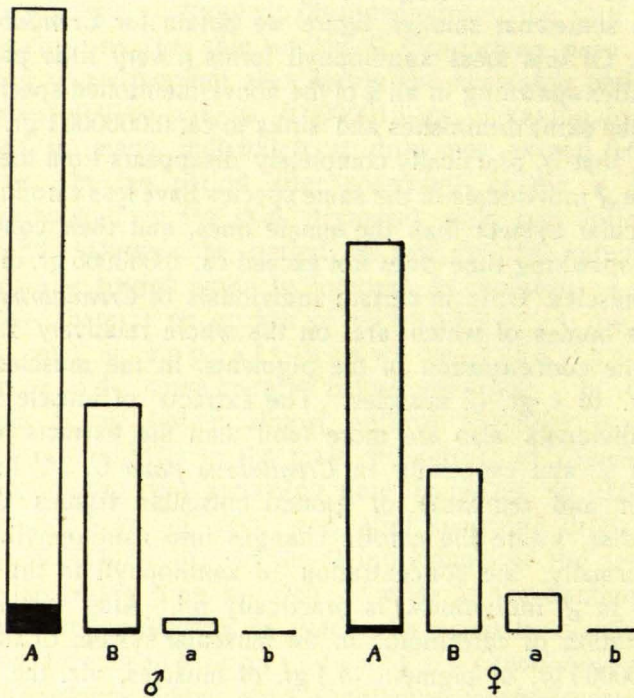


Fig. 1. *Crenilabrus pavo* C. V.

The relative content of the pigments. A — in the skin during the spawning period, B — in the skin during the time after spawning, a — in the muscular system during the spawning time, b — in the muscular system during the time after spawning. The black part of the diagram shows the relative part of the xanthophyll among the whole mass of carotinoids in the same individual.

Relatīvais pigmentu saturs *Crenilabrus pavo* ķermenī. A — ādā nārsta laikā; B — ādā pēcnārsta laikā; a — muskulatūrā nārsta laikā; b — muskulatūrā pēcnārsta laikā. Stabiņa tušētā daļa rāda ksantofīla daļu korotinoīdu kopmasā.

4. The concentration of the blue diffused pigment in the skin of the ♂ of *Crenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk. and *Crenilabrus mediterraneus* L. reaches its maximum shortly after spawning, that is at the same time when the carotinoid mass and especially xanthophylls has already decreased. Then after some weeks, the blue pigment also begins to diminish. In the muscular system on the contrary the characteristic feature of the whole time after spawning is the maximum concentration of the blue pigment, that coincides with the rising leanness more or less of the whole organism. An impression is left as if the blue carotinalbumin, increased in the skin during the spawning time, were transported away to the muscular system and the skeleton, there precipitated or destroyed and used. Also in the ♀ individuals that have hardly any blue pigment at all in their skin and muscular system during the spawning time, it appears in a small quantity shortly after spawning in order to disappear again after it. Also here the appearance of the blue pigment in the organism corresponds with a certain, though smaller than in the ♂, leanness of the tissues of the whole body. A similar phenomenon may be observed also under experimental conditions, when the fishes kept for a long time in an aquarium and fed very seldom become lean and accumulate in their tissues very much of the blue diffused pigment.

5. The bright yellow, orange and red xanthophylls are to be regarded as the sexual specific pigments of the skin of the males of *Crenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk., and *Crenilabrus mediterraneus* L. The sexual unspecific brown and greenish yellow pigments of female type, that may be extracted in benzine and are common in both sexes are the carotins. The blue diffused pigment of the males, as a derivate of carotinoids, is to be regarded as a secondary sexual specific pigment: its appearance in the body depends upon the appearance of carotin, and especially upon that of xanthophyll, and the maximum of its accumulation coincides with the decrease of carotinoids (particularly of xanthophylls). The carotins ($C_{40}H_{56}$) as well as the xanthophylls ($C_{40}H_{56}O_2$) are unsaturated autooxidable substances (*J. Verne*), but the xanthophylls are of a higher degree of oxidation. From this point of view it is possible to formulate the sexual differences in the genus *Crenilabrus* with regard to the

pigments of the skin as follows: the sexual specific pigments of the skin of the males of *Crenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk, and *Crenilabrus mediterraneus* L. compared with the unspecific pigments of the ♀ type, that are common in both sexes, are substances of a higher degree of oxidation. Being present in the organism of the ♂ in comparatively small quantities they all the same decide the characteristic aspect of an animal, being localised in the order of a typical ornament in definitely certain points of the skin.

Conclusion.

Leaving the more detailed discussion and the theoretical motivation of the obtained results for the future, I will formulate already now the following leading theses.

1. With regard to the colour of the body of a mature individual the difference between both sexes of the genus *Crenilabrus* is of a gradual, not of a qualitative nature. The typical ornament of the skin is a common feature of the species for both sexes. In the ♂ in this pattern accumulate on the whole more pigments than in the ♀, besides the oxidation of carotins and their change into xanthophylls and proteid carotins take place in certain points of the ornament. In connection with it there arise some other tasks of investigation. It would be of great importance to attend to the ♂ and ♀ individuals the R. Q. during the time of the whole sexual cycle, in order to see whether the rapid growth of the process of oxidation during the spawning time is not characteristic for the body of the ♂ on the whole. Further we should investigate where the increase of the oxygen, that is indispensable for the oxidation of pigments, comes from and what glands stimulate the oxidation. At last it is necessary to investigate more closely the localisation of the oxidation points and the physically-chemical conditions of this process in the skin. These tests have been begun already by the author.

2. The pigments of the skin of ♂ and ♀ of the genus *Crenilabrus* very sensibly reflect the general metabolic process of the organism. In this respect they are to be regarded as the physiological indicators of the metabolic state of the organism, inspired from his general sexual state.

3. The amplitude of the increase and the decrease of the joint mass of pigments in the skin of the ♂ during the time of the sexual cycle is much greater than in the skin of the ♀. In accordance with the these 2, we can accept with great probability that also the fluctuations of all the other physiological and morphogenetic processes during the time of the sexual cycle are much smaller in the ♀ than in the ♂. Also here the gradual character of the difference between the sexes is professed.

4. In separate species of the genus *Crenilabrus* the sex differences with regard to the colour of the bodies are of different extent: very great in *Crenilabrus mediterraneus* L., *Crenilabrus ocellatus* Forsk., moderate in *Crenilabrus pavo* C. V., and hardly to be stated in *Crenilabrus massa* and *Crenilabrus Roissali*.

5. We have to accept that the forming of the body colour into the limits of an ornament characteristic in its leading features in the whole genus is decided by only one factor. To solve whether this factor itself in different species and in individuals of different sexes is gradually raised, or whether its graduality is caused by other processes that take place in the respective organism, is the task of further investigations.

I have the pleasure to express my sincerest thanks to the Direction of the Zoological Station at Naples, the Professors *O. Gross*, *M. Fedele*, *E. Sereni*, and *S. Ranzi*, but particularly to the Director Prof. Dr. *Reinhard Dohrn* for granting me the work place, his friendly interest in the progress of the researches and kind disposition to all my wishes that so greatly furthered my work at the Station. I am very thankful also to the International Education Board (Rockefeller Foundation) which granting me the fellowship made this work possible.

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Kolorimetriskis pētījums par *Crenilabrus* ģints zivju ādas pigmentu seksuālspecifisko raksturu.

(Kopsavilkums.)

Leo Āboliņš.

Turpinādams savus darbus par zivju ķermeņa krāsu (1, 2) es uzsāku 1927. g. pavasarī, Neapoles zooloģiskā stacijā, pētījumu par *Crenilabrus* ģints seksuālfizioloģiju. Šī publikācija ir uzskatāma kā iepriekšējs ziņojums un daļa no attiecīgā tuvākā laikā pabeidzamā darba. Mana darba nolūks bij izsekot zivju ķermeņa krāsu maiņas abējos dzimumos seksuālcikla laikā un mēģināt atvasināt šīs maiņas no vispārīgiem organisma vielu maiņas procesiem.

Parasti par galveno atšķirību *Crenilabrus* ģints tipiskāko sugu ķermeņa krāsā starp ♀ un ♂ uzskata pēdējo zilo pigmentu. Dzimumgatavam tēviņam noteiktās ķermeņa vietās parādās zili punkti, kas saplūst raksturīgi sakārtotos laukumos un strīpās. Kamēr melnie, dzeltenie un sarkanie pigmenti ir šūnās lokalizēti karotīni un ksantofili, zilais karotīnproteīns difūzi piesātina zivs ķermeni, pat muskulatūru un kaulus. Dzimumgatavai mātītei zilā ornamenta ādā vai nu nemaz nav, vai arī tas tikko manāms.

Izpētot lielāku skaitu abēju dzimumu *Crenilabrus pavo* C. V., *Cr. ocellatus* Forsk. un *Cr. mediterraneus* L. individu nācu pie pārliecības, ka zilais difūzais pigments ir tikai viens no seksuālspecifiskiem pigmentiem šinī ģintī, un ka minēto sugu abēju dzimumu ķermeņa krāsas seksuālcikla laikā periodiski likumīgi mainās.

Attiecībā uz ķermeņa krāsu, seksuālcikls ir iedalāms 4 periodos: nārsta periodā jeb specifiskā tēviņa kāzu tērpa maksimālās attīstības laikā; pēcnārsta periodā jeb specifiskā „kāzu tērpa“ un pigmentu noārdīšanas laikā vispār; atpūtas periodā jeb nespecifisko (♀ tipa) pigmentu atjaunošanas laikā abēju dzimumu individos un sagatavošanās periodā jeb specifiskā kāzu tērpa jaunizveidošanas laikā. Galvenā abēju dzimumu ķermeņa krāsas atšķirība ir meklējama tēviņu tipiskos spilgti dzeltenos un oranžainos pigmentos; viņu zilā pigmenta rašanās ir vedama sakarā ar dzeltēno pigmentu uzkrāšanos ķermenī sagatavo-

šanās periodā. Nākušam pie tikko formulētiem slēdzieniem, radās jautājums par pašu pigmentu ķīmisko dabu un viņu daudzumu ♂ un ♀ ķermenī. Jautājuma atrisināšanai pagatavoju pēc attiecīgām metodēm no lielāka individu skaita ādas pigmentu benzīna ekstraktus. Pēc tam šos ekstraktus fracionēju ar metilalkoholu, lai šķirtu ksantofīlus no karotīniem. Ekstrahēju arī zilo difūzo pigmentu. Pagatavotos ekstraktus kolorimetriski salīdzināju un ieguvu sekošus rezultātus.

Pie *Crenilabrus pavo C. V.* un *Crenilabrus ocellatus Forsk.* vīrišķiem individiem visu karotīnoidu absolūtā masa ādā ir lielāka, kā pie sievišķiem individiem, kā nārsta, tā pēcnārsta laikā. Pēc nārstošanas pie abējiem dzimumiem karotīnoidu masa ādā samazinās, pie tam pie ♂ caurmērā lielākos apmēros kā pie ♀. Tas sevišķi spilgti novērojams pie *Crenilabrus ocellatus Forsk.*, kur pie ♂ karotīnoidu masa ādā krīt līdz $\frac{1}{14}$ daļai no pirmsnārsta masas, bet pie ♀ tik līdz $\frac{1}{9}$ daļai.

Līdzīgas attiecības abējos dzimumos atrodam arī pie *Crenilabrus mediterraneus L.* Tikai *Crenilabrus massa* un *Crenilabrus Roissali*, kuŗiem arī morfoloģiski nav novērojamas seksuāldiferences, neuzrāda nekādu noteiktu kvantitatīvu starpību karotīnoidu masā abējos dzimumos.

Nārstam tuvojoties un karotīnoidu kopējai masai organismā pieaugot, pie *Crenilabrus pavo C. V.*, *Crenilabrus ocellatus Forsk.* un *Crenilabrus mediterraneus L.* vīrišķiem individiem sevišķi strauji pavairojas ksantofili. Nārstam izbeidzoties un pigmentu masai samazinoties, pirmie pazūd ksantofili. Sievišķiem individiem nārsta laikā ādā rodas tikai ļoti niecīgs ksantofila daudzums un nārstam beidzoties tas arī tikai nedaudz samazinās. Pēcnārsta laikā ♂ individi savā pigmentu sastāvā stipri tuvojas ♀.

Arī pie *Crenilabrus Roissali* abējiem dzimumiem ksantofilu masa ķermenī nārsta un pēcnārsta periodos svārstās, bet šinī sugā nav novērojama kaut cik ievērojama starpība abējos dzimumos. *Crenilabrus massa* ādā, kā pie ♂, tā pie ♀ ksantofilu masa praktiski līdzinās nullei.

Kamēr ādā nārsta periodā karotīnoidu kopējā masa pie ♂ individiem ir krietni lielāka kā pie ♀, muskulatūrā otrādi, ♀ ir vairāk pigmentu, kā ♂. Citiem vārdiem, pie ♂ karotīnoidi sadalīti pa dažādām ķermeņa daļām stipri nevienmērīgi un gandrīz visi bez izņēmuma koncentrēti ādā, bet pie mātītēm sadalīti vienmērīgāk un relatīvi ievērojamos apmēros sastopami arī muskulatūrā (un gonādās). Pēcnārsta laikā karotīnoidu masa abēju dzimumu muskulatūrā krīt gandrīz līdz nullei un kļūst vienāda. Karotīna un ksantofila savstarpējas masu attiecības ādā un muskuļos pie *Crenilabrus pavo C. V.* ♂ un ♀ rāda tekstā ievietotās diagramas.

Zilā difūzā pigmenta koncentrācija *Crenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk. un *Crenilabrus mediterraneus* L. ♂ adā savu maksimumu sasniedz īsi pēc nārstošanas, t. i. tanī pat laikā, kad karotīnoidu un sevišķi kansofilu masa ir jau samazinājusies. Tad, pēc kādām nedēļām, sāk samazināties arī zilais pigments. Muskulātūrā, turpretim, visu pēcnārsta periodu raksturo maksimāla zilā pigmenta koncentrācija, kas sakrīt ar lielāku vai mazāku organisma noliesēšanu.

Par *Grenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk un *Crenilabrus mediterraneus* L. tēviņu specifiskiem ādas seksualpigmentiem ir uzskatāmi spilgti dzeltenie, oranžainie un sarkanie ksantofili. Brūnie un zaļgandzeltenie benzīnā ekstrahējamie, abiem dzimumiem kopīgie, nespecifiskie mātītes tipa ādas pigmenti ir karotīni. Zilais difūzais tēviņu pigments, kā karotīnoidu derivāts, ir uzskatāms par sekundāri specifisku seksualpigmentu; viņa parādīšanās ķermenī stāv atkarībā no karotīna, bet it sevišķi ksantofila parādīšanās un viņa uzkrāšanās maksimums sakrīt ar karotīnoidu (sevišķi ksantofila) samazināšanos. Kā karotīni ($C_{40}H_{56}$), tā ksantofili ($C_{40}H_{56}O_2$) ir nepiesātināti, autooksidabli savienojumi (*J. Verne*), bet ksantofili no abiem ir ar augstāku oksidācijas pakāpi. Raugoties no šī viedokļa seksuālo diferenci attiecībā uz ādas pigmentiem *Crenilabrus ģinti* ir iespējams sekoši īsi formulēt: *Crenilabrus pavo* C. V., *Crenilabrus ocellatus* Forsk., un *Crenilabrus mediterraneus* L. tēviņu seksualspecifiskie ādas pigmenti ir augstākas oksidācijas pakāpes savienojumi salīdzinot tos ar nespecifiskajiem abējiem dzimumiem piemītošiem ♀ tipa pigmentiem. Atrazdamies ♂ organismā samērā mazos kvantumos, tie tomēr noteic raksturīgo dzīvnieka izskatu, būdami lokalizēti zināma ornamenta kārtībā tikai pilnīgi noteiktos ādas punktos.

No visa sacītā redzams, ka attiecībā uz ķermeņa krāsu mūsu zivju ģintī dzimumu izšķirība ir graduālas, ne kvalitatīvas dabas.

Tipiskais ādas ornaments ir abiem dzimumiem kopīga sugas pazīme, kas noteic arī pigmentu oksidācijas punktu lokalizāciju tēviņu adā. Ādas pigmentu sistēma ļoti jūtīgi atspoguļo mūsu zivs organisma vispārīgas īpašības un šinī ziņā ir uzskatāma par organisma seksuālā stāvokļa iespaidoto vielu maiņas procesu fizioloģisku indikatoru. Ir jāpieņem, ka ķermeņa krāsas izveidošanos visai ģintij galvenos vilcienos kopīgi raksturīgā ornamenta robežās noteic viens vienīgs faktors. Atrisināt vai šis faktors dažādās sugās un dažāda dzimuma indivīdos pats ir graduāli kāpināts jeb vai viņa iedarbības graduālītāti rada citi attiecīgā organismā norītoši procesi, ir turpmāku pētījumu uzdevums.

