one might expect distinct muscle contractions of ipsilateral parts of segments in the middle of the trunk as well as contralateral parts of more caudally situated segments.
In some cases, however, where the momentary position of the tail fin was most unfavourable with respect to target angle and electrode location, it was impossible to determine the reaction time by EMG-recordings. In the figure, C and D for example, the body of the fish was going to bend itself just to the contralateral side of the electrode at the onset of the response. Therefore the recorded activity was too small (figure, C) or occurred only with the return of the tail flip and hence appeared to be delayed (figure, D).
If the fishes swam faster than 8–10 cm/sec the recorded muscle activity level was too high most of the time to be used to determine the reaction time. The periods of high muscle activity correspond to certain phases of fast swimming movements (black fishes in figure, E).
For presenting stimuli to the left side of the fishes, the most favourable electrode location was therefore 1. on the right side of the body (contralateral) 5–7 scales away from the tail fin for target angles between 40° right to 90° left and 2. on the left side of the body (ipsilateral) 15 scales away from the tail fin for target angles between about 40° and 90° on the left side of the fishes. Insertion of 2 or more electrode wires proved to be unsatisfactory, because their increased weight and water drag altered the natural position of the small fishes (6–8 cm) at the water surface and hence their responsiveness as well as normal swimming movements.
In 169 out of 399 experiments the onset of the behavioral response by means of concave deflection of the body segment we recorded from, and the beginning of an increased muscle activity, could unequivocally be determined. Based on these 169 trials the activation of red body muscles occurs 30 ± 1.5 msec ($\bar{X} \pm SE$) earlier than the behavioral response itself. The concrete measured times ($\bar{X} \pm SD$) using wave stimuli with pp-amplitudes between 9 and 3 µm are 144 ± 33 msec (video) and 114 ± 31 msec (EMG). The value of 30 msec, which is independent of swimming speed and target angle, agrees well with contraction times of white muscles of several other fishes of similar body length[14] and with the time delay between muscle activation and visible leg movements during prey localization in *Gerris remigis*[15].
Considering the nature of wave signals[13] we can state that the signal analyzing processes of *A. lineatus* last just as long as the first 8–10 wave cycles of a stimulus. Thus the results imply that mainly the initial part of a wave train lasting several hundred msec is utilized by the fish and that neuronal processing is highly sensitive to the frequency spectrum of a wave signal, as has been reported also for prey identification on the water surface in the back swimmer *Notonecta glauca*[16–18].

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Endogenous gibberellins and amylase activity in tall and dwarf strains of rice *(Oryza sativa)*

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Summary. 2 tall and 7 dwarf strains of rice were sprayed with 0 or 40 µg ml^{-1} GA_3. 4 dwarf strains responded to exogenous GA_3, and showed a markedly lower endogenous gibberellin content than the tall strains, while 2 dwarf strains did not respond to GA_3 application and had considerably higher endogenous gibberellin levels than the tall ones. Amylase activity in germinating seeds showed a significant negative correlation with the endogenous gibberellin content.

The phenomenal agronomic success of dwarf cereals, particularly of wheat and rice, has triggered detailed biochemical investigations of generic dwarfness. Gibberellins (GA) have been implicated in genetic dwarfness in wheat (*Triticum aestivum* L. em. Thell); some dwarf strains show limited GA utilization[1,2], while others exhibit reduced GA biosynthesis[2]. Some dwarf mutants of rice (*Oryza sativa* L.) also show limited GA biosynthesis[3,4] but there is no clear-cut evidence for restricted GA utilization in rice[5,6]. Here we describe 2 rice mutants that show restricted GA utilization.
2 tall and 7 dwarf strains of rice were planted in a field in a split plot design with 3 replications, and were sprayed 5 times with 0 or 40 µg ml^{-1} GA_3 (gibberellic acid) at 15-day intervals. Plant height at maturity was recorded on 10 random plants from each subplot. Endogenous gibberellins were extracted from 80-day-old plants grown for this purpose[1], and assayed by endosperm bioassay[7] using half seeds of the wheat cultivar 'K 68'. For investigating amylase activity and isozymes, hand dehulled seeds were germinated in petri dishes at 30 °C for 5 days and homogenized in 0.05 M phosphate buffer (pH 7.0). The homogenate was stored in a refrigerator for 30 min and centrifuged at 4 °C. The amylase activity in the clear supernatant was assayed according to Bernfeld[8]; protein content was estimated following Lowry et al.[9]. Amylase isozymes were separated by polyacrylamide gel electrophoresis[10]; the gels were prepared by adding 2 ml of 4% starch solution to 100 ml of 8% solution of polyacrylamide gel. The gels were stained with iodine reagent after they had been incubated for 30 min in 1% starch solution at room temperature and washed with distilled water. The α-amylase bands were clear, while the β-amylase bands had a reddish tinge.
The 2 tall strains and 5 of the dwarf strains showed a significant increase in plant height in response to exogenous GA_3. 2 dwarf strains, Shyama and Cigar Mutant, did not respond to GA_3 application. The 5 dwarf mutants that

Table 1. Response to 40 µg/ml exogenous GA_3, and endogenous GA content, in shoots of 2 tall and 7 dwarf strains of rice

Strain	Plant height (cm)		Endogenous GA content (µg/100 g fresh weight)	
	Control	40 µg/ml GA_3	Experiment I	Experiment II
Kalimoonch 64	137.8[a]*	148.7[b]	0.210	0.198
T 141	122.3[a]	140.2[b]	0.173	0.181
China 1039	93.2[a]	105.4[b]	0.096	0.083
Dee-geo-woo-gen	88.5[a]	100.2[b]	0.013	0.025
Ratna	87.4[a]	99.3[b]	0.028	0.025
Jaya	82.4[a]	92.0[b]	0.025	0.029
Jagannath	80.9[a]	97.3[b]	0.003	0.005
Mutant 11				
Shyama	80.1[a]	86.3[a]	0.363	0.351
Cigar Mutant	38.5[a]	41.8[a]	0.388	0.397

* Different letters in the superscript denote a significant difference between means; comparison within strains only.

Table 2. Amylase activity (mg maltose/mg protein/3 min at 27°C) and amylase isozymes in germinating seeds of tall and dwarf strains of rice

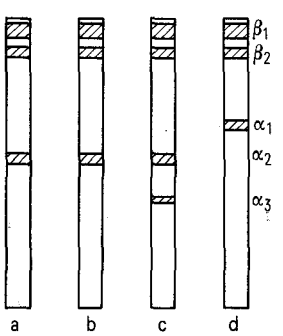
Strain	Amylase activity		Amylase isozymes	
	Experiment I	Experiment II	α-amylase	β-amylase
Kalimoonch 64	46.8	51.3	α_2 (I)*	β_1, β_2 in all strains
T 141	57.2	58.0	α_2	
China 1039	49.6	51.3	α_2	
Dee-geo-woo-gen	78.0	73.6	α_2, α_3 (F)	
Ratna	69.4	69.0	α_2, α_3	
Jaya	68.5	63.3	α_2, α_3	
Jagannath Mutant 11	91.0	87.7	α_2, α_3	
Shyma	42.8	48.9	α_2	
Cigar Mutant	22.8	28.4	α_1 (S)	

* Letters within parenthesis denote mobility of the isozymes; F, fast; I, intermediate; S, slow.

responded to GA_3 application exhibited drastically lower endogenous GA levels than the tall strains (table 1). Thus in these strains GA biosynthesis appears to be partially blocked resulting in a low endogenous GA content and dwarf stature. In contrast, Shyama and Cigar Mutant had considerably higher endogenous GA levels than the tall strains (table 1). It may be inferred that in these 2 dwarf strains GA is not limiting and that utilization of GA is restricted, leading to the higher endogenous GA levels[10-12]. These observations agree closely with the findings in wheat[1,2].

Amylase activity showed significant negative correlation (-0.896 and -0.850, respectively, for the 2 experiments, $p < 0.05$) with endogenous GA content (table 2). A similar negative association between GA content and amylase activity is apparent from data reported in wheat[1,2,11,12]. 'Norin-10', 'Tom Thumb' and 'Minister dwarf' wheats showed appreciably lower amylase activity than the standard height cultivars of wheat[11,12]. These dwarf strains have a considerably higher endogenous GA content than the standard height cultivars[1,2]. The results of the present study support the earlier findings in wheat. They further demonstrate that the dwarf rice strains containing drastically reduced endogenous GA levels exhibited considerably higher amylase activity than the tall strains. These observations suggest a possible role of the endogenous GA level in regulating the amylase activity in germinating seeds of these rice strains, but the mode and the level of this control needs elucidation.

β-Amylase isozymes were slower-moving than those of α-amylase. β-Amylase was represented by 2 isozymes (β_1, β_2) in all the strains. The α-amylase exhibited 3 isozymes. Cigar Mutant had a single slow-moving band (α_1); the 2 tall strains and the dwarf strains China 1039 and Shyama also had a single band of intermediate mobility (α_2), while the remaining semidwarf strains had the major α_2 band and an additional faster-moving minor band (α_3) (table 2, figure). Thus the amylase isozyme patterns of some of the dwarf strains, viz., Shyama and China 1039, were comparable to those of the talls.



Isozymes of α- and β-amylases, *a* T 141, *b* China 1039, *c* Dee-geo-woo-gen, *d* Cigar Mutant.

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