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Chemotactic activities in the Combinations of Attractant and Weak Repellent for Oriental Weatherfish*1

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The chemotactic activities in the combinations of attractant and weak repellent were behaviorally examined for the oriental weatherfish *Misgurnus anguillicaudatus*. The attractants tested were L-lysine and L-alanine, while the weak repellents were DL-lactic acid, pyruvic acid and succinic acid.

The chemotactic activity of either 100mM of L-lysine or L-alanine was significantly affected by an addition of 100mM of each repellent. There was no difference in the activity of repellents. Similarly, the activity of 10mM of DL-lactic acid, pyruvic acid or succinic acid was affected by the addition of 1, 10, and 100mM of L-lysine. It is noted that the activities of the repellents were similar to each other. It seems that the effects of the repellents were more significant than those of the attractants.

1 Introduction

Up to date, many researches involved in feeding stimuli for aquatic animals have been gone into a great deal of effort on surveying the attractants in the foodstuff, and focused on the collaborative effect in the combinations of them.[1] Conversely speaking, it is conceived that the researches have been neglected on the repellents in the foodstuff. However, in consideration of containing many diverse constituents and substances in the foodstuff, the feeding attraction activity mainly depends on chemical stimuli of them. The stimuli consist of a variety of the activators (attractants, stimulants and so on) and inhibitors (repellents, suppressants and so on), to some extent in effect. Accordingly, the attraction activity in the foodstuff must be, as the matter of fact, comprehensively grasped on the effect of the stimuli. The studies on the attraction activities in the combinations of attractant and repellent among chemical stimuli have been not found so far.

In this connection, the combinations of certain attractant and strong repellent for oriental weatherfish were ascertained to be remarkably affected to the chemotactic activity in an exploratory and feeding behavior.[2] To elucidate the effect of attractant vs. weak repellent on chemotactic activity in consideration of the quality of repellent, the present paper deals with the chemotactic activity in the model systems of the combinations of attractant (L-lysine or L-alanine)[3] and weak repellent (DL-lactic acid, pyruvic acid or succinic acid)[4] for the fish.

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2 Materials and Methods

2.1 Test Animals

Oriental weatherfish (average body length, 8.7cm) were obtained from an aquaculture farm in Shiga prefecture. Forty individuals (two groups, 20 individuals) in each were kept in an experimental aquarium for estimating the chemotactic activity.

2.2 Test Samples

Two representative attractants,[3] L-lysine and L-alanine, and three representative weak repellents,[4] DL-lactic acid, pyruvic acid and succinic acid were used. Original solution was prepared at concentration of 200mM each. The solutions were, if necessary, adjusted to pH 6.5 by addition of dilute sodium hydroxide or hydrochloric acid. Final volume of test solutions was made up 7.5m*l* with the equivolume of specific concentration each.

2.3 Estimation of Chemotactic Activities by Their Indexes

Chemotactic activities were estimated according to the previous paper.[5] The method for estimating the chemotaxis index, attraction and repellence ones is as follows. To conduct duplicate experiments at the same time, the experimental aquarium was divided into two chambers and each chamber was consisted of one resident and two test compartments. Twenty individuals were put in each resident chamber. The behavioral experiments were conducted by applying test sample and dummy to the test compartment of each chamber alternately; firstly test sample to one compartment and dummy to the other, and after that the treatment was reversed, according to Latin square. A 7.5m*l* of test sample was absorbed into a crumpled gauze ball (a sheet, 25×25cm), and an untreated ball was used as dummy for control. The gauze ball was placed at the opposite side of test compartment. Water was continously introduced at flow rate of 500m*l*/min into each test compartment through the pipe of water inlet during experiments. The number of individuals entering the test compartment in 1 min for 10 min after application of a test sample was counted. The entering time-course to estimate the chemotaxis index was obtained from integrating each number with passing time for ten minutes.

The time-course mentioned above was applied to a logistic curve $y=g/\{1+\exp[-r(x-a)]\}$. The fitness of the time-course was checked by chi-square test, at 0.100 level. A chemotaxis index R*a* (C.I.R*a*), i.e., the ratio of dummy-a divided to sample-a was calculated. The C.I.R*a* shows the attraction index of being below 1 and a repellence index of being over 1.

3 Results and Discussion

When 100mM of L-lysine or L-alanine containing various concentrations of repellents including 1,10 and 100mM were tested, the chemotactic activity of attractants was found to be significantly affected by addition of repellents as shown in Fig.1. Furthermore there was no difference in the activity of repellents. Especially, when concentrations of repellents were 100mM, the activity of attractants were diminished to greater extent.

To the next place, 10mM of either DL-lactic acid, pyruvic acid or succinic acid containing various concentrations of L-lysine were tested. Three results were quite similar to those obtained in first experiment (Fig.2). It is noted that the effects of repellents on an exploratory and feeding behavior were greater than those of attractants. Such a finding is prominently ascertained in the case of using strong repellents, L-glutamic acid, L-cysteic acid, *n*-butyric acid, or DL-malic acid to same attractants above.[2] Especially, even in 100mM of the attractants containing 10mM of either the strong repellents, the

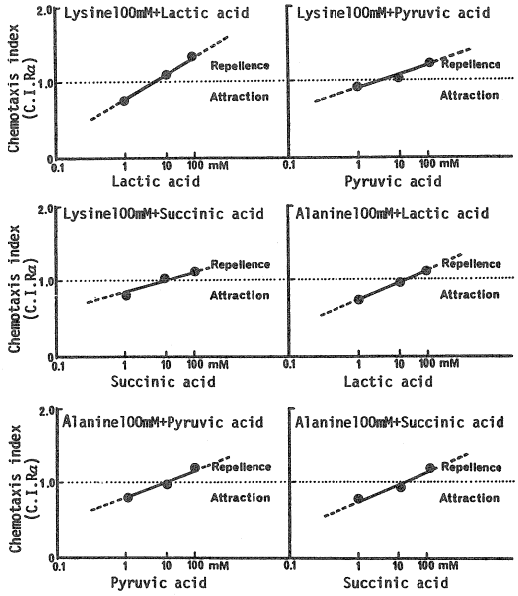

Fig. 1. Chemotaxis activity in the combination of one attractant (constant concentration) and one repellent (variable concentration).

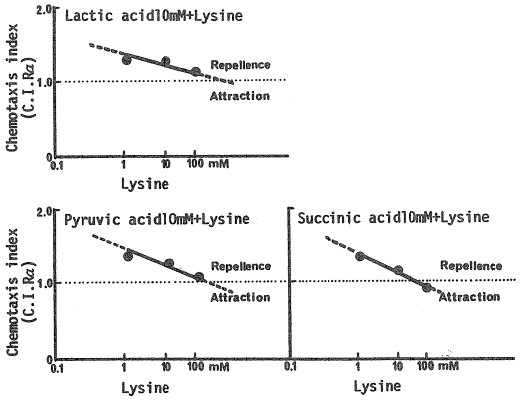

Fig. 2. Chemotaxis activity in the combination of one attractant (variable concentration) and one repellent (constant concentration).

effects of latters were appreciably greater than those of formers. Judging from the results, it is concluded that the chemotactic activity in the combination of attractant and repellent depends remarkably on the effect of repellents irrespective of the quality or kind of repellents used.

Activators (attractants, stimulants and so on) and inhibitors (repellents, suppressants and so on) of organic acids involving in the exploratory and feeding behavior of fishes and shellfishes recorded in literatures were comprehensively shown in Table 1. It is obvious from Table 1 that the exploratory and feeding behavior of all

Table 1. Activators and inhibitors of organic acids involving in an exploratory and feeding behavior of fishes and shellfishes recorded in literatures[1)]

Aquatic animals*	Organic acids	
	Activators	Inhibitors
(Plathelminthes)		
Planarian-"Namiuzumushi"-*Dugesia dorotocephala*		α-Ketoglutaric acid
(Mollusca)		
Sea snail-"Kurotsukegai"-*Monodonta neritoides*		Caprylic acid, Capric acid, Pelargonic acid
Oyster drill-"Kakinakasegai"-*Urosalpinx cinerea*	Oxaloacetic acid	

Table 1. — (Cont'd)

Aquatic animals*	Organic acids	
	Activators	Inhibitors
Mud snail-"Oriireyofubai"*Nassarius obsoletus*	Lactic acid	
Pulmonate snail-"Ooshiinomigai"-*Bulinus rohlfsi*	Caprylic acid	Formic acid, Propionic acid, Succinic acid, Glycolic acid
Sea hare-"Amefurashi"-*Aplysia kurodai*	Oleic acid	
Sea hare-"Janomeamefurashi"-*Aplysia dactylonela*	Oleic acid	
Detritivorous snail-"Shiinomimimigai"-*Melampus bidentatus*		Ferulic acid
Freshwater snail-"Kawanejigai"-*Biomphalaria glabrata*	Propionic acid, Gluconic acid	Citric acid
(Arthropoda)		
California spiny lobster-"Iseebi"-*Panulirus interruptus*	Succinic acid	
American lobster-"Umizarigani"-*Homarus americanus*	Succinic acid	
(Echinodermata)		
Sea star-"Hitode"-*Marthasterias glacialis*	Lactic acid	
(Vertebrata)		
Rainbow trout-"Nijimasu"-*Salmo gairdneri*		Chlorogenic acid
Gold fish-"Kin'gyo"-*Carassius auratus*		Isothiocyanic acid
Live bearer-"Kadayashi"-*Gambusia affinis*		Anthraquinone sulfate

*Common name-"Japanese name"-Scientific name.

fishes tested is inhibited by the organic acids irrespective of quality or kind, while that of invertebrates is inhibited or activated by certain organic acids. Lactic acid and succinic acid inhibit the behavior of oriental weatherfish. Similarly succinic acid also inhibits the behavior of pulmonate snail *Bulinus rohlfsi*. In contrast, lactic acid activates the behavior of mud snail *Nassarious obsoletus* and sea star *Marthasterias glacialis*, and succinic acid also activates California spiny lobster *Panulirus interruptus* and American lobster *Homarus americanus*. Thus, the effects of organic acids differ from species. In this connection, it must be emphasized that the development of fodder and/or baits is taken into consideration of the contents of organic acids as especial repellents.

4 References

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誘引物質と弱い忌避物質との組合わせによるドジョウの走化活性

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ドジョウに対して摂餌に関与する代表的な誘引物質と弱い忌避物質との組合わせにおける走化活性を調べた。誘引物質であるL-リシンあるいはL-アラニンの100mMの活性は，忌避物質であるDL-乳酸，ピルビン酸あるいはコハク酸の100mMの添加によって，著しく低下した。活性低下の程度は，用いた忌避物質の種類に相違がなかった。一方，上述の忌避物質10mMの活性は，L-リシン100mMの添加によっても低下した。これらのことから，忌避物質の効果は，誘引物質のそれより大きいことが明らかとなった。