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RECEIVED 18 February 2025

ACCEPTED 14 April 2025

PUBLISHED 07 May 2025

CITATION

Hu Y, Tan Y, Liu J, Tang H, Wang K, Tang F,
Luo J and Wen X (2025) Corrigendum:
Analysis of the response to high temperature
stress in hybrid grouper (*Epinephelus
fuscoguttatus*♀×*E. lanceolatus*♂).
Front. Mar. Sci. 12:1578671.
doi: 10.3389/fmars.2025.1578671

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Corrigendum: Analysis of the response to high temperature stress in hybrid grouper (*Epinephelus fuscoguttatus*♀×*E. lanceolatus*♂)

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KEYWORDS

hybrid grouper, high temperature tolerance, genetic analysis, gene expression, physiological analysis

A Corrigendum on

[Analysis of the response to high temperature stress in hybrid grouper \(*Epinephelus fuscoguttatus*♀×*E. lanceolatus*♂\)](#)

by Hu Y, Tan Y, Liu J, Tang H, Wang K, Tang F, Luo J and Wen X (2024). *Front. Mar. Sci.* 11:1466656. doi: 10.3389/fmars.2024.1466656

In the published article, there was an error in the legends for [Figures 1–5](#) as published. “Brown-marbled Grouper” should be “Tiger Grouper”, “Orange-spotted Grouper” should be “Giant Grouper”, “Tiger Grouper hybrid” should be “Hulong hybrid Grouper”. The corrected legends appear below.

In the published article, there was an error in [Table 1](#) as published. “Hulong hybrid grouper” should be used instead of “hybrid spot between a tiger and a dragon”. The corrected [Table 1](#) and its caption appear below.

In the published article, there was an error in [Table 2](#) as published. “Brown-marbled Grouper” should be “Tiger Grouper” and “Orange-spotted Grouper” should be “Giant Grouper”. The corrected [Table 2](#) and its caption appear below.

In the published article, there was an error. “pearl gentian grouper” and “hybrid tiger grouper” should be “Hulong hybrid grouper”, “Brown-marbled Grouper” should be “Tiger Grouper” and “saddle grouper” should be “giant grouper”.

A correction has been made to **Abstract**, Paragraphs 10, 13, 16, 24. The sentences previously stated:

“TG, COR) and liver (HSP70, HSP90, SOD, CAT) in pearl gentian grouper and”

“and the lethal temperature of hybrid tiger grouper and saddle grouper is 40°C.”

“between pearl gentian grouper and their parents revealed common DEGs”

“tolerance in pearl gentian grouper and their parents”

The corrected sentences appear below:

“TG, COR) and liver (HSP70, HSP90, SOD, CAT) in Hulong hybrid grouper and”

“and the lethal temperature of Hulong hybrid grouper and giant grouper is 40°C”

“between Hulong hybrid grouper and their parents revealed common DEGs)”

“tolerance in Hulong hybrid grouper and their parents”

A correction has been made to **Introduction**, Paragraphs 51, 57–58, 60, 65, 71, 74, 77, 79–80. The sentences previously stated:

“The suitable water temperature range of saddle”

“Tiger grouper hybrids fed with shrimp diets exhibit high red blood cell”

“Tiger grouper hybrids, resulting from”

“tiger grouper hybrids and their parent species,”

“of tiger grouper hybrids, as well as the parental species, which are”

“indirectly affecting the production of tiger grouper hybrids.”

“tiger grouper hybrids and their parent species,”

“tolerance in tiger grouper hybrids and their intrinsic connections”

“and key genes involved in the heat stress response of tiger grouper hybrids and their parents,”

The corrected sentences appear below:

“The suitable water temperature range of giant”

“Hulong hybrid groupers fed with shrimp diets exhibit high red blood cell”

“Hulong hybrid groupers, resulting from”

“Hulong hybrid groupers and their parent species,”

“of Hulong hybrid groupers, as well as the parental species, which are”

“indirectly affecting the production of Hulong hybrid groupers.”

“Hulong hybrid groupers and their parent species,”

“tolerance in Hulong hybrid groupers and their intrinsic connections”

“and key genes involved in the heat stress response of Hulong hybrid groupers and their parents,”

A correction has been made to **2 Materials and methods, 2.1 Temporary rearing management of Tiger grouper hybrids and their parents**, Sub-section and Paragraphs 3, 7. The sentences previously stated:

“2.1 Temporary rearing management of Tiger grouper hybrids and their parents”

“In October 2022, saddle grouper (*E. lanceolatus*)”

“Additionally, hybrid tiger grouper”

The corrected sentences appear below:

“2.1 Temporary rearing management of Hulong hybrid groupers and their parents”

“In October 2022, giant grouper (*E. lanceolatus*)”

“Additionally, Hulong hybrid groupers”

A correction has been made to **2 Materials and methods, 2.2 Short-term evaluation of heat tolerance in Tiger grouper hybrids and their parents**, Sub-section and Paragraph 1. The sentences previously stated:

“2.2 Short-term evaluation of heat tolerance in Tiger grouper hybrids and their parents”

“A total of 160 individuals each of hybrid tiger grouper, saddle”

The corrected sentences appear below:

“2.2 Short-term evaluation of heat tolerance in Hulong hybrid groupers and their parents”

“A total of 160 individuals each of Hulong hybrid groupers, giant”

A correction has been made to **2 Materials and methods, 2.3 Long-term heat stress experiment on Tiger grouper hybrids and their parents**, Sub-section and Paragraphs 1, 4, 7. The sentences previously stated:

“2.3 Long-term heat stress experiment on Tiger grouper hybrids and their parents”

“A total of 120 individuals, each of hybrid tiger grouper, saddle”

“at a density of 30 individuals per tank. Among them, the saddle”

“hybrid tiger grouper had 60 individuals each in both the control”

The corrected sentences appear below:

“2.3 Long-term heat stress experiment on Hulong hybrid groupers and their parents”

“A total of 120 individuals, each of Hulong hybrid groupers, giant”

“at a density of 30 individuals per tank. Among them, the giant”

“Hulong hybrid grouper had 60 individuals each in both the control”

A correction has been made to **2 Materials and methods, 2.4 Physiological and biochemical analysis of serum and liver in Tiger grouper hybrids and their parents**. This sentence previously stated:

“2.4 Physiological and biochemical analysis of serum and liver in Tiger grouper hybrids and their parents”

The corrected sentence appears below:

“2.4 Physiological and biochemical analysis of serum and liver in Hulong hybrid groupers and their parents”

A correction has been made to **2 Materials and methods, 2.5 Transcriptome analysis of liver in Tiger grouper hybrids and their parents under high-temperature stress**. This sentence previously stated:

“2.5 Transcriptome analysis of liver in Tiger grouper hybrids and their parents under high-temperature stress”

The corrected sentence appears below:

“2.5 Transcriptome analysis of liver in Hulong hybrid groupers and their parents under high-temperature stress”

A correction has been made to **3 Result, 3.1 Evaluation of high-temperature tolerance in Tiger Dragon hybrid groupers and their parents**, Sub-section, Paragraphs 2–3, 3, 8, 9, 12, 13, 14, 16, 20–21, 22, 30, 40. These sentences previously stated:

“3.1 Evaluation of high-temperature tolerance in Tiger Dragon hybrid groupers and their parents”

“The high-temperature tolerance of the tiger dragon hybrid grouper and its parent species, the saddle grouper and the tiger”

“The tiger dragon reached 50% lethality after 1.5 hour at 40°C”

“The saddle grouper showed 50% mortality at”

“tolerance of the tiger dragon hybrid overlapped with that of the saddle grouper at 38–40°C, indicating that the saddle grouper is more sensitive to high temperatures than the tiger dragon hybrid”

“During high-temperature stress, both the tiger dragon hybrid”

“the tiger dragon hybrid’s body color changed from deep black to yellow-black (Figures 1C, D); and the saddle grouper’s skin color changed”

“observed between the experimental and control groups of saddle”

“In the tiger dragon hybrid, there were no significant differences”

The corrected sentences appear below:

“3.1 Evaluation of high-temperature tolerance in Hulong hybrid groupers and their parents”

“The high-temperature tolerance of the Hulong hybrid grouper and its parent species, the giant grouper and the tiger”

“The Hulong hybrid groupers reached 50% lethality after 1.5 hour at 40°C”

“The giant grouper showed 50% mortality at”

“tolerance of the Hulong hybrid grouper overlapped with that of the giant grouper at 38–40°C, indicating that the giant grouper is more sensitive to high temperatures than the Hulong hybrid grouper”

“During high-temperature stress, both the Hulong hybrid grouper”

“the Hulong hybrid grouper’s body color changed from deep black to yellow-black (Figures 1C, D); and the giant grouper’s skin color changed”

“observed between the experimental and control groups of giant”

“In the Hulong hybrid grouper, there were no significant differences”

A correction has been made to **3 Result, 3.2 Physiological and biochemical levels of the Tiger Dragon hybrid grouper and its parents under high-temperature stress**, Sub-section and Paragraphs 4, 33, 65, 88. These sentences previously stated:

“3.2 Physiological and biochemical levels of the Tiger Dragon hybrid grouper and its parents under high-temperature stress”

“The saddle Grouper: Cortisol (COR) levels”

“Tiger Dragon Hybrid: Cortisol (COR) levels were significantly”

“The saddle grouper: On day 1, catalase (CAT) levels in the liver”

“Tiger Dragon Hybrid: Significant differences in liver CAT levels”

The corrected sentences appear below:

“3.2 Physiological and biochemical levels of the Hulong hybrid groupers and its parents under high-temperature stress”

“The Giant Grouper: Cortisol (COR) levels”

“Hulong hybrid Grouper: Cortisol (COR) levels were significantly”

“The giant grouper: On day 1, catalase (CAT) levels in the liver”

“Hulong hybrid Grouper: Significant differences in liver CAT levels”

A correction has been made to **3 Result, 3.3 transcriptome analysis of the Tiger Dragon hybrid and its parents under heat stress**, Sub-section and Paragraphs 3–4, 23–24, 25, 30–31, 32, 57, 65, 73–74, 99. These sentences previously stated:

“3.3 Transcriptome analysis of the Tiger Dragon hybrid and its parents under heat stress”

“Transcriptome sequencing was performed on the tiger dragon hybrid and its parent species”.

“temperature and normal-temperature groups in the tiger dragon hybrid. Among these, 168 genes were downregulated, and 98 genes were upregulated. In saddle Grouper, 947 DEGs were identified”,

“the DEGs identified in the transcriptomes of the tiger dragon hybrid, tiger grouper, and saddle Grouper. The tiger dragon hybrid and saddle Grouper used the same reference genome for”

“the spotted knifejaw and hybrid grouper mainly exhibit”

“*E. lanceolatus*, and their hybrid *Epinephelus lanceolatus*”

“Based on Figure 5, the differential analysis among the hybrid *Epinephelus lanceolatus* and its parental species reveals”

“enriched pathways in the hybrid *Epinephelus lanceolatus*”

The corrected sentence appears below:

“3.3 Transcriptome analysis of the Hulong hybrid groupers and its parents under heat stress”

“Transcriptome sequencing was performed on the Hulong hybrid grouper and its parent species.”

“temperature and normal-temperature groups in the Hulong hybrid grouper. Among these, 168 genes were downregulated, and 98 genes were upregulated. In Giant Grouper, 947 DEGs were identified,”

“the DEGs identified in the transcriptomes of the Hulong hybrid grouper, tiger grouper, and giant grouper. The Hulong hybrid grouper and giant grouper used the same reference genome for”

“the giant grouper and hybrid grouper mainly exhibit”

“*E. lanceolatus*, and the Hulong hybrid grouper”

“Based on Figure 5, the differential analysis among the Hulong hybrid grouper and its parental species reveals”

“enriched pathways in the Hulong hybrid grouper”

A correction has been made to **4 Discussion, 4.1 Evaluation of high-temperature tolerance in hybrid grouper and its parental species**, Paragraphs 31, 44, 46, 51, 52, 54, 55, 56, 57, 72, 83, 98, 101, 109, 111. These sentences previously stated:

“Pearl groupers exposed to different”

“*lanceolatus* × *Epinephelus fuscoguttatus*), with the saddle grouper”

“across other hybrid grouper species. For instance, the tiger”

“Yunlong grouper exhibits high genetic similarity and close genetic distance to the *Epinephelus lanceolatus*”

“temperatures for the hybrid tiger grouper and the hybrid green grouper are 34.9°C and 37.9°C, respectively, higher than their maternal parent but lower than their paternal saddle grouper (Shao et al., 2017). The heat tolerance of hybrid tiger grouper “

“paternal Wami catfish, respectively, suggesting asymmetrical”

“differences in body color intensity, while the saddle grouper”

“Saddle groupers start off yellow with irregular black markings in”

“In this study, saddle groupers exhibited overall”

“aquaculture saddle groupers, possibly due to differences in fish”

TABLE 1 Performance of the hybrid grouper and their parents under different high temperature stress.

Temperature (°C)	Hulong hybrid Grouper	Epinephelus septemfasciatus	Epinephelus septemfasciatus
28	normalcy	normalcy	normalcy
39	normalcy	normalcy	normalcy
30	normalcy	normalcy	normalcy
31	normalcy	normalcy	normalcy
32	normalcy	normalcy	normalcy
33	normalcy	normalcy	normalcy
34	normalcy	Fish with obvious patches and some white spots faded	normalcy
35	normalcy	Fish with visible plaques, white spots that fade and turn golden in color	normalcy
36	Decreased vigor of some fish	Fish with visible plaques, white spots that fade and turn golden in color	Fish are unresponsive, individual fish are stressed
37	Fish become less vigorous and gradually lighten in color.	Fish with visible and increased golden coloration patches	Fish are unresponsive, individual fish are stressed
38	Reduced fish vitality, lighter body color and upward swimming, reduced feeding	Fish with visible, gold-colored patches increase and begin to show ambush and reduced feeding	Reduced feeding and vigor of fish
39	Fish are floating head, bottoming out, sticking to the wall and stopping swimming	Fish are bottomed out, attached to the wall, poor vigor and stop feeding, floating head after 2h	Fish feeding ability is poor, swimming ability decreases, body color begins to lighten, and mild hypoxia occurs after 2h
40	Stopped swimming, appeared to roll over and die, half lethal after 1.5h	Fish stop swimming, half of the wall floating head, half of the bottom, 0.5h later flipped sideways, 1h later half of the lethal	Head floating and body turning sideways after 1h fish body
41			Fish appeared to float their heads against the wall and ambush the bottom after 1h, and began to show death, and half of them were lethal after 1.5h

“artificially reared saddle groupers differ from those of wild juveniles,”

The corrected sentences appear below:

“Hulong hybrid grouper exposed to different”

“*lanceolatus* × *Epinephelus fuscoguttatus*), with the giant grouper”

“across other hybrid grouper species. For instance, the Hulong hybrid”

“hybrid grouper (*Epinephelus moara*♀ × *Epinephelus lanceolatus*♂) exhibits high genetic similarity and close genetic distance to the *Epinephelus moara*”

“temperatures for the hybrid grouper (*Epinephelus moara*♀ × *Epinephelus lanceolatus*♂) and the hybrid grouper (*Epinephelus coioides* ♀ × *Epinephelus lanceolatus*♂) are 34.9°C and 37.9°C,

TABLE 2 Differential gene statistics.

Species	Up-regulated genes	Down-regulated genes
Hybrid Grouper	168	98
Giant Grouper	646	301
Tiger Grouper	173	72

respectively, higher than their maternal parent but lower than their paternal giant grouper (Shao et al., 2017). The heat tolerance of hybrid grouper (*Epinephelus moara*♀ × *Epinephelus lanceolatus*♂)”

“paternal *Pelteobagrus vachelli*, respectively, suggesting asymmetrical”

“differences in body color intensity, while the giant grouper”

“Gaint groupers start off yellow with irregular black markings in”

“In this study, giant groupers exhibited overall”

“aquaculture giant groupers, possibly due to differences in fish”

“artificially reared giant groupers differ from those of wild juveniles,”

A correction has been made to **4 Discussion**, 4.2 Growth characteristics of Tiger grouper hybrid and its parents under different temperature stress, Sub-section and Paragraphs 10, 53. These sentences previously stated:

“4.2 Growth characteristics of Tiger grouper hybrid and its parents under different temperature stress”

“activity in pearl grouper (*Epinephelus fuscoguttatus*) at 25°C”

“tiger grouper hybrid in terms of stress, and indicators such as”

The corrected sentences appear below:

“4.2 Growth characteristics of Hulong hybrid and its parents under different temperature stress”

“activity in tiger grouper (*Epinephelus fuscoguttatus*) at 25°C”

“Hulong hybrid grouper in terms of stress, and indicators such as”

A correction has been made to **4 Discussion**, 4.3 *Physiological and biochemical analysis of Hulong hybrid grouper and its parents under different temperature stress*, Sub-section and Paragraphs 4, 5, 38, 43. These sentences previously stated:

“4.3 Physiological and biochemical analysis of Tiger grouper hybrid and its parents under different temperature stress”

“cortisol levels in the serum of saddle grouper, tiger grouper, and tiger grouper hybrid (Figure 5) were significantly influenced by”

“CAT levels in the high-temperature groups of saddle grouper”

“compared to the control, whereas saddle grouper showed the”

The corrected sentences appear below:

“4.3 Physiological and biochemical analysis of Hulong hybrid grouper and its parents under different temperature stress”

“cortisol levels in the serum of giant grouper, tiger grouper, and Hulong hybrid grouper (Figure 5) were significantly influenced by”

“CAT levels in the high-temperature groups of giant grouper”

“compared to the control, whereas giant grouper showed the”

The authors apologize for the errors and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

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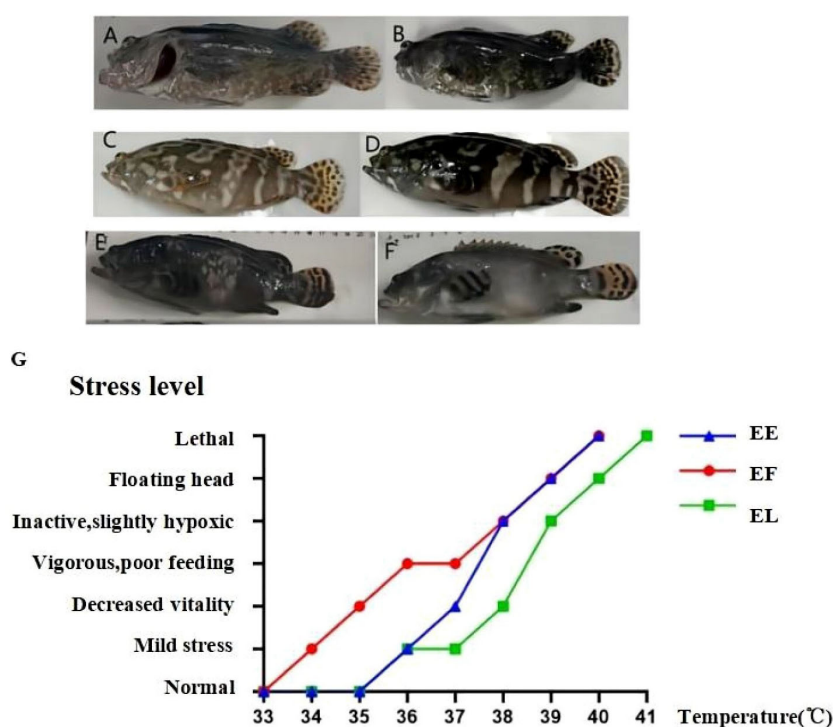


FIGURE 1

Color Differences in Three Types of Groupers under High-Temperature Stress. Tiger Grouper (A, B), Hybrid Grouper (C, D), Giant Grouper (E, F); (A, C, E) represent the high-temperature group, (B, D, F) represent the normal-temperature group; (G) shows the stress responses of the Hybrid Grouper and its parents under different high-temperature stresses. EE represents the Hybrid Grouper, EL represents the Giant Grouper, and EF represents the Tiger Grouper.

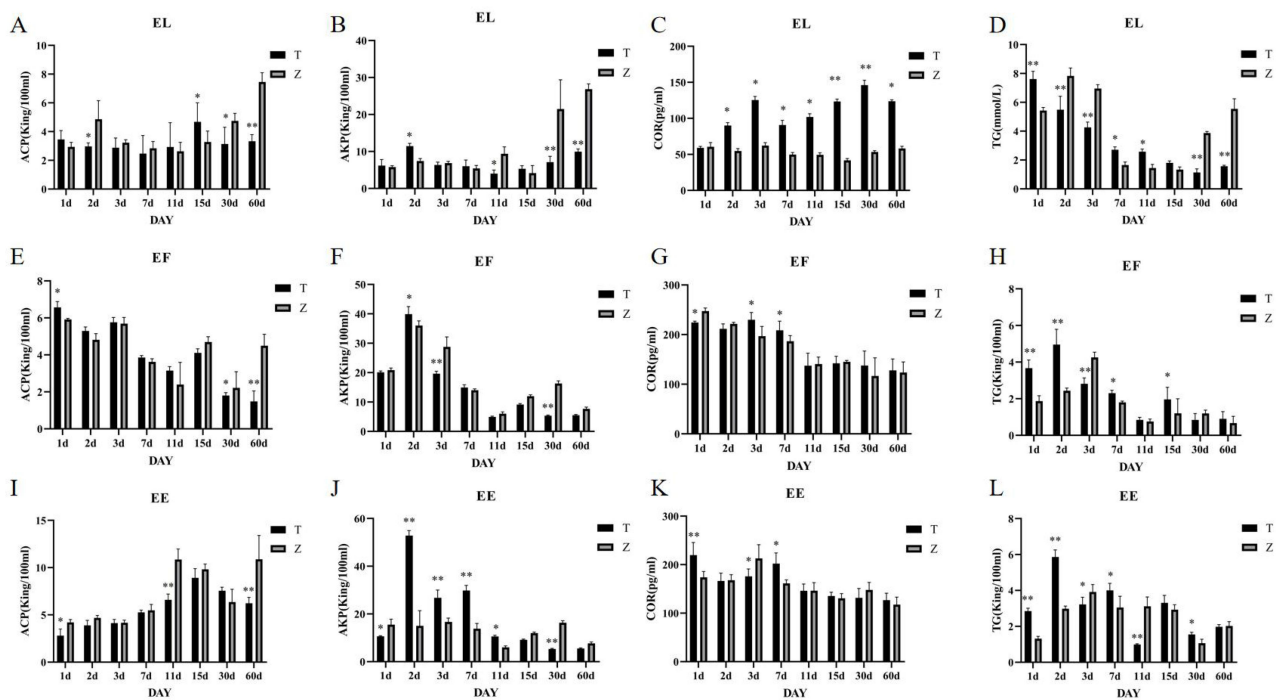


FIGURE 2

(A–L) Changes in serum ACP, AKP, COR, and TG activities in the three grouper species under different stress days. T represents the high temperature group (36°C), Z represents the normal-temperature group (28–29°C), and samples were taken on days 1, 2, 3, 7, 11, 15, 30, and 60 of cultivation. EE represents the Hybrid Grouper, EL represents the Giant Grouper, and EF represents the Tiger Grouper.

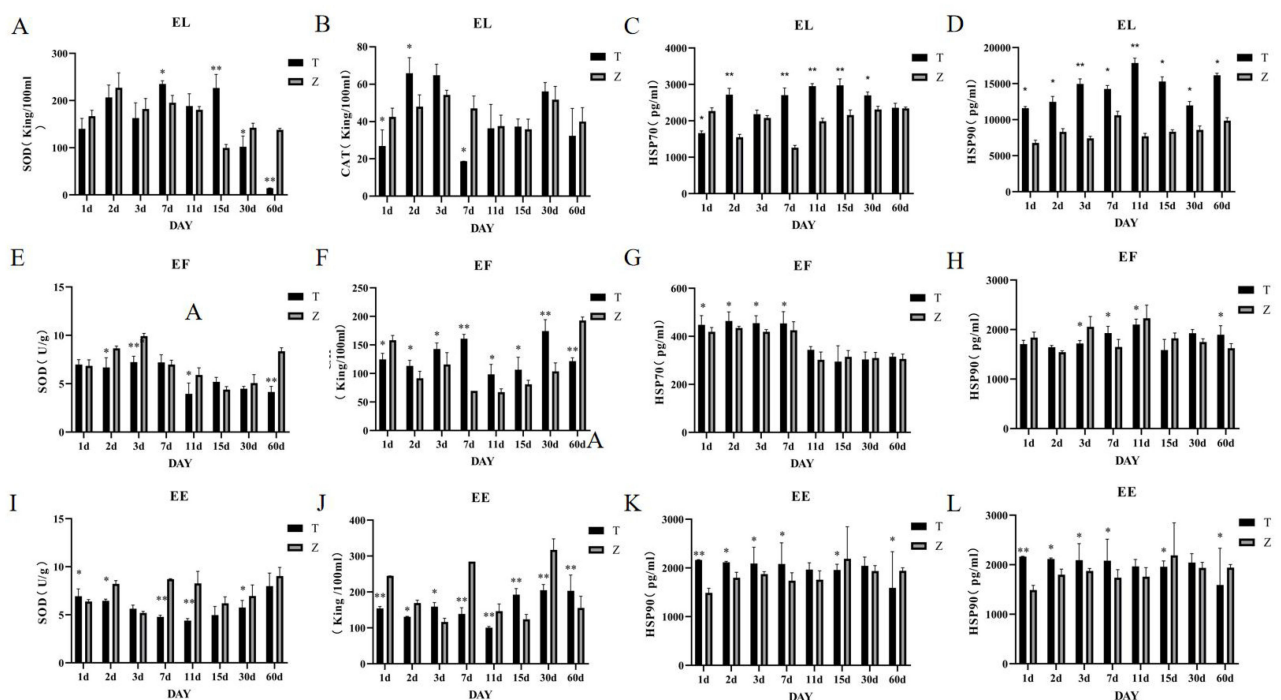


FIGURE 3

(A–L) Changes in liver SOD, CAT, HSP70, and HSP90 activities in the three grouper species under different stress days. T represents the high temperature group (36°C), Z represents the normal-temperature group (28–29°C), and samples were taken on days 1, 2, 3, 7, 11, 15, 30, and 60 of cultivation. EE represents the Hybrid Grouper, EL represents the Giant Grouper, and EF represents the Tiger Grouper.

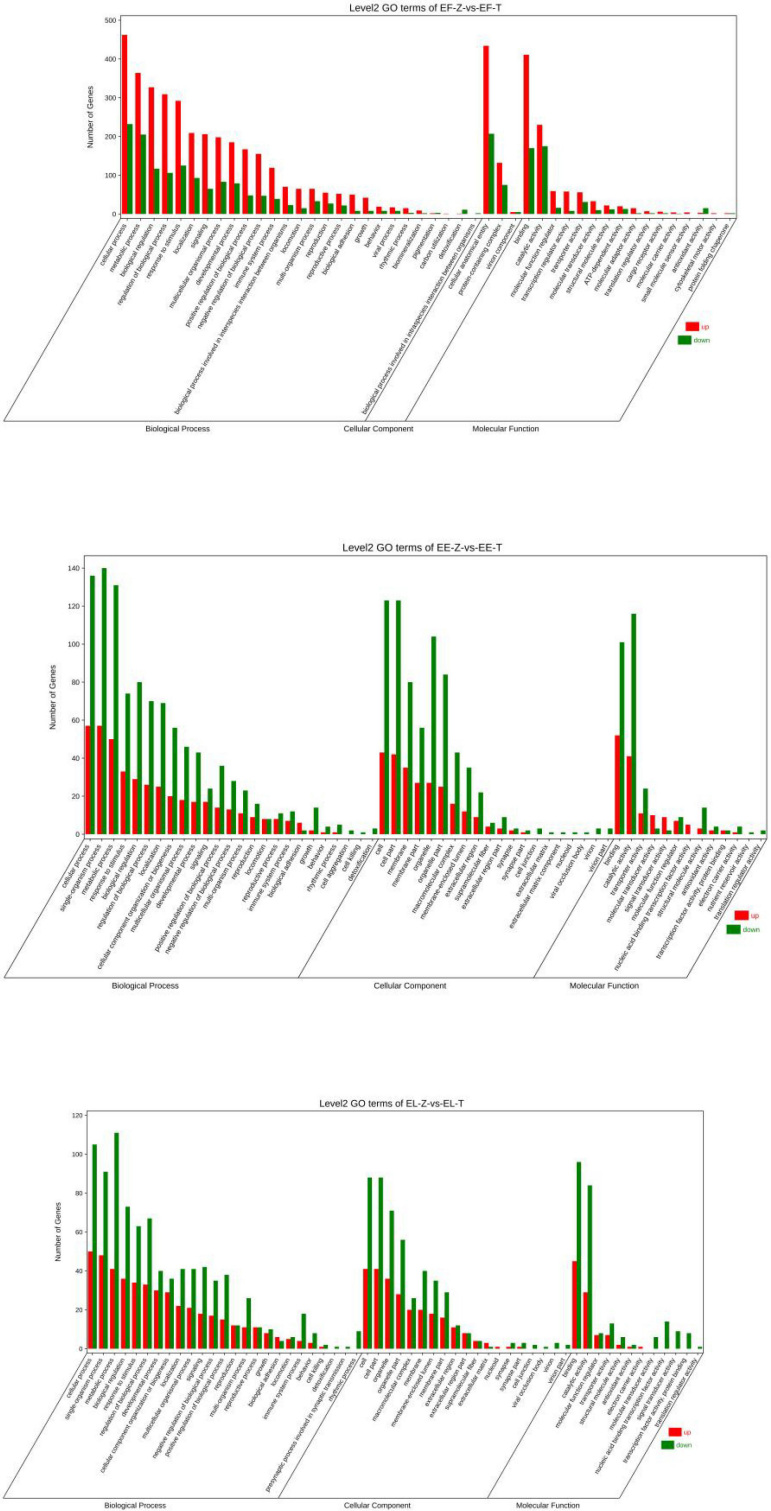


FIGURE 4
GO classification of the Hulong hybrid Grouper and its parents.

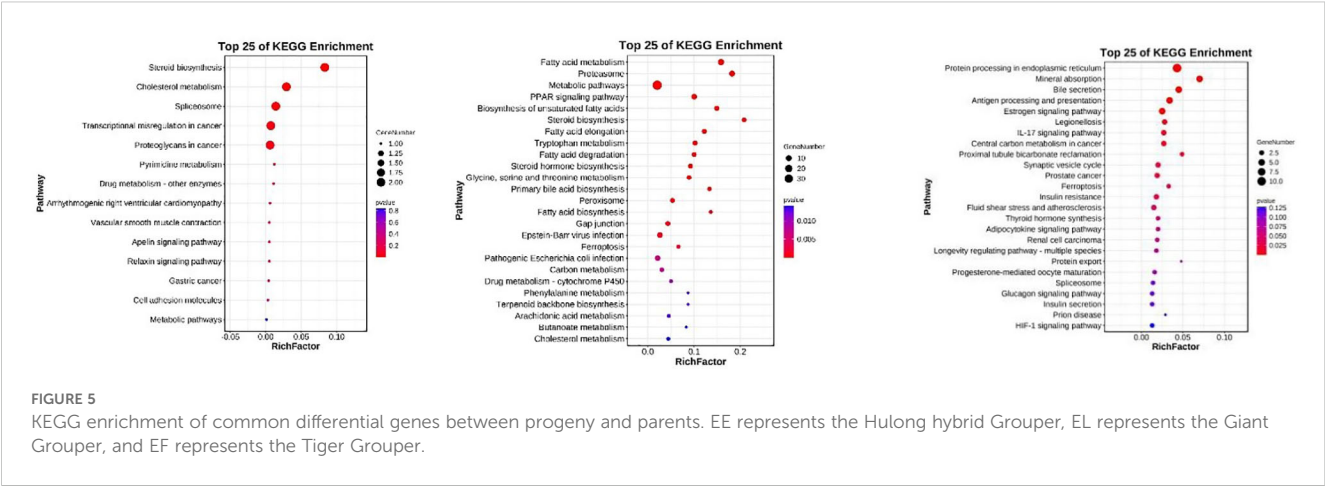


FIGURE 5 KEGG enrichment of common differential genes between progeny and parents. EE represents the Hulong hybrid Grouper, EL represents the Giant Grouper, and EF represents the Tiger Grouper.