Production of Inhibitors of Lytic Activity in the *Micrococcaceae*

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Eight *Staphylococcus xylosus* strains lacking lytic activity (LA) were found to excrete agar-diffusible factors inhibiting the LA of LA-positive strains of the same species. The same eight strains, when tested against LA-positive indicator strains from other species of *Micrococcaceae*, caused marked LA inhibition only of strains of *S. saprophyticus* and *S. cohnii*, both species closely related to *S. xylosus*. Micrococci and planococci, unlike staphylococci, do not normally show LA, yet *Micrococcus lylae* and *M. sedentarius* strains produced inhibitors effective against the LA of almost all the indicator strains, and planococci inhibited the LA of a few indicator strains. *Micrococcus luteus* strains caused LA inhibition of homologous indicators only, i.e. exceptional *M. luteus* strains exhibiting LA. Thus, a specific and a non-specific type of LA inhibition can be distinguished, and it is suggested that the apparent lack of LA might, in some instances, be explained by the simultaneous production of a specific inhibitor.

INTRODUCTION

A recent approach to the taxonomy and identification of the *Micrococcaceae* is based on the lytic activity (LA) of the strains. Six groups (lyogroups), closely related to species, were recognized within human staphylococci based on the analysis of their LA (Varaldo *et al.*, 1978*a, b*; Varaldo & Satta, 1978). Moreover, LA was shown to be a general feature of the genus *Staphylococcus*, whereas other *Micrococcaceae* (*Micrococcus* and *Planococcus*) lacked this property (Satta *et al.*, 1977, 1978). Exceptions to this rule were, however, shown in previous studies, where both LA-negative staphylococci (under 0.5% of total staphylococci) and LA-positive micrococci (about 1% of total micrococci) were described (Satta *et al.*, 1978; Varaldo *et al.*, 1978*a*, 1979, 1980, 1981). Both exceptions were confined to specific groups of organisms, in particular *S. xylosus* for LA-negative staphylococci and *M. luteus* for LA-positive micrococci. The exceptional strains from both groups represent a scant minority within their respective species, since most *S. xylosus* strains are LA-positive, and belong to lyogroup IV (Varaldo & Satta, 1978), while most *M. luteus* strains are LA-negative (Satta *et al.*, 1978; Varaldo *et al.*, 1979).

The present study shows that LA-negative *S. xylosus* strains excreted factors which inhibited the LA of LA-positive *S. xylosus* strains, suggesting that in the former, LA might be masked *in vivo* by such inhibitors. Extension of the study to micrococci and planococci showed that a specific and a non-specific type of LA inhibition existed: the former was effective with the LA of strains from homologous species, the latter with strains from different species.

METHODS

Strains tested for production of LA-inhibiting factors. Thirty LA-negative strains were tested. Eight were isolated in our laboratory from healthy human skin and identified as *S. xylosus* (Schleifer & Kloos, 1975).

Table 1. *List of strains used (from the genera Staphylococcus, Micrococcus and Planococcus)**Strains tested*

<i>S. xylosus</i> CM-20*	<i>M. kristinae</i> CCM 2690	<i>M. roseus</i> CCM 633
<i>S. xylosus</i> CN-11*	<i>M. kristinae</i> CCM 2691	<i>M. roseus</i> CCM 837
<i>S. xylosus</i> CO-07*	<i>M. luteus</i> ATCC 4698	<i>M. sedentarius</i> CCM 314
<i>S. xylosus</i> CO-13*	<i>M. luteus</i> CCM 337	<i>M. sedentarius</i> CCM 2697
<i>S. xylosus</i> CP-14*	<i>M. luteus</i> CCM 351	<i>M. varians</i> CCM 418
<i>S. xylosus</i> K2-12*	<i>M. luteus</i> CCM 410	<i>M. varians</i> CCM 884
<i>S. xylosus</i> K3-04*	<i>M. lylae</i> CCM 2693	<i>P. citreus</i> CCM 2389
<i>S. xylosus</i> K3-12*	<i>M. lylae</i> CCM 2694	<i>P. citreus</i> CCM 2415
<i>M. agilis</i> CCM 2131	<i>M. nishinomiyaensis</i> CCM 2140	<i>Planococcus</i> sp. CCM 2104
<i>M. agilis</i> CCM 2390	<i>M. nishinomiyaensis</i> CCM 2669	<i>Planococcus</i> sp. CCM 2414

Indicator strains

<i>S. aureus</i> ATCC 12600	<i>S. hominis</i> CCM 2733	<i>S. xylosus</i> CCM 1400
<i>S. aureus</i> CCM 2504	<i>S. hyicus</i> CCM 2368	<i>S. xylosus</i> CCM 2210
<i>S. aureus</i> AT-12*	<i>S. hyicus</i> SH1†	<i>S. xylosus</i> CCM 2725
<i>S. capitis</i> CCM 2735	<i>S. intermedius</i> CCM 5739	<i>S. xylosus</i> CCM 2738
<i>S. capitis</i> AP-07*	<i>S. intermedius</i> G8†	<i>S. xylosus</i> F-21*
<i>S. cohnii</i> CCM 2726	<i>S. saprophyticus</i> CCM 2682	<i>S. xylosus</i> G-09*
<i>S. cohnii</i> CCM 2736	<i>S. saprophyticus</i> CCM 2728	<i>S. xylosus</i> AK-21*
<i>S. cohnii</i> BO-20*	<i>S. saprophyticus</i> BO-03*	<i>S. xylosus</i> BK-20*
<i>S. epidermidis</i> ATCC 14852	<i>S. sciuri</i> ATCC 29062	<i>S. xylosus</i> BL-10*
<i>S. epidermidis</i> ATCC 14990	<i>S. sciuri</i> ATCC 29070	<i>S. xylosus</i> BZ-01*
<i>S. epidermidis</i> AH-15*	<i>S. simulans</i> CCM 2705	<i>M. luteus</i> CCM 559
<i>S. haemolyticus</i> CCM 1798	<i>S. simulans</i> O-12*	<i>M. luteus</i> K1-01*
<i>S. haemolyticus</i> CCM 2737	<i>S. warneri</i> CCM 2445	<i>M. luteus</i> K1-06*
<i>S. hominis</i> CCM 2732	<i>S. warneri</i> CCM 2730	<i>M. luteus</i> MI-08*

* From our Institute collection. † Obtained from Dr V. Hajek, Olomouc, Czechoslovakia.

Fig. 1. Narrowing of the zones of transparency surrounding the streaks of two LA-positive *S. xylosus* indicators (strains CCM 1400 and CCM 2210, upper and lower horizontal streaks, respectively) caused by an LA-negative *S. xylosus* strain (CP-14, left vertical streak). No narrowing is caused by an LA-negative strain of *M. varians* (CCM 418, right vertical streak).

Eighteen strains were micrococci and four planococci (Table 1), all supplied by the Czechoslovak Collection of Microorganisms (CCM) or the American Type Culture Collection (ATCC).

Indicator strains. Forty-two LA-positive strains were used as indicators, i.e. their LA was the target of

LA-inhibiting factors produced by the LA-negative test strains. These indicator strains included 38 staphylococci from 13 different species and four LA-positive *M. luteus* strains (Table 1).

Evaluation of LA inhibition. Suspensions of the strains to be tested for production of LA inhibitors were made in sterile saline from 24 h cultures, and their turbidity was adjusted to about half that of a McFarland nephelometer barium sulphate no. 1 standard. Using a calibrated loop, standard amounts (0.05 ml) of these suspensions were streaked on the surface of 15 cm diameter plastic dishes containing the LA test medium (AH47TP2, see Varaldo *et al.*, 1978a, 1979, for its composition and preparation), making two parallel streaks of different strains about 9 cm apart. After incubation of the plates, which varied according to the growth rates of the strains tested, equal amounts of suspensions of indicator strains were streaked on the plate surface between and perpendicular to the two initial parallel streaks. Two to four different indicators were thus streaked on each plate so that their ends were close to the two streaks of the LA-negative test strains (Fig. 1). Plates were incubated for 48 h at 35 °C, and examined for zones of transparency around the indicator strains. A narrowing of this zone of transparency in the area near the perpendicular streak of an LA-negative strain was interpreted as production by the latter of some factor(s) inhibiting the LA of the indicator strain. The degree of inhibition was scored qualitatively as indicated in Table 2.

RESULTS

Production of LA inhibitors by LA-negative strains of S. xylosus

The eight LA-negative strains of *S. xylosus* (Table 1) were tested for their ability to produce diffusible factors which inhibited the LA from ten *S. xylosus* indicator strains (Table 1). The LA of each indicator strain was inhibited to varying degrees by all eight LA-negative strains tested. The narrowing of the zone of transparency of indicator strains was not associated with growth inhibition.

In order to evaluate whether the LA inhibition exerted by the eight LA-negative strains of *S. xylosus* towards LA-positive strains of the same species was specific, the same eight strains were tested against a set of indicator strains including at least two representatives of all other recognized staphylococcal species. Four LA-positive *M. luteus* strains were also included in this set of indicators. The results (Table 2) showed that the LA of strains of *S. aureus*, *S. epidermidis*, *S. simulans*, *S. intermedius*, *S. hyicus* and *M. luteus* was not inhibited by the eight LA-negative *S. xylosus* strains. A sporadic and weak inhibition was observed with indicator strains of *S. hominis*, *S. haemolyticus*, *S. warneri*, *S. capitis* and *S. sciuri*. In contrast, a marked LA inhibition was generally observed with indicator strains of *S. saprophyticus* and *S. cohnii*. LA inhibition was never associated with any growth inhibition.

Production of LA inhibitors by micrococci and planococci

The finding that certain staphylococci apparently devoid of LA produced LA inhibitors, led us to investigate whether the ability to release similar inhibitors was a property shared by micrococci and planococci, which, unlike staphylococci, are generally LA-negative (Satta *et al.*, 1978). Eighteen micrococci and four planococci, including at least two representatives of the recognized species, were tested for the release of LA inhibitors against a set of 35 indicator strains. LA inhibition effects varied with the species of the strains tested (Table 3). Strains of *M. varians*, *M. roseus*, *M. nishinomiyaensis*, *M. kristinae*, and *M. agilis* produced virtually no inhibition of the LA of the indicator strains, whereas inhibition was sporadically exhibited by planococci. A strong inhibition effective against the LA of almost all the indicator strains was displayed by the strains of *M. lylae* and *M. sedentarius*. A more specific behaviour was shown by the four strains of *M. luteus*, which consistently caused inhibition of the LA of homologous indicator strains (i.e. LA-positive *M. luteus* strains), but caused virtually no inhibition of the LA of the other indicator strains. Again, the narrowing of the zones of transparency of indicator strains denoting LA inhibition was never associated with any growth inhibition.

DISCUSSION

The LA inhibition exerted by LA-negative strains towards LA-positive strains of *Micrococcaceae*, as shown in this study, seems to be mediated by extracellular agar-diffusible

Table 2. *LA* inhibition exerted by 8 *LA*-negative strains of *Staphylococcus xylosus* against 32 *LA*-positive indicator strains from other species of *Micrococcaceae*

<i>S. xylosus</i> strain tested	<i>S. aureus</i>			<i>S. capitis</i>			<i>S. cohnii</i>			<i>S. epidermidis</i>			<i>S. haemolyticus</i>			<i>S. hominis</i>			<i>S. hyicus</i>	
	ATCC 12600	CCM 2504	AT-12	CCM 2735	AP-07	CCM 2726	CCM 2736	BO-20	ATCC 14852	ATCC 14990	AH-15	CCM 1798	CCM 2737	CCM 2732	CCM 2733	CCM 2368	SH1			
CM-20	—	—	—	—	±	+	+	±	—	—	—	±	—	—	—	—	—	—	—	
CN-11	—	—	—	—	—	++	++	++	—	—	—	+	—	—	+	—	—	—	—	
CO-07	—	—	—	—	—	+	++	+	—	—	—	—	—	—	—	—	—	—	—	
CO-13	—	—	—	—	—	+	++	++	—	—	—	±	±	—	—	—	—	—	—	
CP-14	—	—	—	—	—	+	+	+	—	—	—	—	—	±	—	—	—	—	—	
K2-12	—	—	—	—	+	++	++	+	—	—	—	—	—	+	—	—	—	—	—	
K3-04	—	—	—	—	—	+	++	++	—	—	—	—	—	—	—	—	—	—	—	
K3-12	—	—	—	—	—	++	++	++	—	—	—	—	+	±	—	—	—	—	—	

<i>S. xylosus</i> strain tested	<i>S. intermedius</i>		<i>S. saprophyticus</i>			<i>S. sciuri</i>			<i>S. simulans</i>		<i>S. warneri</i>			<i>M. luteus</i>		
	CCM 5739	G8	CCM 2682	CCM 2728	BO-03	ATCC 29062	ATCC 29070	CCM 2705	O-12	CCM 2445	CCM 2730	CCM 559	K1-01	K1-06	MI-08	
CM-20	—	—	++	+	+	—	+	—	—	—	—	—	—	—	—	—
CN-11	—	—	++	++	++	—	—	—	—	±	—	—	—	—	—	—
CO-07	—	—	++	++	++	—	—	—	—	—	—	—	—	—	—	—
CO-13	—	—	++	++	++	—	—	—	—	±	—	—	—	—	—	—
CP-14	—	—	+	+	±	—	—	—	—	—	—	—	—	—	—	—
K2-12	—	—	++	+	+	±	—	—	—	—	—	—	—	+	—	—
K3-04	—	—	++	+	++	—	—	—	—	—	—	—	—	—	—	—
K3-12	—	—	++	++	++	—	—	—	—	—	—	—	—	—	—	—

Inhibition of lytic activity: ++, complete; +, marked; ±, weak; —, negative.

Table 3. LA inhibition exerted by 22 LA-negative strains of *Micrococcus* or *Planococcus* against 35 LA-positive indicator strains from other species of Micrococcaceae

Strain tested	<i>S. aureus</i>			<i>S. capitis</i>		<i>S. cohnii</i>			<i>S. epidermidis</i>			<i>S. haemolyticus</i>			<i>S. hominis</i>			<i>S. hyicus</i>		
	ATCC 12600	CCM 2504	AT-12	CCM 2735	AP-07	CCM 2726	CCM 2736	BO-20	ATCC 14852	ATCC 14990	AH-15	CCM 1798	CCM 2737	CCM 2732	CCM 2733	CCM 2368	SH1			
<i>M. agilis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2131	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2390	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. kristinae</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2690	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2691	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. luteus</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATCC 4698	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 337	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 351	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 410	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. lylae</i>	++	+	++	±	+	++	+	++	+	++	+	+	+	+	++	++	+	+	+	+
CCM 2693	++	++	++	+	++	+	+	+	+	++	+	±	+	+	++	++	+	+	+	+
CCM 2694	++	++	++	+	++	+	+	+	+	++	+	±	+	+	++	++	+	+	+	+
<i>M. nishinomiyaensis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2669	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. roseus</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 633	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 837	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. sedentarius</i>	++	+	++	±	+	+	+	+	+	+	++	++	±	±	+	+	+	+	+	+
CCM 314	+	+	+	—	+	+	±	+	++	+	++	+	±	±	±	±	±	±	±	±
CCM 2697	+	+	+	—	+	+	±	+	++	+	++	+	±	±	±	±	±	±	±	±
<i>M. varians</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 418	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 884	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>P. citreus</i>	—	—	+	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2389	—	—	+	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2415	—	—	±	—	—	±	—	—	—	—	—	—	+	—	—	—	—	—	—	—
<i>Planococcus</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2104	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2414	—	±	—	—	—	+	—	—	—	—	—	—	±	—	—	—	—	—	—	—

Table 3 — continued

Strain tested	<i>S. intermedius</i>		<i>S. saprophyticus</i>			<i>S. sciuri</i>		<i>S. simulans</i>		<i>S. warneri</i>		<i>S. xylosus</i>			<i>M. luteus</i>			
	CCM 5739	G8	CCM 2682	CCM 2728	BO-03	ATCC 29062	ATCC 29070	CCM 2705	O-12	CCM 2445	CCM 2730	CCM 1400	CCM 2210	AK-21	CCM 559	K1-01	K1-06	MI-08
<i>M. agilis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2131	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2390	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. kristinae</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2690	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2691	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. luteus</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ATCC 4698	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 337	—	—	—	—	—	±	—	—	—	—	—	—	—	—	+	++	+	+
CCM 351	—	—	—	—	—	—	—	—	—	—	—	—	—	—	±	+	+	±
CCM 410	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	+	+
<i>M. lyellae</i>	+	++	++	+	+	—	+	++	±	++	—	+	++	+	±	+	+	++
CCM 2693	++	++	+	++	++	+	++	++	+	+	+	++	++	+	+	++	+	++
CCM 2694																		
<i>M. nishinomiyaensis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 2669	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. roseus</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 633	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 837	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. sedentarius</i>	+	++	+	+	+	+	+	++	+	+	+	+	+	±	++	+	+	+
CCM 314	++	+	+	++	+	+	+	+	+	+	±	++	+	+	+	+	+	+
CCM 2697																		
<i>M. varians</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 418	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CCM 884	—	—	—	—	—	—	—	—	±	—	—	—	—	—	—	—	—	—
<i>P. citreus</i>	—	—	—	—	—	±	—	—	±	—	—	—	—	—	+	—	—	—
CCM 2389	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	+	—	—
CCM 2415	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Planococcus</i> sp.	—	±	—	—	—	—	—	—	—	—	—	±	—	—	—	±	—	—
CCM 2104	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
CCM 2414	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Inhibition of lytic activity: ++, complete; +, marked; ±, weak; —, negative.

factors. This is suggested by the experimental conditions under which LA inhibition has been detected and by the complete and consistent absence of any growth reduction associated with LA inhibition. We have recently isolated a fraction which is resistant to proteolysis from the culture supernatant of a LA-negative *S. xylosus* strain. This compound inhibits the LA from LA-positive strains of the same species. Further investigation is underway in our laboratory to define the chemical nature as well as the physiological significance of these inhibitors of lytic enzymes. These enzymes are known to be required for cell wall extension and division (Rogers, 1970; Shockman *et al.*, 1974) and inhibitors have been described recently and shown, in some instances, to play a role in the regulation of cell wall biosynthesis (Ghuysen, 1977).

Our findings suggest that a specific and a non-specific type of LA inhibition may be distinguished. The latter seems to be peculiar to *M. lylae* and *M. sedentarius* strains which caused strong LA inhibition when tested against indicator strains from all LA-positive *Micrococcaceae* examined. Similarly, LA inhibition by planococci was non-specific, but less marked and consistent than that caused by *M. lylae* and *M. sedentarius*. In contrast, specific LA inhibition was displayed by *M. luteus* strains, which released factors effective against the LA of LA-positive strains of the same species only. Similarly, the LA inhibition caused by LA-negative *S. xylosus*, although apparent against indicators from three species (*S. xylosus*, *S. saprophyticus* and *S. cohnii*), should be regarded as specific. The species *S. saprophyticus*, *S. cohnii* and *S. xylosus* are in the same lyogroup (Varaldo & Satta, 1978); consequently both LA-negative staphylococci, and those LA-positive staphylococci undergoing inhibition of their LA caused by the former, belong to a well-defined three-species group. Moreover, these species are known to be very closely related in other respects including low acid production from glucose under anaerobic conditions, resistance to novobiocin, and DNA homology (Schleifer & Kloos, 1975; Schleifer *et al.*, 1979). It is consistent that strains from species which are closely related and share the same type of LA should also share susceptibility to a particular LA inhibitor.

Differences from species to species in the production of or susceptibility to LA inhibitors, together with the established taxonomic relevance of LA within *Micrococcaceae* (Varaldo *et al.*, 1978a, b; Varaldo & Satta, 1978; Satta *et al.*, 1978), suggest that further studies of LA inhibitors may be useful for taxonomic purposes.

Within *S. xylosus* and *M. luteus* (the species containing LA-negative strains which produced specific LA inhibitors), the lack of observable LA by a given strain might reflect its ability to produce the specific inhibitor rather than its failure to produce the lytic enzymes. Thus, the LA would be masked by the specific inhibitor and the strain would appear LA-negative. The lack of LA in certain staphylococci (a minority of *S. xylosus* strains) might be due to their ability to produce a specific LA inhibitor. Conversely, the exceptional LA-positive micrococci (a minority of *M. luteus* strains) might result from the loss of a specific LA inhibitor normally produced by strains of this species. As LA has not so far been observed within other micrococcal or planococcal species (Satta *et al.*, 1978), a specific LA inhibition cannot be observed in these instances. However, from the above hypothesis, it may be that simultaneous production of specific LA inhibitors is the reason for the apparent failure of these strains to produce LA.

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