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Comparison in indicators of growth and development affecting the meat productivity of cockerels in resource populations

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Abstract. Creation of animal resource populations is a convenient tool for studying genetic diversity, increasing efficiency of breeding, and conserving genetic resources. In the article, we studied the resource population of males of egg and meat direction of productivity, as well as their progeny of the first and second generations, analyzed the differences in growth and development in different generations. An analysis of the difference and variability in terms of live weight was carried out. Characteristic of exterior was given based on the indices of massiveness and broad body — indicators that have dependencies with meat productivity of poultry. In birds of the first and second generation, a significant difference in live weight was revealed in comparison with the parental form of the Russian White breed at all ages, and in comparison, with the Cornish breed — from the 4th to the 12th week in birds of the second generation and to the 16th week in birds of the first generation. Coefficient of variation showed that in males of the first generation at the age of 10…12 weeks it was above 25%, which indicates a high degree of variability of the trait in terms of live weight, in comparison with other animals in the resource population. The Cornish breed had the lowest coefficient of variability for the traits at 6, 12, and 20 weeks of age. In terms of broad body and massive indices, the effect of heterosis was observed in males of the second generation during their development by the age of 20 weeks, which

characterized them as healthy and fast-growing individuals with well-developed muscles. The results of our study can help poultry farmers in breeding work when selecting chickens to create new breeds and lines with improved characteristics, and for private and personal farms to increase the efficiency of their own production.

Key words: chickens, Russian White breed, Cornish breed, crossbreeds, body indices

Author contributions. Vetokh A.N. designed the experiments, collected and processed data, analyzed the data, wrote the paper; Volkova N.A. conceived and designed the experiments; Dzhagaev A.Y. collected data.

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Introduction

Chicken farming is one of the most widespread and economically profitable branches of poultry farming, including for meat production. Growth and development are important factors that determine productivity and quality of poultry meat [1]. In the modern poultry industry, there is a problem of efficient use of resources to obtain maximum profit. In recent years, poultry farmers have been paying more and more attention to the creation of new breeds of chickens that will better meet market needs and ensure high productivity, while another task remains the preservation of biodiversity [1, 2]. However, in order to create a new breed, it is necessary to conduct a lot of research and experiments. One of the methods that helps to study the growth and development of farm animals is the creation of a resource population [3, 4]. The use of model animals makes it possible to consider not only physiological characteristics of birds, but also their genetic characteristics [5—7].

The aim of the study was to conduct a comparative analysis of growth and development of cockerels of different generations in a resource population, as well as to study phenotypic variability of some traits of meat productivity.

Materials and methods

The object of the study was a resource population of cockerels of meat (Cornish White breed) and egg (Russian White breed) productivity directions and their descendants of the first and second generations. The birds were kept in the department of the organization of experimental base, Federal Research Center for Animal Husbandry named after Academy Member L.K. Ernst. The premises for keeping the birds were equipped with supply ventilation. The temperature in the poultry house was maintained at a level of

20 to 25 ºC, humidity — from 48.5 to 51.2%. The birds were fed with industrial compound feed depending on age in accordance with the established feeding standards[1].

We examined 130 cockerels. All birds were wing-marked using number plates. From the moment of hatching from the egg, weight and linear indicators were taken from the conditional chickens until they reached the age of 24 weeks. Phenotypic parameters were recorded dynamically at the age of 2, 4, 6, 8, 10, 12, 16, 20, 24 weeks. Live weight measurements were made using Vitek electronic scales and household electronic scales of the steelyard type, pelvic width was measured using caliper: these parameters characterize development of pectoral muscles, and body length was measured using centimeter tape. Based on the established parameters, the indices of the bird's constitution were calculated (according to P.A. Kabystina), such as the massiveness index ($MI = \frac{\text{live weight, g}}{\text{body length, cm}}$) and the wideness index ($WI = \frac{\text{pelvic width} \times 100}{\text{body length}}$). These parameters are used to compare the phenotypic profiles of birds of different breeds, and also characterize meat productivity, fatness and compactness of the constitution[2].

All digital values were entered into electronic database maintained in MS Excel program, and measurement data were processed using descriptive statistics methods in STATISTICA 7.0 program with determination of variation coefficient, average values, and errors ($M \pm m$); t-test and F-criterion in ANOVA were used to assess significance levels. The results were presented in the form of graphs and tables to clearly show the differences between the original and model forms.

Results and discussion

Growth and development of cockerels of different generations of model hens with original forms — parent stock of original breeds (RW — Russian White, COR — Cornish) of the first F1 and second F2 generations — were compared. It was revealed that the compared indicators of the resource population cockerels differed depending on the generation of hens.

In the dynamics of live weight of cockerels studied in the research (Fig. 1) depending on age and generation, it was noted that cockerels of Russian White breed had reliably lower weight indicators in comparison with all other groups of animals at all ages. Chickens at the age of 2 weeks were reliably smaller than Cornish chickens by 2.79 times (at $p < 0.01$) and crossbred chickens of the F1 and F2 generations — by 2.45 and 1.94 times ($p < 0.001$), respectively. The greatest differences in live weight were between Russian White and Cornish cockerels at 6 weeks of age ($p < 0.001$), and the difference was 301%, which on average corresponded to 1373.86 g. During pairwise comparisons, no reliable differences in weight were found between meat cockerels and cockerels of the resource population from the first and second generations in the first weeks after hatching and upon reaching sexual maturity, but reliable differences were found between Cornish cockerels

[1] Epimakhova EE, Belik NI, Zakotin VE, Vaitsekhovskaya SS, Khodusov AA, Trubina IA. *Nauchno obosnovannye rekomendatsii po proizvodstvu produktsii ptitsevodstva v organizatsiyakh vsekh form sobstvennosti Stavropol'skogo kraya* [Scientifically based recommendations for the production of poultry products in organizations of all forms of ownership in the Stavropol Territory]. Stavropol; 2014. (In Russ.).

[2] Kulikov LV. Praktikum po ptitsevodstvu [Practical training in poultry farming]. 2nd ed. Moscow; 2002. (In Russ.).

and first-generation offspring at 4, 6, 8, and 10 weeks of age, and second-generation offspring at 4, 6, 8, 10, and 16 weeks of age. The greatest difference between purebred individuals and the second generation was at the age of 4 weeks and amounted to 1.73 times (at $p \le 0.01$), and with the first generation it was 1.66 times at the age of 6 weeks ($p \le 0.001$). When comparing the offspring roosters, reliable differences were observed at the beginning of growth and with the onset of sexual maturity. The first-generation chickens were larger than the F2 generation chickens at the age of 2 weeks, the difference in live weight between individuals was 21%, and by the age of 4 weeks it no longer exceeded 13% ($p \le 0.001$). At the age of 16 weeks, the F2 individuals showed increased growth and became larger than the F1 roosters by 20.68% ($p \le 0.05$). At the ages of 20 and 24 weeks, the second-generation individuals were also larger than their counterparts, but the differences were insignificant and amounted to 7.95 and 4.12%, respectively.

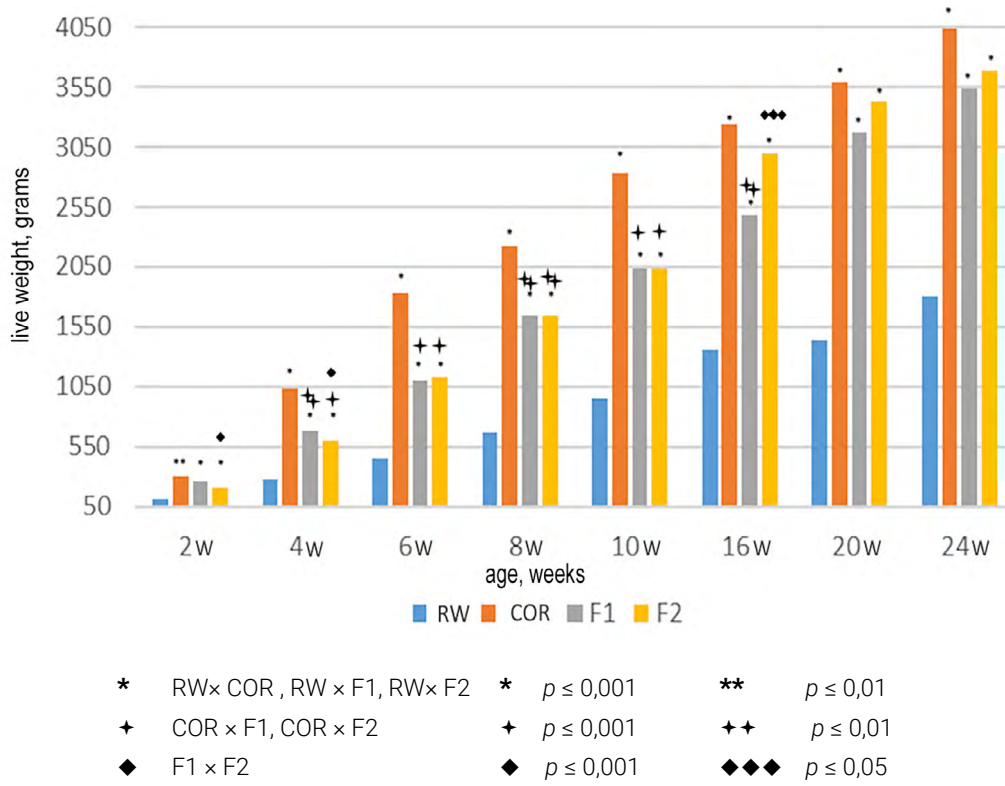

Fig. 1. Dynamics of weight indicators in the resource population: RW — Russian White breed; COR — Cornish breed; F1 — first generation crossbreeds; F2 — second generation crossbreeds

Source: created by A.N. Vetokh , N.A. Volkova , A.Y. Dzhagaev using MS Excel

To assess the degree of dispersion of values for live weight indicator, coefficient of variability was also calculated (Fig. 2), which, as is known, shows how much the data deviate from the average value and can be used to assess reliability of measurements and analyze their similarity.

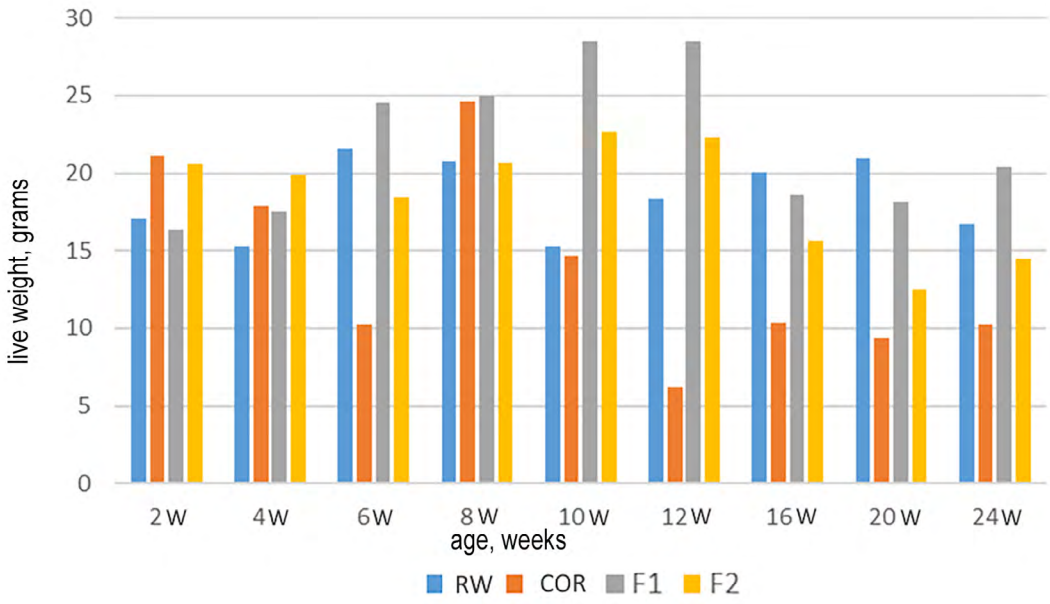

Fig. 2. Dynamics of coefficient of variation in the resource population: RW — Russian White breed; COR — Cornish breed; F1 — first generation crossbreeds; F2 — second generation crossbreeds

Source: created by A.N. Vetokh , N.A. Volkova , A.Y. Dzhagaev using MS Excel

The results showed that the first-generation cockerels aged 10…12 weeks had a variation coefficient exceeding 25%, indicating a high degree of variability of live weight compared to other birds in the study. The degree of variability at this age may depend on both genetic characteristics of cockerels and conditions of keeping and feeding [8, 9]. However, as the graph shows, the parental forms of the cockerels also had a high degree of variability of live weight at some ages, which could probably lead to a higher coefficient of variability of weight indicators in the offspring. Cornish breed had the lowest coefficient of variability of the trait at the ages of 6, 12 and 20 weeks. These ages coincide with changes in keeping conditions, which may characterize these individuals as the most susceptible to stress. At the age of 6 and 20 weeks, the industrial compound feed was changed, and at the age of 12 weeks, the birds were transferred from the premises for chicks and young birds to the poultry house for adult birds.

In order to characterize the phenotypic variability in terms of meat productivity, it is necessary to have an idea of the exterior profile of individuals [10]. We calculated the massiveness indices and the wide-body indices for cockerels of the resource population (Table). The greater the body weight, the higher the massiveness index. In poultry farming, massiveness index indicates that the bird is in good health and highly productive, and can be used to determine quality of poultry meat and efficiency of feed use [11—13].

Indices of massiveness and broad body of cockerels with different genotypes *M* ± *m*

Age, weeks	Genotypes			
	RW (*n* = 30)	COR (*n* = 21)	F1 (*n* = 33)	F2 (*n* = 46)
Indices of massiveness				
2	14,55 ± 0,35	26,92 ± 6,40	32,27 ± 1,32*	23,44 ± 0,26*,◆
4	24,79 ± 0,57	70,43 ± 12,3**	51,05 ± 2,22*,◆	43,88 ± 0,46*,◆◆,▸
6	34,43 ± 0,71	99,36 ± 8,98*	66,03 ± 3,45*,◆◆	64,43 ± 0,70*,◆
8	44,53 ± 0,78	124,2 ± 14,0*	68,21 ± 3,32*,◆	84,38 ± 1,08*,◆◆,▸
10	54,37 ± 1,75	126,2 ± 5,19*	79,95 ± 4,02*,◆	91,68 ± 2,13*,◆,▸▸▸
12	58,51 ± 1,96	127,2 ± 2,65*	92,82 ± 5,89*,◆	104,1 ± 2,67*,◆
16	66,68 ± 3,40	133,1 ± 3,12*	105,9 ± 6,58*,◆◆	124,9 ± 3,42*,▸▸▸
20	67,96 ± 5,16	144,5 ± 7,8*	121,4 ± 4,1*,◆◆	146,7 ± 2,75*,▸
24	83,94 ± 15,0	156,4 ± 12,9**	154,8 ± 0,97*	159,1 ± 3,13*
Indices of broad body, %				
2	42,3 ± 0,5	43,4 ± 1,0	37,2 ± 1,0◆	42,4 ± 0,3▸
4	38,7 ± 0,7	44,1 ± 5,0	38,5 ± 1,1	40,3 ± 0,3
6	39,2 ± 0,4	46,9 ± 2,0	37,3 ± 0,1◆	40,3 ± 0,3◆◆,▸▸
8	40,7 ± 0,4	45,5 ± 2,1	40,2 ± 0,1◆◆◆	41,2 ± 0,3
10	39,9 ± 0,6	45,3 ± 2,0	40,6 ± 1,1	40,6 ± 0,6
12	39,0 ± 0,8	44,5 ± 2,1	37,3 ± 0,1◆◆	40,3 ± 0,6▸
16	39,7 ± 0,9	44,1 ± 2,0	38,4 ± 0,1	42,1 ± 1,0▸▸▸
20	40,5 ± 1,6	41,9 ± 2,8	37,7 ± 0,1	46,3 ± 1,1▸
24	41,4 ± 7,2	39,8 ± 4,0	36,4 ± 0,1	47,1 ± 0,7▸

*	RW × COR, RW × F1, RW×F2	*	$p \le 0{,}001$	**	$p \le 0{,}01$	***	$p \le 0{,}05$
◆	COR × F1, COR × F2	◆	$p \le 0{,}001$	◆◆	$p \le 0{,}01$	◆◆◆	$p \le 0{,}05$
▸	F1×F2	▸	$p \le 0{,}001$	▸▸	$p \le 0{,}01$	▸▸▸	$p \le 0{,}05$

The broad body index is also applicable for assessing quality of poultry meat, as it can indicate amount of fat and muscle mass in the carcass [14]. The higher the broad body index, the more developed the muscles and bones of the bird, which is due to its health and ability to grow quickly. However, it should be noted that the broad body index is not the only indicator of poultry quality and should not be used as the main criterion when choosing poultry for breeding or growing [15].

According to the body weight index, Cornish cockerels from the age of 4 weeks surpassed individuals from other groups, which is typical for individuals of meat breeds. However, by the onset of sexual maturity, at the age of 20 weeks, individuals of the second generation were equal to or slightly exceeded the parental form by 24 weeks: no more than 1.2%. According to the broad body index, the second-generation individuals

also showed higher values at maturity when compared with the parental forms of meat productivity. At the same time, a reliable difference between Cornish and second-generation crossbreeds was only at the age of 6 weeks. Based on the obtained results, F2 cockerels can be characterized as healthy and fast-growing individuals with well-developed muscles, showing the effect of heterosis and being promising for growing.

However, despite the differences, all generations of chickens had a number of common characteristics, such as rapid growth in the first months of life, intensive development of muscle mass and bone structure.

Conclusion

The study showed that chicken selection can lead to different results depending on the breeding goals. It is important to monitor growth and development of chickens during selection process to avoid deterioration of indicators and maintain the desired characteristics.

The data obtained indicate that the growth and development of chickens can be improved using modern technologies and selection methods. The use of model forms can serve as an effective tool for improving growth and development of chickens, since high values of variability of phenotypic traits are a good prerequisite for genetic analysis with subsequent identification of loci of quantitative traits associated with growth and development based on the GWAS method.

References

1. Buyarov AV, Buyarov VS, Komolikova IV. Production and processing of poultry products in modern economic conditions: trends and innovations. *Bulletin of Agrarian Science*. 2023;(3):133—143. (In Russ.). doi: 10.17238/issn2587-666X.2023.3.133

2. Buyarov VS, Buyarov AV, Aldobaeva NA. Scientific support of egg and meat poultry farming in Russia. *Effektivnoe zhivotnovodstvo*. 2018;(3):64—68. (In Russ.).

3. Mueller S, Taddei L, Albiker D, Kreuzer M, Siegrist M, Messikommer RE, et al. Growth, carcass, and meat quality of 2 dual-purpose chickens and a layer hybrid grown for 67 or 84 D compared with slow-growing broilers. *Journal of Applied Poultry Research*. 2020;29(1):185—196. doi: 10.1016/j.japr.2019.10.005

4. Dadousis C, Somavilla A, Ilska JJ, Johnsson M, Batista L, Mellanby RJ, et al. A genome-wide association analysis for body weight at 35 days measured on 137,343 broiler chickens. *Genetics Selection Evolution*. 2021;53:70. doi: 10.1186/s12711-021-00663-w

5. Li F, Han H, Lei Q, Gao J, Liu J, Liu W, et. al. Genome-wide association study of body weight in Wenshang Barred chicken based on the SLAF-seq technology. *Journal of Applied Genetics*. 2018;59(3):305—312. doi: 10.1007/s13353-018-0452-7

6. Brandt M, Ahsan M, Honaker CF, Siegel PB, Carlborg Ö. Imputation-Based Fine-Mapping Suggests That Most QTL in an Outbred Chicken Advanced Intercross Body Weight Line Are Due to Multiple, Linked Loci. *G3 (Bethesda)*. 2017;7(1):119—128. doi: 10.1534/g3.116.036012

7. Gu X, Feng C, Ma L, Song C, Wang Y, Da Y, et al. Genome-wide association study of body weight in chicken F2 resource population. *PLoS One*. 2011;6(7): e21872. doi: 10.1371/journal.pone.0021872

8. Dementyeva NV, Mitrofanova OV, Larkina TA. Genetic variability of chick populations with different productivity directions for SNPs in the locus containing the myostatin gene. *Izvestia Orenburg State Agrarian University*. 2020;(4):231—235. (In Russ.). doi: 10.37670/2073-0853-2020-84-4-231-235

9. Zhuchaev K, Sulimova L, Kochneva M, Saveliev AA, Novikov EA, Kondratyuk EY, et al. Meat breed laying hens' response on chronic stress in different housing systems. *Genetics and breeding of animals*. 2019;(2):121—128. (In Russ.). doi: 10.31043/2410-2733-2019-2-121-128

10. Sheng Z, Pettersson ME, Hu X, Luo C, Qu H, Shu D, et.al. Genetic dissection of growth traits in a Chinese indigenous × commercial broiler chicken cross. *BMC Genomics*. 2013; 14:151. doi: 10.1186/1471-2164-14-151

11. Lukanov H, Pavlova I. Morphological and morphometric characterization of Bulgarian local chicken breed. *Agricultural Science and Technology*. 2021;13(2):147—151. doi: 10.15547/ast.2021.02.024

12. Bhuiyan M, Ferdaus AJ, Bhuiyan AKFH, Hassin B, Ali M. Body conformation, morphometry indices and inheritance pattern of indigenous dwarf chickens of Bangladesh. *Journal of Poultry Research*. 2019;16(2):55—61. doi: 10.34233/jpr.605051

13. Fajemilehin SOK. Discriminant analysis of sexual dimorphism in zoometrical characters of normal feathered Yoruba ecotype adult local chicken in the Tropical Forest Zone of Nigeria. *Journal of Animal Science and Veterinary Medicine*. 2017;2(4):139—144. doi: 10.31248/JASVM2017.060

14. Pirany N, Bakrani Balani A, Hassanpour H, Mehraban H. Differential expression of genes implicated in liver lipid metabolism in broiler chickens differing in weight. *British Poultry Science*. 2020;61(1):10—16. doi: 10.1080/00071668.2019.1680802

15. Kokoszyński D, Bernacki Z, Saleh M, Stęczny K, Binkowska M. Body conformation and internal organs characteristics of different commercial broiler lines. *Brazilian Journal of Poultry Science.* 2017;19(1):47—52. doi: 10.1590/1806-9061-2016-0262

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Сравнение показателей роста и развития, влияющих на мясную продуктивность петушков в ресурсных популяциях

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Аннотация. Создание ресурсных популяций животных является удобным инструментом для изучения генетического разнообразия, повышения эффективности селекции и сохранении генетических ресурсов. Изучена ресурсная популяция петушков, состоящая из особей яичного и мясного направления продуктивности, а также их потомков первого и второго поколения, проанализированы различия в росте и развитии у разных генераций. Проведен анализ разности и изменчивости по показателю живой массы.

Дана характеристика экстерьера на основе индексов массивности и широкотелости — показателей, имеющих зависимости с мясной продуктивностью птицы. У особей первого и второго поколения выявлена достоверная разность по живой массе в сравнении с родительской формой породы русская белая во всех возрастах, а в сравнении с породой корниш — с 4-й по 12-ю неделю у особей второго поколения и по 16-ю неделю у особей первого поколения. Изучение коэффициента вариации показало, что у петушков первого поколения в возрасте 10…12 недель он был выше 25 %, что говорит о высокой степени изменчивости признака по показателю живой массы в сравнении с остальными особями в ресурсной популяции. У породы корниш наблюдался самый низкий коэффициент вариабельности признака в возрастах 6, 12 и 20 недель. По индексам широкотелости и массивности у петушков второго поколения наблюдался эффект гетерозиса при их развитии к возрасту 20 недель, что характеризовало их как здоровых и быстрорастущих особей с хорошо развитой мускулатурой. Результаты нашего исследования могут помочь птицеводам в селекционной работе при подборе кур с целью создания новых пород и линий с улучшенными характеристиками, а для частных и личных хозяйств повысить эффективность собственного производства.

Ключевые слова: куры, русская белая, корниш, помеси, индексы телосложения

Вклад авторов: Ветох А.Н. — дизайн исследования, сбор и обработка материала, анализ полученных данных, написание текста; Волкова Н.А. — концепция и дизайн исследования; Джагаев А.Ю. — сбор материала.

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