

資 料

致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との 組換え価の計算プログラム (RECLOD 20)

大庭喜八郎¹⁾・河崎 久男²⁾・倉本 哲嗣³⁾・戸丸 信弘¹⁾・
津村 義彦⁴⁾・荒木 眞之¹⁾・内田 煌二¹⁾・中村 徹¹⁾・
奥泉 久人⁵⁾・陶山 佳久⁵⁾・戸丸智恵美¹⁾

A Computer Program for Estimation of Value of Recombination
between a Lethal Gene and Marker, RFLP or RAPD Loci

Kihachiro OHBA¹⁾, Hisao KAWASAKI²⁾, Noritsugu KURAMOTO³⁾,
Nobuhiro TOMARU¹⁾, Yoshihiko TSUMURA⁴⁾, Masayuki ARAKI¹⁾,
Koji UCHIDA¹⁾, Toru NAKAMURA¹⁾, Hisato OKUIZUMI⁵⁾,
Yoshihisa SUYAMA⁵⁾, and Chiemi TOMARU¹⁾

1 連鎖分析計算方法

1) 標識遺伝子座, RFLP 座および RAPD 座間の組換え価の計算方法の組立

優性・劣性あるいは共優性の標識遺伝子座, RFLP 座と RAPD 座の連鎖分析において致死遺伝子がない場合には表-1に示した①(1:1)×(1:1), ②(3:1)×(1:1), ③(3:1)×(3:1), ④(1:2:1)×(1:1), ⑤(1:2:1)×(3:1), ⑥(1:2:1)×(1:2:1)の6通りの分離型の計算方法を考えればよい。しかし, 致死遺伝子座が存在する場合には, その致死遺伝子座と他の2座, すなわち標識遺伝子座, RFLP 座あるいは RAPD 座との3座の配列順序ならびに相引・相反の配置関係を考慮する必要があり, 組換え価計算の一般式の誘導は困難である。そのため, この資料においては, 致死遺伝子による分離比の偏りの有無の検定と組換え価の計算は, 前記の6通りの分離型について各遺伝子座の集計した分離頻度を用いて行うこととした。

なお, 人工交雑による検定林等の資料を利用する場合, 胚致死遺伝子のほか白子, 淡緑色苗, 矮性苗など成熟樹に到達できない表現型をしめす異常個体は一般的には死滅してしまうため, 致

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1) Institute of Agriculture and Forestry, University of Tsukuba

2) Tohoku Forest Tree Breeding Institute, Ministry of Agriculture, Forestry and Fisheries (M.A.F.F.).

3) Doctoral Degree Program in Agricultural Sciences, University of Tsukuba

4) Forestry and Forest Products Research Institute, M.A.F.F.

5) Research fellow of the Agency of Sciences and Technology, Japan

表-1 標識遺伝子2座と致死遺伝子座について自殖および交雑による期待分離比、致死遺伝子による分離比の偏りの有無は各遺伝子座の集計した分離比の項で検定する。

Table 1 Expected segregation ratio of two marker gene loci and a lethal gene locus after selfing and crossing. Deviation of segregation ratio by the presence of lethal gene will be tested on the summed segregation frequency for respective loci.

					Program list	
					Value of recombination	Lod score
①	Segregation ratio and observed numbers of (1:1) × (1:1) (cf. Table 2, lethal - Table 8)					
	<i>DD(Dd)</i>	<i>Dd(dd)</i>	Sum		100~ 3000~	10100~ 13000~
	<i>AA(Aa)</i>	1 <i>c</i> ₁₁	1 <i>c</i> ₁₂	<i>a</i> ₁	GOSUB 23290(Chi-square data)	GOSUB 33346
	<i>Aa(aa)</i>	1 <i>c</i> ₂₁	1 <i>c</i> ₂₂	<i>a</i> ₂	GOSUB 23324(Chi-square test)	(AGEN\$ 1:1)
	Sum	<i>b</i> ₁	<i>b</i> ₂	<i>n</i>	GOSUB 23502(AGEN\$ 1:1)	
②	Segregation ratio and observed numbers of (3:1) × (1:1) (cf. Table 3, lethal - Tables 8, 9)					
	<i>D-</i>	<i>dd</i>	Sum		4000~	14000~
	<i>AA(Aa)</i>	3 <i>c</i> ₁₁	1 <i>c</i> ₁₂	<i>a</i> ₁	GOSUB 23255(AGEN\$ 1:1 data)	GOSUB 34056
	<i>Aa(aa)</i>	3 <i>c</i> ₂₁	1 <i>c</i> ₂₂	<i>a</i> ₂	GOSUB 23290(Chi-square data)	(DGEN\$ 3:1)
	Sum	<i>b</i> ₁	<i>b</i> ₂	<i>n</i>	GOSUB 23324(Chi-square test)	GOSUB 33346
					GOSUB 24306(DGEN\$ 3:1)	(AGEN\$ 1:1)
					GOSUB 23502(AGEN\$ 1:1)	
③	Segregation ratio and observed numbers of (3:1) × (3:1) (cf. Table 4, lethal - Table 9)					
	<i>D-</i>	<i>dd</i>	Sum		5000~	15000~
	<i>A-</i>	9 <i>c</i> ₁₁	3 <i>c</i> ₁₂	<i>a</i> ₁	GOSUB 25053(AGEN\$ 3:1 data)	GOSUB 34056
	<i>aa</i>	3 <i>c</i> ₂₁	1 <i>c</i> ₂₂	<i>a</i> ₂	GOSUB 23290(Chi-square data)	(DGEN\$ 3:1)
	Sum	<i>b</i> ₁	<i>b</i> ₂	<i>n</i>	GOSUB 23324(Chi-square test)	GOSUB 35177
					GOSUB 24306(DGEN\$ 3:1)	(AGEN\$ 3:1)
					GOSUB 25629(AGEN\$ 3:1)	
④	Segregation ratio and observed numbers of (1:2:1) × (1:1) (cf. Table 5, lethal - Tables 8, 10)					
	<i>DD</i>	<i>Dd</i>	<i>dd</i>	Sum	6000~	16000~
	<i>AA(Aa)</i>	1 <i>c</i> ₁₁	2 <i>c</i> ₁₂	1 <i>c</i> ₁₃	GOSUB 23255(AGEN\$ 1:1 data)	GOSUB 36058
	<i>Aa(aa)</i>	1 <i>c</i> ₂₁	2 <i>c</i> ₂₂	1 <i>c</i> ₂₃	GOSUB 23290(Chi-square data)	(DGEN\$ 1:2:1)
	Sum	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃	GOSUB 23324(Chi-square test)	GOSUB 33346
					GOSUB 26360(DGEN\$ 1:2:1)	(AGEN\$ 1:1)
					GOSUB 23502(AGEN\$ 1:1)	
⑤	Segregation ratio and observed numbers of (1:2:1) × (3:1) (cf. Table 6, lethal - Tables 9, 10)					
	<i>DD</i>	<i>Dd</i>	<i>dd</i>	Sum	7000~	17000~
	<i>A-</i>	3 <i>c</i> ₁₁	6 <i>c</i> ₁₂	3 <i>c</i> ₁₃	GOSUB 25053(AGEN\$ 3:1 data)	GOSUB 36058
	<i>aa</i>	1 <i>c</i> ₂₁	2 <i>c</i> ₂₂	1 <i>c</i> ₂₃	GOSUB 23290(Chi-square data)	(DGEN\$ 1:2:1)
	Sum	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃	GOSUB 23324(Chi-square test)	GOSUB 35177
					GOSUB 26360(DGEN\$ 1:2:1)	(AGEN\$ 3:1)
					GOSUB 25629(AGEN\$ 3:1)	
⑥	Segregation ratio and observed numbers of (1:2:1) × (1:2:1) (cf. Table 7, lethal - Table 10)					
	<i>DD</i>	<i>Dd</i>	<i>dd</i>	Sum	8000~	18000~18500
	<i>AA</i>	1 <i>c</i> ₁₁	2 <i>c</i> ₁₂	1 <i>c</i> ₁₃	GOSUB 23290(Chi-square data)	GOSUB 36058
	<i>Aa</i>	2 <i>c</i> ₂₁	4 <i>c</i> ₂₂	2 <i>c</i> ₂₃	GOSUB 23324(Chi-square test)	(DGEN\$ 1:2:1)
	<i>aa</i>	1 <i>c</i> ₃₁	2 <i>c</i> ₃₂	1 <i>c</i> ₃₃	GOSUB 26360(DGEN\$ 1:2:1)	
	Sum	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃		59900~ DATA

致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との組換え価の計算プログラム (RECLD 20) (大庭他)

死遺伝子として検出される場合がある。そのため、ここでは、胚致死遺伝子とともに前記の白子、淡緑色苗等の遺伝子も致死遺伝子として取り扱う場合があるものとした。さらに、林木は他殖性のためヘテロ性が高く、かつ劣悪遺伝子を保有している場合が多く、自殖後代では発芽率の低下、また標識個体の分離比の乱れが生じ易いことが知られている。そのため、種子発芽率が高く、また形質の分離比に偏りが少ない F_1 交雑後代においても組換え価の推定が可能のようにした。すなわち、両親が相引・相反の交雑組合せにおける集計した分離について期待分離比をもとめ組換え価の計算方法を組立てた。

また上記の場合、①相引 (自殖・交雑)、②相反 (自殖・交雑) および③相引・相反 (交雑) の三者のなかでの最適性の判定は、推定した組換え価によるロッドスコア (ロッド得点) の大小によって判定することとした。

本報告で用いた記号は、便宜的に標識遺伝子座 (A, a)、RFLP 座・RAPD 座 (D, d) および胚致死遺伝子座 (L, l) とした。また、3 遺伝子座が関与する場合の組換え価の算出式の誘導に際し、キアズマ干渉がないものと仮定した。すなわち、 ADL/adl の遺伝子型の配偶子の分離について、 $A-L$, $A-D$, $D-L$ の間の組換え価をそれぞれ p , r , s とした場合、 $p=r+s-2rs$ (Trow, 1913) が成立つと仮定した。

なお、アイソザイム、RFLP 等の共優性分離のデータ整理は移動度の大きい (速い) ものに大文字を、移動度の小さい (遅い) ものに小文字を当てた。

2) 分離比の偏りの検定と組換え価およびロッド得点の計算手順

表-1 に 6 通りの分離型に対する A , D の 2 座の遺伝子のデータ配置およびプログラム構成の概要を示した。標識遺伝子座、RFLP 座・RAPD 座間に連鎖がある場合、さらに胚致死遺伝子座 (L) が関与している場合には、独立遺伝の場合から偏りをもった分離比を示すことになる。また、両遺伝子座が独立であり、かつその両者がそれぞれ致死遺伝子座と連鎖している場合も考慮する必要がある。標識遺伝子座 (A) と RFLP 座あるいは RAPD 遺伝子座 (D) および胚致死遺伝子座 (L) が関与している場合の想定分離比の χ^2 検定の有意差の有 (SIG), 無 (NS) による連鎖の有無の検定は、次の手順によって判定する。

(1) 分離比の検定

(i) A , D の両遺伝子座が独立の場合

- ① A についての分離比が NS
- ② D についての分離比が NS
- ③ A , D についての分離比が NS

(ii) A と D の両遺伝子座が連鎖している場合

- ① A についての分離比が NS
- ② D についての分離比が NS

③ A, D についての分離比が SIG(iii) A, D の両遺伝子座が独立で、致死遺伝子座が存在している場合(a) A 遺伝子座と致死遺伝子座が連鎖している場合① A についての分離比が SIG② D についての分離比が NS③ A, D についての分離比が NS(b) D 遺伝子座と致死遺伝子座が連鎖している場合① A についての分離比が NS② D についての分離比が SIG③ A, D についての分離比が NS(c) A, D の両遺伝子座に別々に致死遺伝子座が連鎖している場合① A についての分離比が SIG② D についての分離比が SIG③ A, D についての分離比が NS(iv) A, D の両遺伝子座が連鎖していて、かつ致死遺伝子も連鎖している場合① A についての分離比が SIG または NS② D についての分離比が SIG または NS③ A, D についての分離比が SIG

(2) 組換え価の計算

A, D 両座の連鎖の χ^2 検定が 5% 水準以下で有意な場合、組換え価は致死遺伝子座がないものとして各セルのデータを用いて計算した。その 6 通りの分離型 (表-1) に対する最尤法による組換え価の計算式を表-2～表-7 に示した。前記 6 通りの分離型における各集計欄の分離比が 5% 水準以下で有意な場合は、1:1, 3:1 あるいは 1:2:1 の 3 通りの分離比について致死遺伝子による分離の偏りがあるものとして、致死遺伝子座との組換え価を計算した。その組換え価の計算式を表-8～表-10 に示した。

(3) ロッド得点の計算

A, D 両座の連鎖の χ^2 検定が 5% 水準以下で有意な場合、ロッド得点は、致死遺伝子座がないものとして、先に推定した組換え価を用い各セルの分離データによって計算した。その 6 通りの分離型 (表-1) に対するロッド得点の計算式を表-2～表-7 に示した。前記 6 通りの分離型における各集計欄の分離比が 5% 水準以下で有意な場合は、1:1, 3:1 あるいは 1:2:1 の 3 通りの分離比について推定された致死遺伝子との組換え価を用いてロッド得点を計算した。そのロッド得点の計算式を表-8～表-10 に示した。

致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との組換え価の計算プログラム (RECLD 20) (大庭他)

表- 2 ① 2つの標識遺伝子座について 1:1 と 1:1 の期待分離比で連鎖している場合の組換え価の計算方法

Table 2 ① Calculation of recombination value(r) in expected segregation ratios of 1:1 and 1:1 in two loci.

R = (1-r)			
	<i>DD(Dd)</i> (1)	<i>Dd(dd)</i> (1)	
{1/2}	<i>AaDD(Dd)</i>	<i>AaDd(dd)</i>	
<i>Aa</i> (1)	R	(1-R)	
	c_{11}	c_{12}	a_1
	<i>aaDD(Dd)</i>	<i>aaDd(dd)</i>	
<i>aa</i> (1)	(1-R)	R	
	c_{21}	c_{22}	a_2
	b_1	b_2	n

$$R = (c_{11} + c_{22}) / n \quad \dots\dots\dots (1)$$

$$0 < R < 0.5 \quad r = R \text{ (Rep.)}$$

$$V(R) = \{R(1-R)\} / n \quad \dots\dots\dots (2)$$

$$V(r) = V(R)$$

Odds: {f(r)/f(1/2)}

1) Coupling

$$\frac{(1-r)^{c_{11}+c_{22}}(r)^{c_{12}+c_{21}}}{(0.5)^n} \quad \dots\dots\dots (3)$$

2) Repulsion

$$\frac{(r)^{c_{11}+c_{22}}(1-r)^{c_{12}+c_{21}}}{(0.5)^n} \quad \dots\dots\dots (4)$$

$$\text{LOD score} = \log_{10} \{f(r)/f(1/2)\} \quad \dots\dots\dots (5)$$

(For lethal gene, see Table 8)

表- 3 ② 2つの標識遺伝子座について 3:1 と 1:1 の期待分離比で連鎖している場合の組換え価の計算方法

Table 3 ② Calculation of recombination value(r) in expected segregation ratios of 3:1 and 1:1 in two loci.

R = (1-r)			
	<i>D-</i> (3)	<i>dd</i> (1)	
{1/4}	<i>AaD-</i>	<i>Aadd</i>	
<i>Aa</i> (1)	(1+R)	(1-R)	
	c_{11}	c_{12}	a_1
	<i>aaD-</i>	<i>aadd</i>	
<i>aa</i> (1)	(2-R)	R	
	c_{21}	c_{22}	a_2
	b_1	b_2	n

$$f(R) = A_0 + A_1R + A_2R^2 + A_3R^3 \quad \dots\dots\dots (6)$$

$$A_0 = 2c_{22}$$

$$A_1 = 2c_{11} - 2c_{12} - c_{21} - c_{22}$$

$$A_2 = -3c_{11} - c_{12} - 2c_{22}$$

$$A_3 = c_{11} + c_{12} + c_{21} + c_{22}$$

$$0 < R < 0.5 \quad r = R \text{ (Rep.)}$$

$$V(R) = \frac{2R(1+R)(1-R)(2-R)}{n(1+2R-2R^2)} \quad \dots\dots\dots (7)$$

$$V(r) = V(R)$$

Odds: {f(r)/f(1/2)}

1) Coupling

$$\frac{(2-r)^{c_{11}}(r)^{c_{12}}(1+r)^{c_{21}}(1-r)^{c_{22}}}{(1.5)^{c_{11}+c_{21}}(0.5)^{c_{12}+c_{22}}} \quad \dots\dots\dots (8)$$

2) Repulsion

$$\frac{(1+r)^{c_{11}}(1-r)^{c_{12}}(2-r)^{c_{21}}(r)^{c_{22}}}{(1.5)^{c_{11}+c_{21}}(0.5)^{c_{12}+c_{22}}} \quad \dots\dots\dots (9)$$

$$\text{LOD score} = \log_{10} \{f(r)/f(1/2)\}$$

(For lethal gene, see Tables 8, 9)

表-4 ③ 2つの標識遺伝子座について3:1と3:1の期待分離比で連鎖している場合の組換え価の計算方法

Table 4 ③ Calculation of recombination value(r) in expected segregation ratios of 3:1 and 3:1 in two loci.

1) Coupling or 2) repulsion

$$R = (1-r)^2$$

	<i>D</i> -(3)	<i>dd</i> (1)	
{1/4}	<i>A-D</i> -	<i>A-dd</i>	
<i>A</i> -(3)	(2+ <i>R</i>)	(1- <i>R</i>)	
	<i>c</i> ₁₁	<i>c</i> ₁₂	<i>a</i> ₁
	<i>aaD</i> -	<i>aadd</i>	
<i>aa</i> (1)	(1- <i>R</i>)	<i>R</i>	
	<i>c</i> ₂₁	<i>c</i> ₂₂	<i>a</i> ₂
	<i>b</i> ₁	<i>b</i> ₂	<i>n</i>

$$-2c_{22} - (c_{11} - 2c_{12} - 2c_{21} - c_{22})R + (c_{11} + c_{12} + c_{21} + c_{22})R^2 \dots\dots\dots (10)$$

$$R = \{ (c_{11} - 2c_{12} - 2c_{21} - c_{22}) + \sqrt{(c_{11} - 2c_{12} - 2c_{21} - c_{22})^2 + 8nc_{22}} \} / 2n$$

$$0 < R < 0.25 \quad r = \sqrt{R} \quad (\text{Rep.})$$

$$V(R) = \{ 2R(2+R)(1-R) \} / \{ n(1+2R) \} \dots\dots (11)$$

$$V(r) = V(R) / 4R$$

3) Coupling and repulsion

	<i>D</i> -(3)	<i>dd</i> (1)	
{1/4}	<i>A-D</i> -	<i>A-dd</i>	
<i>A</i> -(3)	(2+ <i>r-r</i> ²)	(1- <i>r+r</i> ²)	
	<i>c</i> ₁₁	<i>c</i> ₁₂	<i>a</i> ₁
	<i>aaD</i> -	<i>aadd</i>	
<i>aa</i> (1)	(1- <i>r+r</i> ²)	(<i>r-r</i> ²)	
	<i>c</i> ₂₁	<i>c</i> ₂₂	<i>a</i> ₂
	<i>b</i> ₁	<i>b</i> ₂	<i>n</i>

$$f(r) = A_0 + A_1r + A_2r^2 + A_3r^3 + A_4r^4 + A_5r^5 \dots\dots (12)$$

$$A_0 = 2c_{22}$$

$$A_1 = c_{11} - 2c_{12} - 2c_{21} - 5c_{22}$$

$$A_2 = -4c_{11} + 5c_{12} + 5c_{21} + 2c_{22}$$

$$A_3 = 6c_{11} + 2c_{22}$$

$$A_4 = -5c_{11} - 5c_{12} - 5c_{21} - 5c_{22} = -5n$$

$$A_5 = 2c_{11} + 2c_{12} + 2c_{21} + 2c_{22} = 2n$$

$$0 < r < 0.5 \quad r \quad (\text{Coup. and rep.})$$

$$V(r) = \frac{2r(2-r)(1-r^2)(1-r+r^2)}{n(1-2r-6r^2+16r^3-8r^4)} \dots\dots\dots (13)$$

$$\text{Odds: } \{f(r)/f(1/2)\}$$

1) Coupling

$$\frac{(3-2r+r^2)^{c_{11}}(2r-r^2)^{c_{12}+c_{21}}(1-2r+r^2)^{c_{22}}}{(2.25)^{c_{11}}(0.75)^{c_{12}+c_{21}}(0.25)^{c_{22}}} \dots\dots\dots (14)$$

2) Repulsion

$$\frac{(2+r^2)^{c_{11}}(1-r^2)^{c_{12}+c_{21}}(r^2)^{c_{22}}}{(2.25)^{c_{11}}(0.75)^{c_{12}+c_{21}}(0.25)^{c_{22}}} \dots\dots\dots (15)$$

3) Coupling and repulsion

$$\frac{(2+r-r^2)^{c_{11}}(1-r+r^2)^{c_{12}+c_{21}}(r-r^2)^{c_{22}}}{(2.25)^{c_{11}}(0.75)^{c_{12}+c_{21}}(0.25)^{c_{22}}} \dots\dots\dots (16)$$

$$\text{Lod score} = \log_{10} \{f(r)/f(1/2)\}$$

(For lethal gene, see Table 9)

致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との組換え価の計算プログラム (RECLD 20) (大庭他)

表-5 ④ 2つの標識遺伝子座について1:2:1と1:1の期待分離比で連鎖している場合の組換え価の計算方法

Table 5 ④ Calculation of recombination value(*r*) in expected segregation ratios of 1:2:1 and 1:1 in two loci.

1) Coupling or 2) repulsion

$$R = (1 - r)$$

	<i>DD</i> (1)	<i>Dd</i> (2)	<i>dd</i> (1)	
{1/4}	<i>AaDD</i>	<i>AaDd</i>	<i>Aadd</i>	
<i>Aa</i> (1)	R	1	(1-R)	
	<i>c</i> ₁₁	<i>c</i> ₁₂	<i>c</i> ₁₃	<i>a</i> ₁
	<i>aaDD</i>	<i>aaDd</i>	<i>aadd</i>	
<i>aa</i> (1)	(1-R)	1	R	
	<i>c</i> ₂₁	<i>c</i> ₂₂	<i>c</i> ₂₃	<i>a</i> ₂
	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃	<i>n</i>

$$R = (c_{11} + c_{23}) / n \dots\dots\dots (17)$$

$$0 < R < 0.5 \quad r = R \text{ (Rep.)}$$

$$V(R) = \{2R(1-R)\} / n \dots\dots\dots (18)$$

$$V(r) = V(R)$$

Odds: {*f*(*r*)/*f*(1/2)}

1) Coupling

$$\frac{(1-r)^{c_{11}+c_{23}}(r)^{c_{13}+c_{21}}}{(0.5)^{c_{11}+c_{13}+c_{21}+c_{23}}} \dots\dots\dots (19)$$

2) Repulsion

$$\frac{(r)^{c_{11}+c_{23}}(1-r)^{c_{13}+c_{21}}}{(0.5)^{c_{11}+c_{13}+c_{21}+c_{23}}} \dots\dots\dots (20)$$

LOD score = log₁₀ {*f*(*r*)/*f*(1/2)}

(For lethal gene, see Table 8, 10)

表-6 ⑤ 2つの標識遺伝子座について1:2:1と3:1の期待分離比で連鎖している場合の組換え価の計算方法

Table 6 ⑤ Calculation of recombination value(r) in expected segregation ratios of 1:2:1 and 3:1 in two loci.

1) Coupling or 2) repulsion

$$R=(1-r)$$

	<i>DD</i> (1)	<i>Dd</i> (2)	<i>dd</i> (1)	
{1/4}	<i>A-DD</i>	<i>A-Dd</i>	<i>A-dd</i>	
<i>A</i> -(3)	(2R-R ²)	(2-2R+2R ²)	(1-R ²)	
	<i>c</i> ₁₁	<i>c</i> ₁₂	<i>c</i> ₁₃	<i>a</i> ₁
	<i>aaDD</i>	<i>aaDd</i>	<i>aadd</i>	
<i>aa</i> (1)	(1-R) ²	(2R-2R ²)	R ²	
	<i>c</i> ₂₁	<i>c</i> ₂₂	<i>c</i> ₂₃	<i>a</i> ₂
	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃	<i>n</i>

$$f(R)=A_0+A_1R+A_2R^2+A_3R^3+A_4R^4+A_5R^5 \cdots (21)$$

$$A_0=2c_{11}+2c_{22}+4c_{23}$$

$$A_1=-4c_{11}-2c_{12}-4c_{21}-5c_{22}-6c_{23}$$

$$A_2=2c_{11}+5c_{12}-4c_{13}+2c_{21}+2c_{22}+2c_{23}$$

$$A_3=2c_{11}+6c_{13}+2c_{22}+4c_{23}$$

$$A_4=-4c_{11}-5c_{12}-6c_{13}-4c_{21}-5c_{22}-6c_{23}$$

$$A_5=2c_{11}+2c_{12}+2c_{13}+2c_{21}+2c_{22}+2c_{23}=2n$$

$$0 < R < 0.5 \quad r=R \text{ (Rep.)}$$

$$V(R)=\frac{2R(2-R)(1-R+R^2)(1-R)(1+R)}{n(4-5R-3R^2+16R^3-8R^4)} \cdots (22)$$

$$V(r)=V(R)$$

$$\text{Odds: } \{f(r)/f(1/2)\}$$

1) Coupling

$$\frac{(1-r^2)^{c_{11}}(2-2r+2r^2)^{c_{12}}(2r-r^2)^{c_{13}}(r^2)^{c_{21}}(2r-2r^2)^{c_{22}}(1-2r+r^2)^{c_{23}}}{(0.75)^{c_{11}+c_{13}}(1.5)^{c_{12}}(0.25)^{c_{21}+c_{23}}(0.5)^{c_{22}}} \cdots (25)$$

2) Repulsion

$$\frac{(2r-r^2)^{c_{11}}(2-2r+2r^2)^{c_{12}}(1-r^2)^{c_{13}}(1-2r+r^2)^{c_{21}}(2r-2r^2)^{c_{22}}(r^2)^{c_{23}}}{(0.75)^{c_{11}+c_{13}}(1.5)^{c_{12}}(0.25)^{c_{21}+c_{23}}(0.5)^{c_{22}}} \cdots (26)$$

3) Coupling and repulsion

$$\frac{(1-r+r^2)^{c_{11}+c_{13}}(1+2r-2r^2)^{c_{12}}(r-r^2)^{c_{21}+c_{23}}(1-2r+2r^2)^{c_{22}}}{(0.75)^{c_{11}+c_{13}}(1.5)^{c_{12}}(0.25)^{c_{21}+c_{23}}(0.5)^{c_{22}}} \cdots (27)$$

$$\text{LOD score}=\log_{10} \{f(r)/f(1/2)\}$$

(For lethal gene, see Table 9, 10)

3) Coupling and repulsion

	<i>DD</i> (1)	<i>Dd</i> (2)	<i>dd</i> (1)	
{1/4}	<i>A-DD</i>	<i>A-Dd</i>	<i>A-dd</i>	
<i>A</i> -(3)	(1-r+r ²)	(1+2r-2r ²)	(1-r+r ²)	
	<i>c</i> ₁₁	<i>c</i> ₁₂	<i>c</i> ₁₃	<i>a</i> ₁
	<i>aaDD</i>	<i>aaDd</i>	<i>aadd</i>	
<i>aa</i> (1)	(r-r ²)	(1-2r+2r ²)	(r-r ²)	
	<i>c</i> ₂₁	<i>c</i> ₂₂	<i>c</i> ₂₃	<i>a</i> ₂
	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃	<i>n</i>

$$f(r)=A_0+A_1r+A_2r^2+A_3r^3+A_4r^4+A_5r^5+A_6r^6+A_7r^7 \cdots (23)$$

$$A_0=c_{21}+c_{23}$$

$$A_1=-c_{11}+2c_{12}-c_{13}-3c_{21}-2c_{22}-3c_{23}$$

$$A_2=3c_{11}-12c_{12}+3c_{13}-c_{21}+4c_{22}-c_{23}$$

$$A_3=2c_{11}+32c_{12}+2c_{13}+18c_{21}+8c_{22}+18c_{23}$$

$$A_4=-20c_{11}-50c_{12}-20c_{13}-40c_{21}-30c_{22}-40c_{23}$$

$$A_5=36c_{11}+48c_{12}+36c_{13}+44c_{21}+40c_{22}+44c_{23}$$

$$A_6=-28c_{11}-28c_{12}-28c_{13}-28c_{21}-28c_{22}-28c_{23}=-28n$$

$$A_7=8c_{11}+8c_{12}+8c_{13}+8c_{21}+8c_{22}+8c_{23}=8n$$

$$0 < r < 0.5 \quad r \text{ (Coup. and rep.)}$$

$$V(r)=\frac{2(1-r+r^2)(1+2r-2r^2)(r-r^2)(1-2r+2r^2)}{n(1-24r^2+80r^3-120r^4+96r^5-32r^6)} \cdots (24)$$

表-7 ⑥ 2つの標識遺伝子座について1:2:1と1:2:1の期待分離比で連鎖している場合の組換え価の計算方法

Table 7 ⑥ Calculation of recombination value(r) in expected segregation ratios of 1:2:1 and 1:2:1 in two loci.

1) Coupling or 2) repulsion R=(1-r)					3) Coupling and repulsion				
	DD(1)	Dd(2)	dd(1)			DD(1)	Dd(2)	dd(1)	
{1/4}	AADD	AADd	AAdd		{1/4}	AADD	AADd	AAdd	
AA(1)	(R ²)	(2R-2R ²)	(1-R) ²		AA(1)	(r-r ²)	(1-2r+2r ²)	(r-r ²)	
	c ₁₁	c ₁₂	c ₁₃	a ₁		c ₁₁	c ₁₂	c ₁₃	a ₁
	AaDD	AaDd	Aadd			AaDD	AaDd	Aadd	
Aa(2)	2R(1-R)	2(1-2R+2R ²)	2R(1-R)		Aa(2)	(1-2r+2r ²)	(4r-4r ²)	(1-2r+2r ²)	
	c ₂₁	c ₂₂	c ₂₃	a ₂		c ₂₁	c ₂₂	c ₂₃	a ₂
	aaDD	aaDd	aadd			aaDD	aaDd	aadd	
aa(1)	(1-R) ²	(2R-2R ²)	R ²		aa(1)	(r-r ²)	(1-2r+2r ²)	(r-r ²)	
	c ₃₁	c ₃₂	c ₃₃	a ₃		c ₃₁	c ₃₂	c ₃₃	a ₃
	b ₁	b ₂	b ₃	n		b ₁	b ₂	b ₃	n
f(R)=A ₀ +A ₁ R+A ₂ R ² +A ₃ R ³ (28)					f(R)=A-2(A+B)r+2(A+B)r ² (30)				
A ₀ = 2c ₁₁ + c ₁₂ + c ₂₁ + c ₂₃ + c ₃₂ +2c ₃₃					A=c ₁₁ +c ₁₃ +c ₂₂ +c ₃₁ +c ₃₃				
A ₁ =-6c ₁₁ -4c ₁₂ -2c ₁₃ -4c ₂₁ -2c ₂₂ -4c ₂₃ -2c ₃₁ -4c ₃₂ -6c ₃₃					B=c ₁₂ +c ₂₁ +c ₂₃ +c ₃₂				
A ₂ = 8c ₁₁ +6c ₁₂ +4c ₁₃ +6c ₂₁ +6c ₂₂ +6c ₂₃ +4c ₃₁ +6c ₃₂ +8c ₃₃					r={n+√n ² -2n(c ₁₁ +c ₁₃ +c ₂₂ +c ₃₁ +c ₃₃)} / 2n				
A ₃ =-4c ₁₁ -4c ₁₂ -4c ₁₃ -4c ₂₁ -4c ₂₂ -4c ₂₃ -4c ₃₁ -4c ₃₂ -4c ₃₃ =-4n					0<r<0.5 r (Coup. and rep.)				
0<R<0.5 r=R (Rep.)					V(r)= $\frac{(r-r^2)(1-2r+2r^2)}{2n(1-4r+4r^2)}$ (31)				
V(R)= $\frac{R(1-R)(1-2R+2R^2)}{2n(1-3R+3R^2)}$ (29)									
V(r)=V(R)									
Odds: {f(r)/f(1/2)}									
1) Coupling									
$\frac{(1-2r+r^2)^{c_{11}+c_{33}}(2r-2r^2)^{c_{12}+c_{21}+c_{23}+c_{32}}(r^2)^{c_{13}+c_{31}}(2-4r+4r^2)^{c_{22}}}{(0.25)^{c_{11}+c_{13}+c_{31}+c_{33}}(0.5)^{c_{12}+c_{21}+c_{23}+c_{32}}}$ (32)									
2) Repulsion									
$\frac{(r^2)^{c_{11}+c_{33}}(2r-2r^2)^{c_{12}+c_{21}+c_{23}+c_{32}}(1-2r+r^2)^{c_{13}+c_{31}}(2-4r+4r^2)^{c_{22}}}{(0.25)^{c_{11}+c_{13}+c_{31}+c_{33}}(0.5)^{c_{12}+c_{21}+c_{23}+c_{32}}}$ (33)									
3) Coupling and repulsion									
$\frac{(r-r^2)^{c_{11}+c_{13}+c_{31}+c_{33}}(4r-4r^2)^{c_{22}}(1-2r+r^2)^{c_{12}+c_{21}+c_{23}+c_{32}}}{(0.25)^{c_{11}+c_{13}+c_{31}+c_{33}}(0.5)^{c_{12}+c_{21}+c_{23}+c_{32}}}$ (34)									

LOD score=log₁₀ {f(r)/f(1/2)}

(For lethal gene, see Table 10)

表-8 標識遺伝子座と致死遺伝子座が1:1の期待分離比で連鎖している場合の集計値による最尤法およびロッド得点法 (LOD score) による組換えの計算方法 (表-2, 3, 5 参照)

Table 8 Calculation of recombination value on summed segregation frequency of 1:1 for a marker locus linked with a lethal gene with the maximum likelihood method and LOD score (cf. Tables 2, 3, 5).

1:1 segregation			
1) Coupling		2) Repulsion	
Genotype	Sum of expected frequency	Genotype	Sum of expected frequency
<i>Aa</i>	(1/3)(2-p)	<i>Aa</i>	(1/3)(1+p)
<i>aa</i>	(1/3)(1+p)	<i>aa</i>	(1/3)(2-p)
Total	1	Total	1
Observed number		Observed number	
<i>a</i> ₁		<i>a</i> ₁	
<i>a</i> ₂		<i>a</i> ₂	
<i>n</i>		<i>n</i>	
$p = (2a_2 - a_1)/n$ (35)		$p = (2a_1 - a_2)/n$ (37)	
0 < p < 0.5 p (Coupling)		0 < p < 0.5 p (Repulsion)	
0.5 < p < 1.0 (1-p) (Rep.)		0.5 < p < 1.0 (1-p) (Coupling)	
$V(p) = \{(1+p)(2-p)\}/n$ (36)		$V(p) = \{(1+p)(2-p)\}/n$ (38)	
S.E. of p = $\sqrt{V(p)}$		S.E. of p = $\sqrt{V(p)}$	
Odds: {f(p)/f(1/2)}		Odds: {f(p)/f(1/2)}	
= {(2-p) ^{a₁} (1+p) ^{a₂} }/(1.5) ^{a₁+a₂} (39)		= {(1+p) ^{a₁} (2-p) ^{a₂} }/(1.5) ^{a₁+a₂} (40)	
LOD score: log ₁₀ {f(p)/f(1/2)}		LOD score: log ₁₀ {f(p)/f(1/2)}	

表-9 標識遺伝子座と致死遺伝子座が 3:1 の期待分離比で連鎖している場合の集計値による最尤法およびロッド得点法 (LOD score) による組換え価の計算方法 (表-3, 4, 6 参照)

Table 9 Calculation of recombination value on summed segregation frequency of 3:1 for a marker locus linked with a lethal gene with the maximum likelihood method and LOD score (cf. Tables 3, 4, 6).

3:1 segregation			
1) Coupling		2) Repulsion	
3) Coupling and repulsion			
Genotype	Sum of expected frequency	Observed number	Observed number
A-	(1/3)(3-2p+p ²)	a ₁	a ₁
aa	(1/3)(2p-p ²)	a ₂	a ₂
Total	1	n	n
$f(p) = A_0 + A_1p + A_2p^2 + A_3p^3 \dots (41)$ $A_0 = 3a_2$ $A_1 = -2a_1 - 5a_2$ $A_2 = 3a_1 + 3a_2 = 3n$ $A_3 = -a_1 - a_2 = -n$			
$0 < p < 0.5 \quad p \text{ (Coup.)}$ $0.5 < p < 1.0 \quad (1-p) \text{ (Rep.)}$			
$V(p) = \{(3-2p+p^2)(2p-p^2)\} / \{4n(1-2p+p^2)\} \dots (42)$ $\text{S.E. of } p = \sqrt{V(p)}$			
$\text{Odds: } \{f(p)/f(1/2)\}$ $\frac{(3-2p+p^2)^{a_1}(2p-p^2)^{a_2}}{(2.25)^{a_1}(0.75)^{a_2}} \dots (47)$			
LOD score: $\log_{10}\{f(p)/f(1/2)\}$			
$p^2 = (a_1 - 2a_2)/n \dots (43)$ $p = \sqrt{p^2}$			
$0 < p < 0.5 \quad p \text{ (Rep.)}$ $0.5 < p < 1.0 \quad (1-p) \text{ (Coup.)}$			
$V(p) = \{(2+p^2)(1-p^2)\} / 4np^2 \dots (44)$ $\text{S.E. of } p = \sqrt{V(p)}$			
$\text{Odds: } \{f(p)/f(1/2)\}$ $\frac{(2+p^2)^{a_1}(1-p^2)^{a_2}}{(2.25)^{a_1}(0.75)^{a_2}} \dots (48)$			
LOD score: $\log_{10}\{f(p)/f(1/2)\}$			
$f(p) = A_0 + A_1p + A_2p^2 + A_3p^3 \dots (45)$ $A_0 = a_1 - 2a_2$ $A_1 = -3a_1 + 3a_2$ $A_2 = 3a_1 + 3a_2 = 3n$ $A_3 = -2a_1 - 2a_2 = -2n$			
$0 < p < 0.5 \quad p \text{ (Coup. and rep.)}$			
$V(p) = \{(2+p-p^2)(1-p+p^2)\} / \{n(1-4p+4p^2)\} \dots (46)$ $\text{S.E. of } p = \sqrt{V(p)}$			
$\text{Odds: } \{f(p)/f(1/2)\}$ $\frac{(2+p-p^2)^{a_1}(1-p+p^2)^{a_2}}{(2.25)^{a_1}(0.75)^{a_2}} \dots (49)$			
LOD score: $\log_{10}\{f(p)/f(1/2)\}$			

表-10 標識遺伝子座と致死遺伝子座が1:2:1の期待分離で連鎖している場合の集計値による最尤法およびロッド得点法 (LOD score) による組換えの計算方法 (表-5, 6, 7 参照)

Table 10 Calculation of recombination value on summed segregation frequency of 1:2:1 for a marker locus linked with a lethal gene with the maximum likelihood method and LOD score (cf. Tables 5, 6, 7).

1:2:1 segregation			
1) Coupling			
Genotype	Sum of expected frequency	Observed number	
AA	(1/3)(1-p ²)	a ₁	
Aa	(2/3)(1-p+p ²)	a ₂	
aa	(1/3)(2p-p ²)	a ₃	
Total	1	n	
f(p) = A ₀ + A ₁ p + A ₂ p ² + A ₃ p ³ + A ₄ p ⁴ + A ₅ p ⁵			
..... (50)			
A ₀ =	2a ₃		
A ₁ =	-2a ₂ - 4a ₃		
A ₂ =	-4a ₁ + 5a ₂ + 2a ₃		
A ₃ =	6a ₁ + 2a ₃		
A ₄ =	-6a ₁ - 5a ₂ - 4a ₃		
A ₅ =	2a ₁ + 2a ₂ + 2a ₃ = 2n		
0 < p < 0.5	p (Coup.)		
0.5 < p < 1.0	(1-p) (Rep.)		
V(p) = $\frac{3p(2-p)(1-p^2)(1-p+p^2)}{2n(2-4p-3p^2+14p^3-7p^4)}$ (51)			
S.E. of p = $\sqrt{V(p)}$			
Odds: {f(p)/f(1/2)}			
$\frac{(1-p^2)^{a_1}(1-p+p^2)^{a_2}(2p-p^2)^{a_3}}{(0.75)^{a_1+a_2+a_3}}$ (56)			
LOD score: log ₁₀ {f(p)/f(1/2)}			
2) Repulsion			
Genotype	Sum of expected frequency	Observed number	
AA	(1/3)(2p-p ²)	a ₁	
Aa	(2/3)(1-p+p ²)	a ₂	
aa	(1/3)(1-p ²)	a ₃	
Total	1	n	
f(p) = A ₀ + A ₁ p + A ₂ p ² + A ₃ p ³ + A ₄ p ⁴ + A ₅ p ⁵			
..... (52)			
A ₀ =	2a ₁		
A ₁ =	-4a ₁ - 2a ₂		
A ₂ =	2a ₁ + 5a ₂ - 4a ₃		
A ₃ =	2a ₁ + 6a ₃		
A ₄ =	-4a ₁ - 5a ₂ - 6a ₃		
A ₅ =	2a ₁ + 2a ₂ + 2a ₃ = 2n		
0 < p < 0.5	p (Rep.)		
0.5 < p < 1.0	(1-p) (Coup.)		
V(p) = $\frac{3p(2-p)(1-p^2)(1-p+p^2)}{2n(2-4p-3p^2+14p^3-7p^4)}$ (53)			
S.E. of p = $\sqrt{V(p)}$			
Odds: {f(p)/f(1/2)}			
$\frac{(2p-p^2)^{a_1}(1-p+p^2)^{a_2}(1-p^2)^{a_3}}{(0.75)^{a_1+a_2+a_3}}$ (57)			
LOD score: log ₁₀ {f(p)/f(1/2)}			
3) Coupling and repulsion			
Genotype	Sum of expected frequency	Observed number	
AA	(1/3)(1-p+p ²)	a ₁	
Aa	(1/3)(1+2p-2p ²)	a ₂	
aa	(1/3)(1-p+p ²)	a ₃	
Total	1	n	
f(p) = A ₀ + A ₁ p + A ₂ p ² + A ₃ p ³ (54)			
A ₀ = -a ₁ + 2a ₂ - a ₃			
A ₁ = -6a ₂			
A ₂ = 6a ₁ + 6a ₂ + 6a ₃ = 6n			
A ₃ = -4a ₁ - 4a ₂ - 4a ₃ = -4n			
0 < p < 0.5	p (Coup. and rep.)		
V(p) = $\frac{(1-p+p^2)(1+2p-2p^2)}{2n(1-4p+4p^2)}$ (55)			
S.E. of p = $\sqrt{V(p)}$			
Odds: {f(p)/f(1/2)}			
$\frac{(1-p+p^2)^{a_1+a_2}(1+2p-2p^2)^{a_2}}{(0.75)^{a_1+a_2}(1.5)^{a_2}}$ (58)			
LOD score: log ₁₀ {f(p)/f(1/2)}			

(4) データ入力等

(i) プログラム名: RECLD 20

1 回の計算で入力できる分離データの組数: 20 組

(ii) データ入力

プログラム後尾の DATA 文 (行番号: 59900~) で入力する

データの記入例

```

59900 '
59901 DATA Iwao sugi self 1993 (Test data)..... 交雑メモ
59902 '
59903 DATA 2 ..... データ組数
59904 '
59905 '   D 座 名      分離型      分離項数
59906 '   DGEN$(N)    MDS(N)      NDS(N)
59907 '           |           |           |
59908 '           | 1 1:1      | 2 組
59909 '           | 2 3:1      | 2 組
59910 '           | 3 1:2:1   | 3 組
59911 DATA Dwarf, ②, ②, Lg, ②, ②, ①
59912 DATA 66, 13, 79
59914 DATA 15, 22, 37
59916 DATA 81, 35, 116
59917 '           A 座 名      分離型      分離項数      交雑型
59918 '           AGEN$(N)    MAS(N)      NAS(N)      LCR(N)
59919 '           |           |           |           |
59920 '           | 1 1:1      | 2 項           | 1 自殖
59921 '           | 2 3:1      | 2 項           | 2 交雑
59922 '           | 3 1:2:1   | 3 項           |
59923 DATA Shd - 1, 3, 3, Lg, ②, ②, ①
59924 DATA 7, 47, 1, 55
59926 DATA 0, 2, 16, 18
59928 DATA 7, 49, 17, 73
    
```

(iii) 計算結果 (例)

結果は1分離データごとに, A4版用紙(縦)1枚に出力する。

致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との組換え価の計算結果 例 (1)

```

Iwao sugi self.1993(Test data)
N= 1
DGEN$(N)= Dwarf MDS(N)= 2 NDS(N)= 2 CROS$(N)= Self LCR(N)= 1
          SEGR. D-(3) dd(1) TOTAL
AGEN$(N)= Lg
MAS(N)= 2
NAS(N)= 2
          A-(3)      66      13      79
          aa(1)      15      22      37
          TOTAL      81      35      116

DGEN$(N)= Dwarf      df= 1      5%= 3.841      1% = 6.635
AGEN$(N)= Lg         df= 1      5%= 3.841      1% = 6.635
DGEN$(N)*AGEN$(N)    df= 3      5%= 7.815      1% = 11.340
LINKAGE              df= 1      5%= 3.841      1% = 6.635

DGEN$(N)*AGEN$(N)    df= 3      CDA(N)= 35.632 ** D-A LINKAGE ? JCDA(N)= 2
DGEN$(N)= Dwarf      df= 1      CD(N)= 1.655 NS JCD(N)= 0
AGEN$(N)= Lg         df= 1      CA(N)= 2.943 NS JCA(N)= 0
LINKAGE              df= 1      CLIN(N)= 31.034 ** D-A LINKAGE JLIN(N)= 2

          PHASE      RECOM. VALUE      VARIANCE
Dwarf * Lg
COUP. DA/da      PDAC(N)= 0.247454      DAVC(N)= 0.002249404048

LOD SCORE Dwarf * Lg
PDAC(N)= 0.2475      SC= 4.9222

LOD SCORE Dwarf

LOD SCORE Lg

```

致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との組換え価の計算結果 例 (2)

```

Iwao sugi self.1993(Test data)
N= 2
DGEN$(N)= Shd-1 MDS(N)= 3 NDS(N)= 3 CROS$(N)= Self LCR(N)= 1
          SEGR. DD(1) Dd(2) dd(1) TOTAL
AGEN$(N)= Lg
MAS(N)= 2
NAS(N)= 2
      A-(3)      7      47      1      55
      aa(1)      0      2      16      18
      TOTAL      7      49      17      73

DGEN$(N)= Shd-1      df= 2      5%= 5.991      1% = 9.210
AGEN$(N)= Lg          df= 1      5%= 3.841      1% = 6.635
DGEN$(N)*AGEN$(N)    df= 5      5%= 11.070     1% = 15.090
      LINKAGE          df= 2      5%= 5.991      1% = 9.210

DGEN$(N)*AGEN$(N) df= 5 CDA(N)= 67.895 ** D-A LINKAGE ? JCDA(N)= 2
DGEN$(N)= Shd-1   df= 2 CD(N)= 11.301 ** lethal gene-1 JCD(N)= 2
AGEN$(N)= Lg       df= 1 CA(N)= 0.005 NS JCA(N)= 0
      LINKAGE      df= 2 CLIN(N)= 56.589 ** D-A LINKAGE JLIN(N)= 2

      PHASE      RECOM. VALUE      VARIANCE
Shd-1 * Lg
COUP. DA/da      PDAC(N)= 0.036826      DAVC(N)= 0.000500406236

      PHASE      RECOM. VALUE      VARIANCE
DGEN$(N)= Shd-1
1. REP. D1/dL      PDR(N)= 0.144158      DVR(N)= 0.003370790626

LOD SCORE Shd-1 * Lg
PDAC(N)= 0.0368 SC= 12.4048

LOD SCORE Shd-1
PDR(N)= 0.1442 SC= 2.1550

LOD SCORE Lg
    
```

致死遺伝子座と標識遺伝子座, RFLP座およびRAPD座との組換え価の計算プログラム(RECLOD20)

```

100 REM F.N. " RECLOD20 " 1995. 5. 9, OHBA,K.
200 REM
300 REM FILE NAME - RECLOD20 - CALCULATION OF VALUE OF RECOMBINATION
350 DEFINT I-M: DEFDBL A-H,P-Z
400 DIM D1$(2),D2$(2),D3$(3),CROS$(2)
600 DIM DGEN$(20),AGEN$(20),MDS(20),MAS(20)
700 DIM C(20,3,3),SA(20,3),SB(20,3),SN(20),NAS(20),NDS(20),LCR(20)
704 DIM CD(20),CA(20),CDA(20),CLIN(20)
706 DIM JCD(20),JCA(20),JCDA(20),JLIN(20)
708 '
710 DIM PDAC(20),PDAR(20),PDACR(20),DAVC(20),DAVR(20),DAVCR(20)
712 DIM PDC(20),PDR(20),PDCR(20),DVC(20),DVR(20),DVCR(20)
716 DIM PAC(20),PAR(20),PACR(20),AVC(20),AVR(20),AVCR(20)
720 '
740 DIM CHIV5(10),CHIV1(10)
750 D1$(1)="Aa(1)":D1$(2)="aa(1)":CROS$(1)="Self   LCR(N)= 1 "
752 D2$(1)="A-(3)":D2$(2)="aa(1)":CROS$(2)="Cross   LCR(N)= 2 "
754 D3$(1)="AA(1)":D3$(2)="Aa(2)":D3$(3)="aa(1)"
756 '
760 CHIV5(1)=3.841:CHIV5(2)=5.991:CHIV5(3)=7.815:CHIV5(4)=9.488:CHIV5(5)=11.07
762 CHIV5(6)=12.59:CHIV5(7)=14.07:CHIV5(8)=15.51:CHIV5(9)=16.92
764 CHIV1(1)=6.635:CHIV1(2)=9.21:CHIV1(3)=11.34:CHIV1(4)=13.28:CHIV1(5)=15.09
766 CHIV1(6)=16.81:CHIV1(7)=18.48:CHIV1(8)=20.09:CHIV1(9)=21.64
780 DEF FNY(A0,A1,A2,A3,A4,A5,P)=A0+A1*P+A2*P^2+A3*P^3+A4*P^4+A5*P^5
782 DEF FNYD(A1,A2,A3,A4,A5,P)=A1+2!*A2*P+3!*A3*P^2+4!*A4*P^3+5!*A5*P^4
783 '
784 READ RM$
800 READ NDAT
850 FOR N=1 TO NDAT
900 READ DGEN$(N),MDS(N),NDS(N),AGEN$(N),MAS(N),NAS(N),LCR(N)
1110 KNO(N)=N
1120 FOR I=1 TO NAS(N)
1121 FOR J=1 TO NDS(N)
1122 READ C(N,I,J)
1123 NEXT J
1124 READ SA(N,I)
1125 NEXT I
1127 FOR J=1 TO NDS(N)
1128 READ SB(N,J)
1129 NEXT J
1130 READ SN(N)
1140 NEXT N
2500 '
2502 'LPRINT:LPRINT:LPRINT:LPRINT " CHI-SQUARE TEST FOR SEGREGATION "
2505 ' CHI-SQUARE TEST FOR SEGREGATION
2510 '
2515 FOR N=1 TO NDAT
2517 '
2520 ON MDS(N) GOTO 3000,3030,3060
3000 '
3001 LPRINT CHR$(12)
3002 LPRINT USING "& ";& RM$
3003 LPRINT:LPRINT USING "N= ## ";N
3004 LPRINT "DGEN$(N)= ";DGEN$(N);" MDS(N)= ";MDS(N);" NDS(N)= ";NDS(N);
3005 LL=LCR(N):LPRINT " CROS$(N)= ";CROS$(LL)
3006 LPRINT " SEGR. DD(Dd)(1) Dd(dd)(1) TOTAL "
3028 GOTO 3200
3030 '
3031 LPRINT CHR$(12)
3032 ' LPRINT OUT OF DATA 3:1
3033 LPRINT USING "& ";& RM$
3034 LPRINT USING "N= ## ";N
3036 LPRINT "DGEN$(N)= ";DGEN$(N);" MDS(N)= ";MDS(N);" NDS(N)= ";NDS(N);

```

```

3037 LL=LCR(N):LPRINT "   CROSS$(N)= ";CROSS$(LL)
3038 LPRINT "           SEGR.   D-(3)   dd(1)   TOTAL   "
3040 '
3058 GOTO 3202
3060 '
3061 LPRINT CHR$(12)
3062 ' LPRINT OUT OF DATA 1:2:1
3063 LPRINT USING " & " ;RM$
3064 LPRINT USING "N= ## ";N
3066 LPRINT "DGEN$(N)= ";DGEN$(N);"   MDS(N)= ";MDS(N);"   NDS(N)= ";NDS(N);
3067 LL=LCR(N):LPRINT "   CROSS$(N)= ";CROSS$(LL)
3068 LPRINT "           SEGR.   DD(1)   Dd(2)   dd(1)   TOTAL   "
3070 '
3098 GOTO 3204
3200   ON MAS(N) GOTO 3250,3250,3250
3202   ON MAS(N) GOTO 4000,5000,5000
3204   ON MAS(N) GOTO 6000,7000,8000
3250 '   1:1:1:1
3251 '
3252 GOSUB 23255
3270 '
3272 ' CALCULATION OF CHI-SQUARE FOR 1:1:1:1
3274 'LPRINT:LPRINT:LPRINT " CALCULATION OF CHI-SQUARE FOR 1:1:1:1 "
3276 LPRINT
3280 '
3282 K1=NDS(N)-1;K2=NAS(N)-1;K12=NDS(N)*NAS(N)-1;K22=K12-K1-K2
3284 CHID5=CHIV5(K1):CHID1=CHIV1(K1):CHIA5=CHIV5(K2):CHIA1=CHIV1(K2)
3286 CHIDA5=CHIV5(K12):CHIDA1=CHIV1(K12):CV5=CHIV5(K22):CV1=CHIV1(K22)
3288 '
3289 GOSUB 23290
3310 '
3312 CD(N)=(SB(N,1)^2+SB(N,2)^2)/(.5*SN(N))-SN(N)
3314 CA(N)=(SA(N,1)^2+SA(N,2)^2)/(.5*SN(N))-SN(N)
3316 X1=C(N,1,1)^2+C(N,1,2)^2+C(N,2,1)^2+C(N,2,2)^2
3318 CDA(N)=X1/(.25*SN(N))-SN(N)
3320 CLIN(N)=CDA(N)-CD(N)-CA(N)
3321 LPRINT
3322 '
3323 GOSUB 23324
3324 '
3425 'CALCULATION OF RECOM. VALUE WITH MAXIMUM LIKELIHOOD METHOD "
3426 IF JLIN(N)=0 THEN GOTO 3466
3428 P=(C(N,1,1)+C(N,2,2))/SN(N)
3430 DAVR(N)=(P*(1-P))/SN(N)
3432 LPRINT:LPRINT:LPRINT "           PHASE       RECOM. VALUE       VARIANCE   "
3434 LPRINT USING " &   &* &   & ";DGEN$(N),AGEN$(N)
3436 IF P > .5 THEN GOTO 3450
3438 PDAR(N)=P
3440 '
3442 LPRINT "   REP.   Da/da ";
3444 LPRINT USING "   PDAR(N)= #.##### ";PDAR(N);
3446 LPRINT USING "   DAVR(N)= #.##### ";DAVR(N)
3448 GOTO 3458
3450 PDAC(N)=1!-P:DAVC(N)=DAVR(N)
3452 LPRINT "   COUP.   DA/da ";
3454 LPRINT USING "   PDAC(N)= #.##### ";PDAC(N);
3456 LPRINT USING "   DAVC(N)= #.##### ";DAVC(N)
3458 '
3466 ' " CAL. OF RECOM VALUE WITH LETHAL FOR DGEN$(N) BY MAX.L. METHOD "
3468 IF JCD(N)=0 THEN GOTO 3496
3470 '
3472 P=(2!*SB(N,2)-SB(N,1))/SN(N)
3474 VR=((1!+P)*(2!-P))/SN(N)

```

```

3476 LPRINT:LPRINT:LPRINT "          PHASE          RECOM. VALUE          VARIANCE  "
3478 LPRINT USING "   DGEN$(N)= &          & ";DGEN$(N)
3480 IF P > .5 THEN GOTO 3492
3482 PDC(N)=P
3484 DVC(N)=VR
3486 LPRINT " 1. COUP.DL/dl ";
3488 LPRINT USING "   PDC(N)=          #.##### ";PDC(N);
3490 LPRINT USING "   DVC(N)=          #.##### ";DVC(N)
3491 GOTO 3496
3492 PDR(N)=1!-P:DVR(N)=VR
3493 LPRINT " 1. REP.  D1/dL ";
3494 LPRINT USING "   PDR(N)=          #.##### ";PDR(N);
3495 LPRINT USING "   DVR(N)=          #.##### ";DVR(N)
3496 ' " CAL. OF RECOM VALUE WITH LETHAL FOR AGEN$(N) BY MAX.L. METHOD "
3498 IF JCA(N)=0 THEN GOTO 3550
3500 '
3501 GOSUB 23502
3550 '
3999 GOTO 9500
4000 '
4002 ' 3:1:3:1
4008 '
4010 GOSUB 23255
4040 '
4042 K1=NDS(N)-1:K2=NAS(N)-1:K12=NDS(N)*NAS(N)-1:K22=K12-K2-K1
4044 CHID5=CHIV5(K1):CHID1=CHIV1(K1):CHIA5=CHIV5(K2):CHIA1=CHIV1(K2)
4046 CHIDA5=CHIV5(K12):CHIDA1=CHIV1(K12):CV5=CHIV5(K22):CV1=CHIV1(K22)
4047 LPRINT
4048 '
4049 GOSUB 23290
4080 '
4082 CD(N)=SB(N,1)^2/(.75*SN(N))+SB(N,2)^2/(.25*SN(N))-SN(N)
4084 CA(N)=(SA(N,1)^2+SA(N,2)^2)/(.5*SN(N))-SN(N)
4086 X1=(C(N,1,1)^2+C(N,2,1)^2)/(.375*SN(N))
4087 X2=(C(N,1,2)^2+C(N,2,2)^2)/(.125*SN(N))
4088 CDA(N)=(X1+X2)-SN(N)
4090 CLIN(N)=CDA(N)-CD(N)-CA(N)
4091 LPRINT
4092 '
4093 GOSUB 23324
4200 '
4202 'CALCULATION OF RECOM. VALUE WITH MAXIMUM LIKELIHOOD METHOD "
4204 IF JLIN(N)=0 THEN GOTO 4300
4206 '
4208 A0=2!*C(N,2,2)
4210 A1=2!*C(N,1,1)-2!*C(N,1,2)-C(N,2,1)-C(N,2,2)
4212 A2=-3!*C(N,1,1)-C(N,1,2)-2!*C(N,2,2)
4214 A3=SN(N)
4216 A4=0!
4218 A5=0!
4220 '
4222 P=.001:EPS=1E-08
4224 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
4226 Y2=FNYD(A1,A2,A3,A4,A5,P)
4228 P1=P-Y1/Y2
4230 IF(ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 4236
4232 P=P1
4234 GOTO 4224
4236 V71=2!*P*(2!-P)*(1!-P)*(1!+P)
4238 V72=SN(N)*(1!+2!*P-2!*P^2)
4240 V7=V71/V72
4242 '
4244 LPRINT:LPRINT:LPRINT "          PHASE          RECOM. VALUE          VARIANCE  "

```

```

4246 LPRINT USING "  &    &* &    & ";DGEN$(N),AGEN$(N)
4248 IF P > .5 THEN GOTO 4262
4250 PDAR(N)=P
4252 DAVR(N)=V7
4254 LPRINT "    REP.  Da/da ";
4256 LPRINT USING "    PDAR(N)=  #.##### ";PDAR(N);
4258 LPRINT USING "    DAVR(N)=  #.##### ";DAVR(N)
4260 GOTO 4270
4262 PDAC(N)=1!-P:DAVC(N)=V7
4264 LPRINT "    COUP.  DA/da ";
4266 LPRINT USING "    PDAC(N)=  #.##### ";PDAC(N);
4268 LPRINT USING "    DAVC(N)=  #.##### ";DAVC(N)
4270 '
4300 ' " CAL. OF RECOM VALUE WITH LETHAL FOR DGEN$(N) BY MAX.L. METHOD "
4302 IF JCD(N)=0 THEN GOTO 4500
4304 '
4305 GOSUB 24306
4462 '
4500 ' " CAL. OF RECOM VALUE WITH LETHAL FOR AGEN$(N) BY MAX.L. METHOD "
4502 IF JCA(N)=0 THEN GOTO 4536
4504 '
4505 GOSUB 23502
4536 '
4999 GOTO 9500
5000 '
5010 ON MAS(N) GOTO 5050,5050,6000
5012 '
5049 ' 9:3:3:1
5050 ' LPRINT OUT OF DATA 3:1 AGEN$(N)
5051 '
5052 GOSUB 25053
5070 '
5072 K1=NDS(N)-1:K2=NAS(N)-1:K12=NDS(N)*NAS(N)-1:K22=K12-K1-K2
5074 CHID5=CHIV5(K1):CHID1=CHIV1(K1):CHIA5=CHIV5(K2):CHIA1=CHIV1(K2)
5076 CHIDA5=CHIV5(K12):CHIDA1=CHIV1(K12):CV5=CHIV5(K22):CV1=CHIV1(K22)
5077 LPRINT
5078 '
5079 GOSUB 23290
5150 '
5152 CD(N)=SB(N,1)^2/(.75*SN(N))+SB(N,2)^2/(.25*SN(N))-SN(N)
5154 CA(N)=SA(N,1)^2/(.75*SN(N))+SA(N,2)^2/(.25*SN(N))-SN(N)
5156 X1=C(N,1,1)^2/(.5625*SN(N))
5158 X2=(C(N,1,2)^2+C(N,2,1)^2)/(.1875*SN(N))
5159 X3=C(N,2,2)^2/(.0625*SN(N))
5160 CDA(N)=(X1+X2+X3)-SN(N)
5162 CLIN(N)=CDA(N)-CD(N)-CA(N)
5190 LPRINT
5192 '
5195 GOSUB 23324
5304 '
5310 'CALCULATION OF RECOM. VALUE WITH MAXIMUM LIKELIHOOD METHOD "
5312 IF JLIN(N)=0 THEN GOTO 5450
5314 '
5316 A0=-2!*C(N,2,2)
5318 A1=-C(N,1,1)+2!*C(N,1,2)+2!*C(N,2,1)+C(N,2,2)
5320 A2=SN(N)
5322 A3=0!
5324 A4=0!
5326 A5=0!
5328 '
5330 P=.001:EPS=1E-08
5332 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
5334 Y2=FNYD(A1,A2,A3,A4,A5,P)

```

```

5336 P1=P-Y1/Y2
5338 IF(ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 5344
5340 P=P1
5342 GOTO 5332
5344 V71=(2!+P)*(1!-P)
5346 V72=2!*SN(N)*(1!+2!*P)
5348 V7=V71/V72
5349 PS=SQR(P)
5350 LPRINT:LPRINT:LPRINT "          PHASE      RECOM. VALUE      VARIANCE  "
5352 LPRINT USING "    &      &*      &      ";DGEN$(N),AGEN$(N)
5354 IF PS > .5 THEN GOTO 5368
5356 PDAR(N)=PS
5358 DAVR(N)=V7
5360 LPRINT "      REP.   Da/dA ";
5362 LPRINT USING "      PDAR(N)= #.##### ";PDAR(N);
5364 LPRINT USING "      DAVR(N)= #.##### ";DAVR(N)
5366 GOTO 5376
5368 PDAC(N)=1!-PS:DAVC(N)=V7
5370 LPRINT "      COUP.   DA/da ";
5372 LPRINT USING "      PDAC(N)= #.##### ";PDAC(N);
5374 LPRINT USING "      DAVC(N)= #.##### ";DAVC(N)
5376 ' CAL OF RECOM. VALUE FOR COUP. AND REP.
5378 IF LCR(N)=1 THEN GOTO 5450
5379 A0=2!*C(N,2,2)
5380 A1=C(N,1,1)-2!*C(N,1,2)-2!*C(N,2,1)-5!*C(N,2,2)
5381 A2=-4!*C(N,1,1)+5!*C(N,1,2)+5!*C(N,2,1)+2!*C(N,2,2)
5382 A3=6!*C(N,1,1)+2!*C(N,2,2)
5383 A4=-5!*SN(N)
5384 A5=2!*SN(N)
5385 A6=0!
5386 P=.001:EPS=1E-09
5387 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
5388 Y2=FNYD(A1,A2,A3,A4,A5,P)
5389 P1=P-Y1/Y2
5390 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 5393
5391 P=P1
5392 GOTO 5387
5393 VZ=2!*P*(2!-P)*(1!-P^2)*(1!-P+P^2)
5394 VW=SN(N)*(1!-2!*P-6!*P^2+16!*P^3-8!*P^4)
5395 VR=VZ/VW
5396 PDACR(N)=P:DAVCR(N)=VR
5397 LPRINT "      COUP.AND REP.";
5398 LPRINT USING "      PDACR(N)= #.##### ";PDACR(N);
5399 LPRINT USING "      DAVCR(N)=#.##### ";DAVCR(N)
5400 '
5450 ' " CAL. OF RECOM VALUE WITH LETHAL FOR DGEN$(N) BY MAX.L. METHOD "
5452 IF JCD(N)=0 THEN GOTO 5626
5454 '
5455 GOSUB 24306
5624 '
5626 ' " CAL. OF RECOM VALUE WITH LETHAL FOR AGEN$(N) BY MAX.L. METHOD "
5627 IF JCA(N)=0 THEN GOTO 5750
5628 '
5629 GOSUB 25629
5750 '
5999 GOTO 9500
6000 '
6002 ON MAS(N) GOTO 6010,7000,8000
6010 ' 1:2:1:1:2:1
6011 ' LPRINT OUT OF DATA 1:1 AGEN$(N)
6012 '
6013 GOSUB 23255
6050 '

```

致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との組換え価の計算プログラム (RECLD20) (大庭他)

```

6052 K1=NDS(N)-1:K2=NAS(N)-1:K12=NDS(N)*NAS(N)-1:K22=K12-K1-K2
6054 CHID5=CHIV5(K1):CHID1=CHIV1(K1):CHIA5=CHIV5(K2):CHIA1=CHIV1(K2)
6056 CHIDA5=CHIV5(K12):CHIDA1=CHIV1(K12):CV5=CHIV5(K22):CV1=CHIV1(K22)
6057 LPRINT
6058 '
6059 GOSUB 23290
6150 '
6152 CD(N)=(SB(N,1)^2+SB(N,3)^2)/(.25*SN(N))+SB(N,2)^2/(.5*SN(N))-SN(N)
6154 CA(N)=(SA(N,1)^2+SA(N,2)^2)/(.5*SN(N))-SN(N)
6156 X1=(C(N,1,1)^2+C(N,1,3)^2+C(N,2,1)^2+C(N,2,3)^2)/(.125*SN(N))
6158 X2=(C(N,1,2)^2+C(N,2,2)^2)/(.25*SN(N))
6159 '
6160 CDA(N)=(X1+X2)-SN(N)
6162 CLIN(N)=CDA(N)-CD(N)-CA(N)
6163 LPRINT
6164 '
6195 GOSUB 23324
6304 '
6306 ' CALCULATION OF RECOM. VALUE WITH MAXIMUM LIKELIHOOD METHOD '
6308 IF JLIN(N)=0 THEN GOTO 6352
6310 '
6320 P=(C(N,1,1)+C(N,2,3))/SN(N)
6322 V6=(2!*P*(1!-P))/SN(N)
6326 LPRINT:LPRINT:LPRINT "          PHASE          RECOM. VALUE          VARIANCE  "
6328 LPRINT USING "          &* &          & ";DGEN$(N),AGEN$(N)
6330 IF P > .5 THEN GOTO 6344
6332 PDAR(N)=P
6334 DAVR(N)=V6
6336 LPRINT "          REP.  Da/dA ";
6338 LPRINT USING "          PDAR(N)= #.##### ";PDAR(N);
6340 LPRINT USING "          DAVR(N)= #.##### ";DAVR(N)
6342 GOTO 6352
6344 PDAC(N)=1!-P:DAVC(N)=V6
6346 LPRINT "          COUP.  DA/da ";
6348 LPRINT USING "          PDAC(N)= #.##### ";PDAC(N);
6350 LPRINT USING "          DAVC(N)= #.##### ";DAVC(N)
6352 '
6354 ' " CAL. OF RECOM VALUE WITH LETHAL FOR DGEN$(N) BY MAX.L. METHOD "
6356 IF JCD(N)=0 THEN GOTO 6532
6358 '
6359 GOSUB 26360
6530 '
6532 ' " CAL. OF RECOM VALUE WITH LETHAL FOR AGEN$(N) BY MAX.L. METHOD "
6534 IF JCA(N)=0 THEN GOTO 6610
6536 '
6537 GOSUB 23502
6610 '
6999 ' GOTO 9500
7000 '
7002 ' 3:6:3:1:2:1
7010 '
7011 ' LPRINT OUT OF DATA 3:1 AGEN$(N)
7012 '
7013 GOSUB 25053
7050 '
7052 K1=NDS(N)-1:K2=NAS(N)-1:K12=NDS(N)*NAS(N)-1:K22=K12-K1-K2
7054 CHID5=CHIV5(K1):CHID1=CHIV1(K1):CHIA5=CHIV5(K2):CHIA1=CHIV1(K2)
7056 CHIDA5=CHIV5(K12):CHIDA1=CHIV1(K12):CV5=CHIV5(K22):CV1=CHIV1(K22)
7057 LPRINT
7058 '
7059 GOSUB 23290
7150 '
7152 CD(N)=(SB(N,1)^2+SB(N,3)^2)/(.25*SN(N))+SB(N,2)^2/(.5*SN(N))-SN(N)

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7154 CA(N)=SA(N,1)^2/(.75*SN(N))+SA(N,2)^2/(.25*SN(N))-SN(N)
7156 X1=(C(N,1,1)^2+C(N,1,3)^2)/(.1875*SN(N))
7158 X2=C(N,1,2)^2/(.375*SN(N))+C(N,2,2)^2/(.125*SN(N))
7159 X3=(C(N,2,1)^2+C(N,2,3)^2)/(.0625*SN(N))
7160 CDA(N)=(X1+X2+X3)-SN(N)
7162 CLIN(N)=CDA(N)-CD(N)-CA(N)
7163 LPRINT
7164 '
7195 GOSUB 23324
7299 '
7300 'CALCULATION OF RECOM. VALUE WITH MAXIMUM LIKELIHOOD METHOD "
7302 IF JLIN(N)=0 THEN GOTO 7420
7304 '
7306 A0=2!*C(N,1,1)+2!*C(N,2,2)+4!*C(N,2,3)
7308 A1=-4!*(C(N,1,1)+C(N,2,1))-2!*C(N,1,2)-5!*C(N,2,2)-6!*C(N,2,3)
7310 A2=2!*(C(N,1,1)+C(N,2,1)+C(N,2,2)+C(N,2,3))+5!*C(N,1,2)-4!*C(N,1,3)
7312 A3=2!*(C(N,1,1)+C(N,2,2))+6!*C(N,1,3)+4!*C(N,2,3)
7314 A4=-5!*SN(N)+C(N,1,1)+C(N,2,1)-C(N,1,3)-C(N,2,3)
7316 A5=2!*SN(N)
7318 '
7320 P=.001:EPS=1E-08
7322 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
7324 Y2=FNYD(A1,A2,A3,A4,A5,P)
7325 P1=P-Y1/Y2
7326 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 7329
7327 P=P1
7328 GOTO 7322
7329 V71=2!*P*(2!-P)*(1!-P+P^2)*(1!-P^2)
7330 V72=SN(N)*(4!-5!*P-3!*P^2+16!*P^3-8!*P^4)
7331 V7=V71/V72
7332 LPRINT:LPRINT:LPRINT "          PHASE      RECOM. VALUE      VARIANCE  "
7334 LPRINT USING "    &    &* &    & ";DGEN$(N),AGEN$(N)
7338 IF P > .5 THEN GOTO 7352
7340 PDAR(N)=P
7342 DAVR(N)=V7
7344 LPRINT "    REP.    Da/da ";
7346 LPRINT USING "    PDAR(N)= #.##### ";PDAR(N);
7348 LPRINT USING "    DAVR(N)= #.##### ";DAVR(N)
7350 GOTO 7360
7352 PDAC(N)=1!-P:DAVC(N)=V7
7354 LPRINT "    COUP.    DA/da ";
7356 LPRINT USING "    PDAC(N)= #.##### ";PDAC(N);
7358 LPRINT USING "    DAVC(N)= #.##### ";DAVC(N)
7360 ' CAL OF RECOM. VALUE FOR COUP. AND REP.
7361 IF LCR(N)=1 THEN GOTO 7422
7362 A0=C(N,2,1)+C(N,2,3)
7364 A1=-SN(N)+3!*C(N,1,2)-2!*C(N,2,1)-C(N,2,2)-2!*C(N,2,3)
7366 A2=3!*(C(N,1,1)+C(N,1,3)+C(N,2,2))-12!*C(1,2)+C(N,2,2)-C(N,2,1)-C(N,2,3)
7368 A3=2!*SN(N)+30!*C(N,1,2)+16!*C(N,2,1)+6!*C(N,2,2)+16!*C(N,2,3)
7370 A4=-20!*SN(N)-30!*C(N,1,2)-20!*C(N,2,1)-10!*C(N,2,2)-20!*C(N,2,3)
7372 A5=36!*SN(N)+12!*C(N,1,2)+8!*C(N,2,1)+4!*C(N,2,2)+8!*C(N,2,3)
7374 A6=-28!*SN(N)
7376 A7=8!*SN(N)
7378 '
7380 '
7382 P=.001:EPS=1E-08
7384 TZ=A0+A1*P+A2*P^2+A3*P^3+A4*P^4+A5*P^5+A6*P^6+A7*P^7
7386 TW=A1+2!*A2*P+3!*A3*P^2+4!*A4*P^3+5!*A5*P^4+6!*A6*P^5+7!*A7*P^6
7390 P1=P-TZ/TW
7392 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 7398
7394 P=P1
7396 GOTO 7384
7398 PDACR(N)=P

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7400 VZ=2!*(1!-P+P^2)*(1!+2!*P-2!*P^2)*(P-P^2)*(1!-2!*P+2!*P^2)
7402 VW=SN(N)*(1!-24!*P^2+80!*P^3-120!*P^4+96!*P^5-32!*P^6)
7403 IF VW=0! THEN GOTO 7406
7404 VR=VZ/VW:DAVCR(N)=VR:GOTO 7408
7406 DAVCR(N)=0!
7408 LPRINT "      COUP.AND REP.";
7410 LPRINT USING "      PDACR(N)=#.#####";PDACR(N);
7412 LPRINT USING "      DAVCR(N)=#.#####";DAVCR(N):GOTO 7420
7414 'LPRINT "      COUP. AND REP. - SQR(-) "
7420 '
7422 ' " CAL. OF RECOM VALUE WITH LETHAL FOR DGEN$(N) BY MAX.L. METHOD "
7424 IF JCD(N)=0 THEN GOTO 7600
7426 '
7427 GOSUB 26360
7584 '
7600 ' " CAL. OF RECOM VALUE WITH LETHAL FOR AGEN$(N) BY MAX.L. METHOD "
7602 IF JCA(N)=0 THEN GOTO 7742
7604 '
7605 GOSUB 25629
7742 '
7999 GOTO 9500
8000 '
8001 ' 1:2:1:2:4:2:1:2:1
8002 ' LPRINT OUT OF DATA 1:2:1 AGEN$(N)
8003 LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
8004 LPRINT "NAS(N)= ";NAS(N)
8006 FOR I=1 TO NAS(N):LPRINT USING "          &      ";D3$(I);
8008 FOR J=1 TO NDS(N)
8010 LPRINT USING " ##### ";C(N,I,J);
8012 NEXT J
8014 LPRINT USING " ##### ";SA(N,I)
8016 NEXT I
8018 LPRINT:LPRINT "          TOTAL ";
8020 FOR J=1 TO NDS(N)
8022 LPRINT USING " ##### ";SB(N,J);
8024 NEXT J
8026 LPRINT USING " ##### ";SN(N)
8030 '
8032 K1=NDS(N)-1:K2=NAS(N)-1:K12=NDS(N)*NAS(N)-1:K22=K12-K1-K2
8034 CHID5=CHIV5(K1):CHID1=CHIV1(K1):CHIA5=CHIV5(K2):CHIA1=CHIV1(K2)
8036 CHIDA5=CHIV5(K12):CHIDA1=CHIV1(K12):CV5=CHIV5(K22):CV1=CHIV1(K22)
8037 LPRINT
8038 '
8039 GOSUB 23290
8150 '
8152 CD(N)=(SB(N,1)^2+SB(N,3)^2)/(.25*SN(N))+SB(N,2)^2/(.5*SN(N))-SN(N)
8154 CA(N)=(SA(N,1)^2+SA(N,3)^2)/(.25*SN(N))+SA(N,2)^2/(.5*SN(N))-SN(N)
8156 X1=(C(N,1,1)^2+C(N,1,3)^2+C(N,3,1)^2+C(N,3,3)^2)/(.0625*SN(N))
8158 X2=(C(N,1,2)^2+C(N,2,1)^2+C(N,2,3)^2+C(N,3,2)^2)/(.125*SN(N))
8159 X3=C(N,2,2)^2/(.25*SN(N))
8160 CDA(N)=(X1+X2+X3)-SN(N)
8162 CLIN(N)=CDA(N)-CD(N)-CA(N)
8163 LPRINT
8164 '
8195 GOSUB 23324
8196 '
8300 ' CALCULATION OF RECOM. VALUE(P) WITH MAXIMUM LIKELIHOOD METHOD "
8310 IF JLIN(N) = 0 THEN GOTO 8585
8315 LPRINT
8320 A0=2!*(C(N,1,1)+C(N,3,3))+C(N,1,2)+C(N,2,1)+C(N,2,3)+C(N,3,2)
8325 A1=-4!*SN(N)-2!*(C(N,1,1)+C(N,3,3)-C(N,1,3)-C(N,2,2)-C(N,3,1))
8330 A2=6!*SN(N)+2!*(C(N,1,1)+C(N,3,3)-C(N,1,3)-C(N,3,1))
8335 A3=-4!*SN(N)

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8340 A4=0!
8345 A5=0!
8350 '
8355 P=.001:EPS=1E-09
8360 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
8365 Y2=FNYD(A1,A2,A3,A4,A5,P)
8370 P1=P-Y1/Y2
8375 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 8390
8380 P=P1
8385 GOTO 8360
8390 LPRINT:LPRINT:LPRINT "          PHASE      RECOM. VALUE      VARIANCE  "
8400 LPRINT USING "      &      &* &      & ";DGEN$(N),AGEN$(N)
8401 VR=(P*(1!-P)*(1-2!*P+2!*P^2))/(2!*SN(N)*(1!-3!*P+3!*P^2))
8405 IF P > .5 THEN GOTO 8420
8410 PDAR(N)=P
8415 DAVR(N)=VR
8416 LPRINT "      REP.   Da/dA ";
8417 LPRINT USING "      PDAR(N)= #.##### ";PDAR(N);
8418 LPRINT USING "      DAVR(N)= #.##### ";DAVR(N)
8419 GOTO 8425
8420 PDAC(N)=1!-P:DAVC(N)=VR
8421 LPRINT "      COUP.  DA/da ";
8422 LPRINT USING "      PDAC(N)= #.##### ";PDAC(N);
8423 LPRINT USING "      DAVC(N)= #.##### ";DAVC(N)
8424 'GOTO 8950
8425 '
8430 IF LCR(N) = 1 THEN GOTO 8585
8435 ' COUP. AND REP.
8440 Z1=C(N,1,1)+C(N,1,3)+C(N,2,2)+C(N,3,1)+C(N,3,3)
8445 Z2=SN(N)^2-2!*SN(N)*Z1
8450 IF Z2 < 0! GOTO 8582
8455 P8=(SN(N)+SQR(Z2))/(2!*SN(N))
8460 VR8=((P8-P8^2)*(1!-2!*P8+2!*P8^2))/(2!*SN(N)*(1!-4!*P8+4!*P8^2))
8465 PDACR(N)=P8:DAVCR(N)=VR8
8470 LPRINT "      COUP.AND REP.";
8475 LPRINT USING "      PDACR(N)= #.##### ";PDACR(N);
8480 LPRINT USING "      DAVCR(N)=#.##### ";DAVCR(N):GOTO 8585
8485 LPRINT "      COUP. AND REP. - SQR(-) "
8490 '
8495 ' " CAL. OF RECOM VALUE WITH LETHAL FOR DGEN$(N) BY MAX.L. METHOD "
8500 IF JCD(N)=0 THEN GOTO 8760
8505 '
8510 GOSUB 26360
8515 '
8520 ' " CAL. OF RECOM VALUE WITH LETHAL FOR AGEN$(N) BY MAX.L. METHOD "
8525 IF JCA(N)=0 THEN GOTO 8950
8530 '
8535 A0=2!*SA(N,3)
8540 A1=-2!*SA(N,2)-4!*SA(N,3)
8545 A2=-4!*SA(N,1)+5!*SA(N,2)+2!*SA(N,3)
8550 A3=6!*SA(N,1)+2!*SA(N,3)
8555 A4=-6!*SA(N,1)-5!*SA(N,2)-4!*SA(N,3)
8560 A5=2!*SN(N)
8565 '
8570 P=.001:EPS=1E-09
8575 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
8580 Y2=FNYD(A1,A2,A3,A4,A5,P)
8585 P1=P-Y1/Y2
8590 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 8794
8595 P=P1
8600 GOTO 8575
8605 LPRINT:LPRINT:LPRINT "          PHASE      RECOM. VALUE      VARIANCE  "
8610 LPRINT USING "      AGEN$(N)= &      & ";AGEN$(N)

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8798 V1=3!*P*(2!-P)*(1!-P^2)*(1!-P+P^2)
8800 V2=2!*SN(N)*(2!-4!*P-3!*P^2+14!*P^3-7!*P^4)
8802 VR=V1/V2
8804 IF P > .5 THEN GOTO 8818
8806 PAC(N)=P
8808 AVC(N)=VR
8810 LPRINT " 1. COUP.DL/d1 ";
8812 LPRINT USING "    PAC(N)=    #.##### ";PAC(N);
8814 LPRINT USING "    AVC(N)=    #.##### ";AVC(N)
8816 GOTO 8828
8818 PAR(N)=1!-P:AVR(N)=VR
8820 LPRINT " 1. REP.    D1/dL ";
8822 LPRINT USING "    PAR(N)=    #.##### ";PAR(N);
8824 LPRINT USING "    AVR(N)=    #.##### ";AVR(N)
8826 ,
8828 IF LCR(N)=1 THEN GOTO 8950
8830 A0=-SA(N,1)+2!*SA(N,2)-SA(N,3)
8832 A1=-6!*SA(N,2)
8834 A2=6!*SN(N)
8836 A3=-4!*SN(N)
8838 A4=0!:A5=0!
8840 ,
8842 P=.001:EPS=1E-09
8844 Y1=FN1(A0,A1,A2,A3,A4,A5,P)
8846 Y2=FN2(A1,A2,A3,A4,A5,P)
8848 P1=P-Y1/Y2
8850 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 8896
8892 P=P1
8894 GOTO 8844
8896 VR8=SN(N)*(1!-4!*P+4!*P^2)
8898 IF VR8 <= 0! THEN GOTO 8904
8900 AVCR(N)=((1!-P+P^2)*(1!+2!*P-2!*P^2))/(2!*SN(N)*(1!-4!*P+4!*P^2))
8902 GOTO 8908
8904 AVCR(N)=0!
8906 ,
8908 PACR(N)=P
8910 LPRINT " 3. COUP.AND REP.";
8912 LPRINT USING "    PACR(N)=    #.##### ";PACR(N);
8914 LPRINT USING "    AVCR(N)=    #.##### ";AVCR(N):GOTO 8950
8916 LPRINT " 3. COUP. AND REP. - SQR(-) "
8950 ,
9500 ,
10100 REM  CALCULATION OF LOD SCORE
10801 DEF FNZ1(P,N1)=(1-P)^N1
10802 DEF FNZ2(P,N2)=P^N2
10803 DEF FNZ3(P,N3)=(2!-P)^N3
10804 DEF FNZ4(P,N4)=(1!+P)^N4
10805 DEF FNZ5(P,N5)=(3!-2!*P+P^2)^N5
10806 DEF FNZ6(P,N6)=(2!*P-P^2)^N6
10807 DEF FNZ7(P,N7)=(2!+P^2)^N7
10808 DEF FNZ8(P,N8)=(1!-P^2)^N8
10809 DEF FNZ9(P,N9)=(2!+P-P^2)^N9
10810 DEF FNZ10(P,N10)=(1!-P+P^2)^N10
10811 DEF FNZ11(P,N11)=(1!-2!*P+P^2)^N11
10812 DEF FNZ12(P,N12)=(P^2)^N12
10813 DEF FNZ13(P,N13)=(P-P^2)^N13
10814 DEF FNZ14(P,N14)=(1!+2!*P-2!*P^2)^N14
10815 DEF FNZ15(P,N15)=(2!-2!*P+2!*P^2)^N15
10816 DEF FNZ16(P,N16)=(2!*P-2!*P^2)^N16
10817 DEF FNZ17(P,N17)=(1!-2!*P+2!*P^2)^N17
10818 DEF FNZ18(P,N18)=(2!-4!*P+4!*P^2)^N18
10819 DEF FNZ19(P,N19)=(4!*P-4!*P^2)^N19
10820 TL=LOG(10)

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10821 DEF FNW1(M1)=(2.25)^M1
10822 DEF FNW2(M2)=(1.5)^M2
10823 DEF FNW3(M3)=(.75)^M3
10824 DEF FNW4(M4)=(.5)^M4
10825 DEF FNW5(M5)=(.25)^M5
12502 'LPRINT:LPRINT:LPRINT:LPRINT " CHI-SQUARE TEST FOR SEGREGATION "
12505 ' CHI-SQUARE TEST FOR SEGREGATION
12515 'N=KNO(N)
12520 ON MDS(N) GOTO 13200,13202,13204
13200 ON MAS(N) GOTO 13250,13250,13250
13202 ON MAS(N) GOTO 14000,15000,15000
13204 ON MAS(N) GOTO 16000,17000,18000
13250 ' 1:1:1:1
13255 'LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
13256 'LPRINT "NAS(N)= ";NAS(N):LPRINT:LPRINT
13258 '
13260 IF JLIN(N)=0 THEN GOTO 13294
13262 K1=C(N,1,1):K2=C(N,1,2)
13264 K3=C(N,2,1):K4=C(N,2,2)
13265 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &*&      &";DGEN$(N),AGEN$(N)
13266 IF PDAC(N)=<0! OR PDAC(N)>.5 THEN GOTO 13280
13268 P=PDAC(N):LPRINT USING " PDAC(N)= #.#### ";P;
13270 U1=FNZ1(P,K1)/FNW4(K1):U2=FNZ1(P,K4)/FNW4(K4)
13272 U3=FNZ2(P,K2)/FNW4(K2):U4=FNZ2(P,K3)/FNW4(K3)
13274 UU=U1*U2*U3*U4
13276 SC=LOG(UU)/TL:LPRINT USING "      SC=###.#### ";SC
13278 GOTO 13294
13280 IF PDAR(N)=<0! OR PDAR(N)>.5 THEN GOTO 13294
13282 P=PDAR(N):LPRINT USING " PDAR(N)= #.#### ";P;
13284 U1=FNZ2(P,K1)/FNW4(K1):U2=FNZ2(P,K4)/FNW4(K4)
13286 U3=FNZ1(P,K2)/FNW4(K2):U4=FNZ1(P,K3)/FNW4(K3)
13288 UU=U1*U2*U3*U4
13290 SC=LOG(UU)/TL:LPRINT USING "      SC=###.#### ";SC
13292 '
13294 ' LOD SCORE CALCULATION FOR DGEN$(N) 1:1
13296 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &";DGEN$(N)
13298 IF JCD(N)=0 THEN GOTO 13340
13300 N1=SB(N,1):N2=SB(N,2)
13302 IF PDC(N)=<0! OR PDC(N)>.5 THEN GOTO 13320
13304 P=PDC(N):LPRINT USING " PDC(N)= #.#### ";P;
13306 '
13308 G1=FNZ3(P,N1)/FNW2(N1):G2=FNZ4(P,N2)/FNW2(N2)
13310 GG=G1*G2:IF GG=<0! THEN GOTO 13316
13312 GS=LOG(GG)/TL
13314 LPRINT USING "      SC=###.#### ";GS: GOTO 13340
13316 LPRINT "      ODDS= 0. ":GOTO 13340
13318 '
13320 IF PDR(N)=<0! OR PDR(N)>.5 THEN GOTO 13340
13322 P=PDR(N):LPRINT USING " PDR(N)= #.#### ";P;
13324 G21=FNZ4(P,N1)/FNW2(N1):G22=FNZ3(P,N2)/FNW2(N2)
13326 GG2=G21*G22: IF GG2=<0! THEN GOTO 13334
13328 GS2=LOG(GG2)/TL
13330 LPRINT USING "      SC=###.#### ";GS2
13332 GOTO 13340
13334 LPRINT "      ODDS= 0. "
13340 ' LOD SCORE CALCULATION FOR AGEN$(N) 1:1
13341 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &";AGEN$(N)
13342 IF JCA(N)=0 THEN GOTO 13400
13343 '
13344 GOSUB 33346
13345 '
13346 N1=SA(N,1):N2=SA(N,2)
13348 IF PAC(N)=<0! OR PAC(N)>.5 THEN GOTO 13366

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13350 P=PAC(N):LPRINT USING " PAC(N)=  ########. ";P;
13354 G1=FNZ3(P,N1)/FNW2(N1):G2=FNZ4(P,N2)/FNW2(N2)
13356 GG=G1*G2:IF GG=<0! THEN GOTO 13362
13358 GS=LOG(GG)/TL
13360 LPRINT USING " SC=####.#### ";GS:GOTO 13400
13362 LPRINT " ODDS= 0. ":GOTO 13400
13366 IF PAR(N)=<0! OR PAR(N)>.5 THEN GOTO 13400
13368 P=PAR(N):LPRINT USING " PAR(N)=  ########. ";P;
13370 G21=FNZ4(P,N1)/FNW2(N1):G22=FNZ3(P,N2)/FNW2(N2)
13372 GG2=G21*G22:IF GG2=<0! THEN GOTO 13380
13374 GS2=LOG(GG2)/TL
13376 LPRINT USING " SC=####.#### ";GS2
13378 GOTO 13400
13380 LPRINT " ODDS= 0. "
13400 GOTO 18490
14000 '
14002 ' 3:1:3:1
14012 'LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
14014 'LPRINT "NAS(N)= ";NAS(N):LPRINT:LPRINT
14016 IF JLIN(N)=0 THEN GOTO 14050
14018 K1=C(N,1,1):K2=C(N,1,2)
14020 K3=C(N,2,1):K4=C(N,2,2)
14021 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &*      &";DGEN$(N),AGEN$(N)
14022 IF PDAC(N)=<0! OR PDAC(N)>.5 THEN GOTO 14036
14024 P=PDAC(N):LPRINT USING " PDAC(N)=  ########. ";P;
14026 U1=FNZ3(P,K1)/FNW2(K1):U2=FNZ4(P,K3)/FNW2(K3)
14028 U3=FNZ2(P,K2)/FNW4(K2):U4=FNZ1(P,K4)/FNW4(K4)
14030 UU=U1*U2*U3*U4
14032 SC=LOG(UU)/TL:LPRINT USING " SC=####.#### ";SC
14034 GOTO 14050
14036 IF PDAR(N)=<0! OR PDAR(N)>.5 THEN GOTO 14050
14038 P=PDAR(N):LPRINT USING " PDAR(N)=  ########. ";P;
14040 U1=FNZ4(P,K1)/FNW2(K1):U2=FNZ3(P,K3)/FNW2(K3)
14042 U3=FNZ1(P,K2)/FNW4(K2):U4=FNZ2(P,K4)/FNW4(K4)
14044 UU=U1*U2*U3*U4
14046 SC=LOG(UU)/TL:LPRINT USING " SC=####.#### ";SC
14050 ' LOD SCORE CALCULATION FOR DGEN$(N) 3:1
14052 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &";DGEN$(N)
14053 IF JCD(N)=0 THEN GOTO 14114
14054 '
14055 GOSUB 34056
14058 '
14114 ' LOD SCORE CALCULATION FOR AGEN$(N) 1:1
14122 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &";AGEN$(N)
14123 IF JCA(N)=0 THEN GOTO 14200
14124 '
14125 GOSUB 33346
14128 '
14200 GOTO 18490
15000 '
15010 ' ON MAS(N) GOTO 15050,15050,16000
15050 ' 9:3:3:1
15052 ' LPRINT OUT OF DATA 3:1 AGEN$(N)
15053 'LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
15054 'LPRINT "NAS(N)= ";NAS(N):LPRINT:LPRINT
15056 IF JLIN(N)=0 THEN GOTO 15110
15058 K1=C(N,1,1):K2=C(N,1,2)
15060 K3=C(N,2,1):K4=C(N,2,2)
15061 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &*      &";DGEN$(N),AGEN$(N)
15062 IF PDAC(N)=<0! OR PDAC(N)>.5 THEN GOTO 15076
15064 P=PDAC(N):LPRINT USING " PDAC(N)=  ########. ";P;
15066 U1=FNZ5(P,K1)/FNW1(K1):U2=FNZ6(P,K2)/FNW3(K2)
15068 U3=FNZ6(P,K3)/FNW3(K3):U4=FNZ11(P,K4)/FNW5(K4)

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```

15070 UU=U1*U2*U3*U4
15072 SC=LOG(UU)/TL:LPRINT USING "    SC=###.#### ";SC
15074 GOTO 15090
15076 IF PDAR(N)=<0! OR PDAR(N)>.5 THEN GOTO 15090
15078 P=PDAR(N):LPRINT USING " PDAR(N)= #.#### ";P;
15080 U1=FNZ7(P,K1)/FNW1(K1):U2=FNZ8(P,K2)/FNW3(K2)
15082 U3=FNZ8(P,K3)/FNW3(K3):U4=FNZ12(P,K4)/FNW5(K4)
15084 UU=U1*U2*U3*U4
15086 SC=LOG(UU)/TL:LPRINT USING "    SC=###.#### ";SC
15088 '
15090 IF LCR(N)=1 THEN GOTO 15110
15092 B1=FNZ9(P,K1)/FNW1(K1):B2=FNZ10(P,K2)/FNW3(K2)
15094 B3=FNZ10(P,K3)/FNW3(K3):B4=FNZ13(P,K4)/FNW5(K4)
15098 BB=B1*B2*B3*B4:IF BB=<0! THEN GOTO 15106
15100 CR=LOG(BB)/TL
15102 P=PDACR(N):LPRINT:LPRINT USING " PDACR(N)= #.#### ";P;
15104 LPRINT USING "    CR=###.#### ";CR:GOTO 15110
15106 LPRINT " COUP.AND REP., ODDS= 0.0 "
15110 ' LOD SCORE CALCULATION FOR DGEN$(N) 3:1
15111 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      ";DGEN$(N)
15112 IF JCD(N)=0 THEN GOTO 15172
15113 '
15114 GOSUB 34056
15116 '
15170 '
15172 ' LOD SCORE CALCULATION FOR AGEN$(N) 3:1
15174 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      ";AGEN$(N)
15175 IF JCA(N)=0 THEN GOTO 15232
15176 '
15177 GOSUB 35177
15178 '
15232 GOTO 18490
16000 '
16002 ON MAS(N) GOTO 16010,17000,18000
16010 ' 1:2:1:1:2:1
16012 ' LPRINT OUT OF DATA 1:1 AGEN$(N)
16014 ' LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
16016 ' LPRINT "NAS(N)= ";NAS(N):LPRINT:LPRINT
16020 IF JLIN(N)=0 THEN GOTO 16054
16022 K1=C(N,1,1):K3=C(N,1,3)
16024 K4=C(N,2,1):K6=C(N,2,3)
16025 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &      &";DGEN$(N),AGEN$(N)
16026 IF PDAC(N)=<0! OR PDAC(N)>.5 THEN GOTO 16040
16028 P=PDAC(N):LPRINT USING " PDAC(N)= #.#### ";P;
16030 U1=FNZ1(P,K1)/FNW4(K1):U2=FNZ1(P,K6)/FNW4(K6)
16032 U3=FNZ2(P,K3)/FNW4(K3):U4=FNZ2(P,K4)/FNW4(K4)
16034 UU=U1*U2*U3*U4
16036 SC=LOG(UU)/TL:LPRINT USING "    SC=###.#### ";SC
16038 GOTO 16054
16040 IF PDAR(N)=<0! OR PDAR(N)>.5 THEN GOTO 16054
16042 P=PDAR(N):LPRINT USING " PDAR(N)= #.#### ";P;
16044 U1=FNZ2(P,K1)/FNW4(K1):U2=FNZ2(P,K6)/FNW4(K6)
16046 U3=FNZ1(P,K3)/FNW4(K3):U4=FNZ1(P,K4)/FNW4(K4)
16048 UU=U1*U2*U3*U4
16050 SC=LOG(UU)/TL:LPRINT USING "    SC=###.#### ";SC
16054 ' LOD SCORE CALCULATION FOR DGEN$(N) 1:2:1
16055 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      ";DGEN$(N)
16056 IF JCD(N)=0 THEN GOTO 16110
16057 '
16058 GOSUB 36058
16059 '
16110 ' LOD SCORE CALCULATION FOR AGEN$(N) 1:1
16112 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      ";AGEN$(N)

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16113 IF JCA(N)=0 THEN GOTO 16152
16114 '
16115 GOSUB 33346
16118 '
16152 GOTO 18490
17000 '
17002 ' 3:6:3:1:2:1
17010 '
17014 ' LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
17016 ' LPRINT "NAS(N)= ";NAS(N):LPRINT:LPRINT
17018 ' LOD SCORE CALCULATION FOR 3:6:3*1:2:1 SEGREGATION
17020 IF JLIN(N)=0 THEN GOTO 17082
17022 K1=C(N,1,1):K2=C(N,1,2):K3=C(N,1,3)
17024 K4=C(N,2,1):K5=C(N,2,2):K6=C(N,2,3)
17025 LPRINT:LPRINT USING "LOD SCORE &      &* &      &";DGEN$(N),AGEN$(N)
17026 IF PDAC(N)=<0! OR PDAC(N)>.5 THEN GOTO 17042
17028 P=PDAC(N):LPRINT USING " PDAC(N)= #.#### ";P;
17030 U1=FNZ8(P,K1)/FNW3(K1):U2=FNZ6(P,K3)/FNW3(K3)
17032 U3=FNZ15(P,K2)/FNW2(K2):U4=FNZ12(P,K4)/FNW5(K4)
17034 U5=FNZ11(P,K6)/FNW5(K6):U6=FNZ16(P,K5)/FNW4(K5)
17038 UU=U1*U2*U3*U4*U5*U6
17040 SC=LOG(UU)/TL:LPRINT USING "      SC=###.#### ";SC
17041 GOTO 17060
17042 IF PDAR(N)=<0! OR PDAR(N)>.5 THEN GOTO 17060
17044 P=PDAR(N):LPRINT USING " PDAR(N)= #.#### ";P;
17046 U1=FNZ8(P,K3)/FNW3(K3):U2=FNZ6(P,K1)/FNW3(K1)
17048 U3=FNZ15(P,K2)/FNW2(K2):U4=FNZ11(P,K4)/FNW5(K4)
17050 U5=FNZ12(P,K6)/FNW5(K6):U6=FNZ16(P,K5)/FNW4(K5)
17054 UU=U1*U2*U3*U4*U5*U6
17056 SC=LOG(UU)/TL:LPRINT USING "      SC=###.#### ";SC
17060 IF LCR(N)=1 THEN GOTO 17082
17062 B1=FNZ10(P,K1)/FNW3(K1):B2=FNZ10(P,K3)/FNW(K3)
17064 B3=FNZ14(P,K2)/FNW2(K2):B4=FNZ13(P,K4)/FNW5(K4)
17066 B5=FNZ13(P,K6)/FNW5(K6):B6=FNZ17(P,K5)/FNW4(K5)
17068 BB=B1*B2*B3*B4*B5*B6: IF BB=<0! THEN GOTO 17076
17070 CR=LOG(BB)/TL
17072 LPRINT:LPRINT USING " PDACR(N)= #.#### ";P;
17074 LPRINT USING " CR=###.#### ";CR:GOTO 17082
17076 LPRINT " COUP.AND REP., ODDS= 0.0 "
17082 ' LOD SCORE CALCULATION FOR DGEN$(N) 1:2:1
17084 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &";DGEN$(N)
17085 IF JCD(N)=0 THEN GOTO 17140
17086 '
17087 GOSUB 36058
17138 '
17140 ' LOD SCORE CALCULATION FOR AGEN$(N) 3:1
17141 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &";AGEN$(N)
17142 IF JCA(N)=0 THEN GOTO 17900
17143 '
17144 GOSUB 35177
17900 '
17950 GOTO 18490
17999 '
18000 ' LOD SCORE CALCULATION FOR 1:2:1 * 1:2:1 SEGREGATION
18001 ' 1:2:1:2:4:2:1:2:1
18002 '
18004 IF JLIN(N)=0 THEN GOTO 18082
18006 K1=C(N,1,1):K2=C(N,1,2):K3=C(N,1,3)
18008 K4=C(N,2,1):K5=C(N,2,2):K6=C(N,2,3)
18010 K7=C(N,3,1):K8=C(N,3,2):K9=C(N,3,3)
18012 LPRINT:LPRINT:LPRINT USING "LOD SCORE &      &* &      &";DGEN$(N),AGEN$(N)
18014 IF PDAC(N) < 0! OR PDAC(N) >.5 THEN GOTO 18038
18016 P=PDAC(N): LPRINT USING " PDAC(N)= #.#### ";P;

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18018 U1=FNZ11(P,K1)/FNW5(K1):U2=FNZ11(P,K9)/FNW5(K9)
18020 U3=FNZ6(P,K2)/FNW4(K2):U4=FNZ6(P,K4)/FNW4(K4)
18022 U5=FNZ6(P,K6)/FNW4(K6):U6=FNZ6(P,K8)/FNW4(K8)
18024 U7=FNZ12(P,K3)/FNW5(K3):U8=FNZ12(P,K7)/FNW5(K7)
18026 U9=FNZ18(P,K5)
18028 UU=U1*U2*U3*U4*U5*U6*U7*U8*U9
18030 SC=LOG(UU)/TL:LPRINT USING " SC=###.#### ";SC
18034 GOTO 18060
18038 IF PDAR(N) <0! OR PDAR >.5 THEN GOTO 18060
18040 P=PDAR(N): LPRINT:LPRINT USING " PDAR(N)= #.#### ";P;
18042 U1=FNZ12(P,K1)/FNW5(K1):U2=FNZ12(P,K9)/FNW5(K9)
18044 U3=FNZ6(P,K2)/FNW4(K2):U4=FNZ6(P,K4)/FNW4(K4)
18046 U5=FNZ6(P,K6)/FNW4(K6):U6=FNZ6(P,K8)/FNW4(K8)
18048 U7=FNZ11(P,K3)/FNW5(K3):U8=FNZ11(P,K7)/FNW5(K7)
18050 U9=FNZ18(P,K5)
18052 UU=U1*U2*U3*U4*U5*U6*U7*U8*U9
18054 SC=LOG(UU)/TL:LPRINT USING " SC=###.#### ";SC
18060 IF LCR(N)=1 THEN GOTO 18082
18062 IF PDACR(N) < 0! OR PDACR(N) >.5 THEN GOTO 18082
18064 P=PDACR(N): LPRINT:LPRINT USING " PDACR(N)= #.#### ";P;
18066 U1=FNZ13(P,K1)/FNW5(K1):U2=FNZ13(P,K3)/FNW5(K3)
18068 U3=FNZ13(P,K7)/FNW5(K7):U4=FNZ13(P,K9)/FNW5(K9)
18070 U5=FNZ17(P,K2)/FNW4(K2):U6=FNZ17(P,K4)/FNW4(K4)
18072 U7=FNZ17(P,K6)/FNW4(K6):U8=FNZ17(P,K8)/FNW4(K8)
18074 U9=FNZ19(P,K5)
18076 UU=U1*U2*U3*U4*U5*U6*U7*U8*U9
18078 SC=LOG(UU)/TL:LPRINT USING " SC=###.#### ";SC
18082 ' LOD SCORE CALCULATION FOR DGEN$(N) 1:2:1
18083 LPRINT:LPRINT:LPRINT USING "LOD SCORE & "&";DGEN$(N)
18084 IF JCD(N)=0 THEN GOTO 18138
18085 '
18086 GOSUB 36058
18137 '
18138 ' LOD SCORE CALCULATION FOR AGEN$(N) 1:2:1
18140 LPRINT:LPRINT:LPRINT USING "LOD SCORE & "&";AGEN$(N)
18141 IF JCA(N)=0 THEN GOTO 18490
18142 N1=SA(N,1):N2=SA(N,2):N3=SA(N,3):N4=SA(N,1)+SA(N,3)
18144 IF PAC(N)=<0! OR PAC(N)>.5 THEN GOTO 18158
18146 P=PAC(N):LPRINT USING " PAC(N)= #.#### ";P;
18148 G1=FNZ8(P,N1)/FNW3(N1):G2=FNZ10(P,N2)/FNW3(N2):G3=FNZ6(P,N3)/FNW3(N3)
18150 GG=G1*G2*G3:IF GG=<0! THEN GOTO 18156
18152 GS=LOG(GG)/TL
18154 LPRINT USING " SC=###.#### ";GS:GOTO 18158
18156 LPRINT " ODDS= 0. ":GOTO 18174
18158 IF PAR(N)=<0! OR PAR(N)>.5 THEN GOTO 18174
18160 P=PAR(N):LPRINT USING " PAR(N)= #.#### ";P;
18162 G21=FNZ8(P,N3)/FNW3(N3):G22=FNZ10(P,N2)/FNW3(N2):G23=FNZ6(P,N1)/FNW3(N1)
18164 GG2=G21*G22*G23:IF GG2=<0! THEN GOTO 18172
18166 GS2=LOG(GG2)/TL
18168 LPRINT USING " SC=###.#### ";GS2
18170 GOTO 18174
18172 LPRINT " ODDS= 0. "
18174 IF LCR(N)=1 THEN GOTO 18490
18176 IF PACR(N)=<0! OR PACR(N)>.5 THEN GOTO 18192
18178 P=PACR(N)
18180 H1=FNZ10(P,N1)/FNW3(N1):H2=FNZ10(P,N3)/FNW3(N3):H3=FNZ14(P,N2)/FNW2(N2)
18182 HH=H1*H2*H3: IF HH <=0! THEN GOTO 18190
18184 HS=LOG(HH)/TL
18186 LPRINT:LPRINT USING " PACR(N)= #.#### ";P;
18188 LPRINT USING " SC=###.#### ";HS:GOTO 18490
18190 LPRINT " ODDS= 0. ":GOTO 18490
18192 LPRINT " 0 > PACR(N) > 0.5 "
18490 NEXT

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18500 END
23250 '
23251 ' CALCULATION OF VALUE OF RECOMBINATION
23253 '
23254 ' GOSUB 23255 DATA OUTPUT FOR AGEN$ 1:1
23255 LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
23256 LPRINT "NAS(N)= ";NAS(N)
23257 FOR I=1 TO NAS(N):LPRINT USING "          &      & ";D1$(I);
23258     FOR J=1 TO NDS(N)
23259         LPRINT USING "##### ";C(N,I,J);
23260     NEXT J
23261 LPRINT USING "          ";SA(N,I)
23262 NEXT I
23263 LPRINT:LPRINT "          TOTAL ";
23264 FOR J=1 TO NDS(N)
23265     LPRINT USING "          ";SB(N,J);
23266 NEXT J
23267 LPRINT USING "          ";SN(N)
23268 RETURN
23288 '
23289 ' GOSUB 23290 CHI-SQUARE DATA
23290 LPRINT USING "DGEN$(N)= &      & ";DGEN$(N);
23291 LPRINT USING "          df=## ";K1;
23292 LPRINT USING "          5%####.###          1%####.### ";CHID5;CHID1
23294 LPRINT USING "AGEN$(N)= &      & ";AGEN$(N);
23296 LPRINT USING "          df=## ";K2;
23298 LPRINT USING "          5%####.###          1%####.### ";CHIA5;CHIA1
23300 '
23302 LPRINT "DGEN$(N)*AGEN$(N) ";
23304 LPRINT USING "          df=## ";K12;
23306 LPRINT USING "          5%####.###          1%####.### ";CHIDA5;CHIDA1
23307 LPRINT "          LINKAGE ";
23308 LPRINT USING "          df=## ";K22;
23309 LPRINT USING "          5%####.###          1%####.### ";CV5,CV1
23310 RETURN
23322 '
23323 ' GOSUB 23324 CHI-SQURE TEST
23324 LPRINT "DGEN$(N)*AGEN$(N)";
23326 LPRINT USING "          df=## ";K12;
23328 LPRINT USING "CDA(N)= ###.### ";CDA(N);
23330 IF CDA(N) > CHIDA5 THEN 23336
23332 '
23334 LPRINT USING "          JCDA(N)= ## ";JCDA(N):GOTO 23348
23336 IF CDA(N) > CHIDA1 THEN 23344
23338 JCDA(N)=1:LPRINT "* D-A LINKAGE ?";
23340 LPRINT USING "          JCDA(N)= ## ";JCDA(N):GOTO 23348
23342 '
23344 JCDA(N)=2:LPRINT "*** D-A LINKAGE ?";
23346 LPRINT USING "          JCDA(N)= ## ";JCDA(N)
23348 '
23350 LPRINT USING "DGEN$(N)= &      & ";DGEN$(N);
23352 LPRINT USING "          df=## ";K1;
23354 LPRINT USING "CD(N)= ###.### ";CD(N);
23356 IF CD(N) > CHID5 THEN 23362
23358 JCD(N)=0:LPRINT "NS ";
23360 LPRINT USING "          JCD(N)= ## ";JCD(N):GOTO 23374
23362 IF CD(N) > CHID1 THEN 23370
23364 '
23366 JCD(N)=1:LPRINT "* lethal gene-1";
23368 LPRINT USING "          JCD(N)= ## ";JCD(N):GOTO 23374
23370 JCD(N)=2:LPRINT "*** lethal gene-1";
23372 LPRINT USING "          JCD(N)= ## ";JCD(N)
23374 '

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23376 LPRINT USING "AGEN$(N)= &      &";AGEN$(N);
23378 LPRINT USING " df=## ";K2;
23380 LPRINT USING "CA(N)= ###.### ";CA(N);
23382 IF CA(N) > CHIA5 THEN 23388
23384 JCA(N)=0:LPRINT "NS ";
23386 LPRINT USING "          JCA(N)= ## ";JCA(N):GOTO 23400
23388 IF CA(N) > CHIA1 THEN 23396
23390 '
23392 JCA(N)=1:LPRINT "* lethal gene-2";
23394 LPRINT USING " JCA(N)= ## ";JCA(N):GOTO 23400
23396 JCA(N)=2:LPRINT "** lethal gene-2";
23398 LPRINT USING " JCA(N)= ## ";JCA(N)
23400 '
23402 LPRINT "          LINKAGE ";
23404 LPRINT USING " df=## ";K22;
23406 LPRINT USING "CLIN(N)=###.### ";CLIN(N);
23408 IF CLIN(N)> CV5 THEN 23414
23410 JLIN(N)=0:LPRINT "NS ";
23412 LPRINT USING "          JLIN(N)= ## ";JLIN(N):GOTO 23424
23414 IF CLIN(N) > CV1 THEN 23422
23418 JLIN(N)=1:LPRINT "* D-A LINKAGE ";
23420 LPRINT USING " JLIN(N)= ## ";JLIN(N):GOTO 23424
23422 JLIN(N)=2:LPRINT "** D-A LINKAGE ";
23423 LPRINT USING " JLIN(N)= ## ";JLIN(N)
23424 RETURN
23500 '
23501 ' GOSUB 23502 CALCULATION OF VALUE OF RECOMBINATION FOR AGEN$ 1:1
23502 P=(2!*SA(N,2)-SA(N,1))/SN(N)
23504 VR=((1!+P)*(2!-P))/SN(N)
23506 LPRINT:LPRINT:LPRINT "          PHASE          RECOM. VALUE          VARIANCE  "
23508 LPRINT USING " AGEN$(N)= &      & ";AGEN$(N)
23510 IF P > .5 THEN GOTO 23524
23512 PAC(N)=P
23514 AVC(N)=VR
23516 LPRINT " 1. COUP.DL/d1 ";
23518 LPRINT USING " PAC(N)= #.##### ";PAC(N);
23520 LPRINT USING " AVC(N)= #.##### ";AVC(N)
23522 GOTO 23530
23524 PAR(N)=1!-P:AVR(N)=VR
23526 LPRINT " 1. REP. DL/dL ";
23528 LPRINT USING " PAR(N)= #.##### ";PAR(N);
23529 LPRINT USING " AVR(N)= #.##### ";AVR(N)
23530 RETURN
24304 '
24305 ' GOSUB 24306 CALCULATION OF VALUE OF RECOMBINATION FOR DGEN$ 3:1
24306 A0=3!*SB(N,2)
24308 A1=-2!*SB(N,1)-5!*SB(N,2)
24310 A2=3!*SB(N,1)+3!*SB(N,2)
24312 A3=-SN(N)
24314 A4=0!
24316 A5=0!
24318 '
24320 P=.001:EPS=1E-08
24322 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
24324 Y2=FNVD(A1,A2,A3,A4,A5,P)
24326 P1=P-Y1/Y2
24328 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 24334
24330 P=P1
24332 GOTO 24322
24334 LPRINT:LPRINT:LPRINT "          PHASE          RECOM. VALUE          VARIANCE  "
24336 LPRINT USING " DGEN$(N)= &      & ";DGEN$(N)
24338 V1=(3!-2!*P+P^2)*(2!*P-P^2)
24340 V2=4!*SN(N)*(1!-2!*P+P^2)

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24342 VR=V1/V2
24344 IF P > .5 THEN GOTO 24358
24346 PDC(N)=P
24348 DVC(N)=VR
24350 LPRINT " 1. COUP.DL/d1 ";
24352 LPRINT USING " PDC(N)= #.##### ";PDC(N);
24354 LPRINT USING " DVC(N)= #.##### ";DVC(N)
24356 GOTO 24366
24358 PDR(N)=1!-P:DVR(N)=VR
24360 LPRINT " 1. REP. D1/dL ";
24362 LPRINT USING " PDR(N)= #.##### ";PDR(N);
24364 LPRINT USING " DVR(N)= #.##### ";DVR(N)
24366 '
24410 IF LCR(N)=1 THEN GOTO 24461
24412 ' COUP. AND REP.
24414 A0=SB(N,1)-2!*SB(N,2)
24416 A1=-3!*SB(N,1)+3!*SB(N,2)
24418 A2=3!*SN(N)
24420 A3=-2!*SN(N)
24422 A4=0!:A5=0!
24424 '
24426 P=.001:EPS=1E-09
24428 Y1=FN(Y1,A0,A1,A2,A3,A4,A5,P)
24430 Y2=FN(Y2,A1,A2,A3,A4,A5,P)
24432 P1=P-Y1/Y2
24434 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 24440
24436 P=P1
24438 GOTO 24428
24440 VR4=SN(N)*(1!-4!*P+4!*P^2)
24442 IF VR4 =< 0! THEN GOTO 24452
24444 DVCR(N)=((2!+P-P^2)*(1-P+P^2))/(SN(N)*(1!-4!*P+4!*P^2))
24450 GOTO 24454
24452 DVCR(N)=0!
24454 PDCR(N)=P
24456 LPRINT " 3. COUP.AND REP.";
24458 LPRINT USING " PDCR(N)= #.##### ";PDCR(N);
24460 LPRINT USING " DVCR(N)= #.##### ";DVCR(N)
24461 RETURN
25051 '
25052 ' GOSUB 25053 DATA OUTPUT FOR AGEN$ 3:1
25053 LPRINT "AGEN$(N)= ";AGEN$(N):LPRINT "MAS(N)= ";MAS(N)
25054 LPRINT "NAS(N)= ";NAS(N)
25055 '
25056 FOR I=1 TO NAS(N):LPRINT USING " & & ";D2$(I);
25057 FOR J=1 TO NDS(N)
25058 LPRINT USING " ##### ";C(N,I,J);
25059 NEXT J
25060 LPRINT USING " ##### ";SA(N,I)
25061 NEXT I
25062 LPRINT:LPRINT " TOTAL ";
25063 FOR J=1 TO NDS(N)
25064 LPRINT USING " ##### ";SB(N,J);
25065 NEXT J
25066 LPRINT USING " ##### ";SN(N)
25068 RETURN
25627 '
25628 ' GOSUB 25629 CALCULATION OF VALUE OF RECOMBINATION FOR AGEN$ 3:1
25629 A0=3!*SA(N,2)
25630 A1=-2!*SA(N,1)-5!*SA(N,2)
25631 A2=3!*SA(N,1)+3!*SA(N,2)
25632 A3=-SN(N)
25633 A4=0!
25634 A5=0!

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25635 '
25636 P=.001:EPS=1E-08
25637 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
25638 Y2=FNVD(A1,A2,A3,A4,A5,P)
25639 P1=P-Y1/Y2
25640 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 25643
25641 P=P1
25642 GOTO 25637
25643 LPRINT:LPRINT:LPRINT "          PHASE          RECOM. VALUE          VARIANCE  "
25644 LPRINT USING "  AGEN$(N)= &          & ";AGEN$(N)
25645 V1=(3!-2!*P+P^2)*(2!*P-P^2)
25646 V2=4!*SN(N)*(1!-2!*P+P^2)
25647 VR=V1/V2
25648 IF P > .5 THEN GOTO 25655
25649 PAC(N)=P
25650 AVC(N)=VR
25651 LPRINT " 1. COUP.DL/d1 ";
25652 LPRINT USING "    PAC(N)= #.##### ";PAC(N);
25653 LPRINT USING "    AVC(N)= #.##### ";AVC(N)
25654 GOTO 25659
25655 PAR(N)=1!-P:AVR(N)=VR
25656 LPRINT " 1. REP. D1/dL ";
25657 LPRINT USING "    PAR(N)= #.##### ";PAR(N);
25658 LPRINT USING "    AVR(N)= #.##### ";AVR(N)
25659 '
25682 IF LCR(N)=1 THEN GOTO 25706
25683 ' COUP. AND REP.
25684 A0=SA(N,1)-2!*SA(N,2)
25685 A1=-3!*SA(N,1)+3!*SA(N,2)
25686 A2=3!*SN(N)
25687 A3=-2!*SN(N)
25688 A4=0!:A5=0!
25689 '
25690 P=.001:EPS=1E-09
25691 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
25692 Y2=FNVD(A1,A2,A3,A4,A5,P)
25693 P1=P-Y1/Y2
25694 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 25697
25695 P=P1
25696 GOTO 25691
25697 VR7=SN(N)*(1!-4!*P+4!*P^2)
25698 IF VR7 =< 0 THEN GOTO 25701
25699 AVCR(N)=((2!+P-P^2)*(1-P+P^2))/(SN(N)*(1!-4!*P+4!*P^2))
25700 GOTO 25702
25701 AVCR(N)=0!
25702 PACR(N)=P
25703 LPRINT " 3. COUP.AND REP.";
25704 LPRINT USING "    PACR(N)= #.##### ";PACR(N);
25705 LPRINT USING "    AVCR(N)= #.##### ";AVCR(N)
25706 RETURN
26358 '
26359 ' GOSUB 26360 CALCULATION OF VALUE OF RECOMBINATION FOR DGEN$ 1:2:1
26360 A0=2!*SB(N,3)
26362 A1=-2!*SB(N,2)-4!*SB(N,3)
26364 A2=-4!*SB(N,1)+5!*SB(N,2)+2!*SB(N,3)
26366 A3=6!*SB(N,1)+2!*SB(N,3)
26368 A4=-6!*SB(N,1)-5!*SB(N,2)-4!*SB(N,3)
26370 A5=2!*SN(N)
26372 '
26374 P=.001:EPS=1E-08
26376 Y1=FNY(A0,A1,A2,A3,A4,A5,P)
26378 Y2=FNVD(A1,A2,A3,A4,A5,P)
26380 P1=P-Y1/Y2

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26382 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 26388
26384 P=P1
26386 GOTO 26376
26388 LPRINT:LPRINT:LPRINT "          PHASE          RECOM. VALUE          VARIANCE  "
26390 LPRINT USING "  DGEN$(N)= &          & ";DGEN$(N)
26392 V1=3!*P*(2!-P)*(1!-P^2)*(1!-P+P^2)
26394 V2=2!*SN(N)*(2!-4!*P-3!*P^2+14!*P^3-7!*P^4)
26396 VR=V1/V2
26398 IF P > .5 THEN GOTO 26412
26400 PDC(N)=P
26402 DVC(N)=VR
26404 LPRINT " 1. COUP.DL/dl ";
26406 LPRINT USING " PDC(N)= #.##### ";PDC(N);
26408 LPRINT USING " DVC(N)= #.##### ";DVC(N)
26410 GOTO 26420
26412 PDR(N)=1!-P:DVR(N)=VR
26414 LPRINT " 1. REP. D1/dL ";
26416 LPRINT USING " PDR(N)= #.##### ";PDR(N);
26418 LPRINT USING " DVR(N)= #.##### ";DVR(N)
26419 ' COUP. AND REP.
26420 IF LCR(N) = 1 THEN GOTO 26509
26422 A0=-SB(N,1)+2!*SB(N,2)-SB(N,3)
26424 A1=-6!*SB(N,2)
26426 A2=6!*SN(N)
26428 A3=-4!*SN(N)
26430 A4=0!:A5=0!
26434 P=.001:EPS=1E-09
26436 Y1=FN1(A0,A1,A2,A3,A4,A5,P)
26438 Y2=FN2(A1,A2,A3,A4,A5,P)
26440 P1=P-Y1/Y2
26442 IF (ABS(P1-P)/ABS(P)) <= EPS THEN GOTO 26486
26444 P=P1
26446 GOTO 26436
26484 '
26486 VR6=SN(N)*(1!-4!*P+4!*P^2)
26488 IF VR6 <= 0! THEN GOTO 26494
26490 DVCR(N)=((1!-P+P^2)*(1!+2!*P-2!*P^2))/(2!*SN(N)*(1!-4!*P+4!*P^2))
26492 GOTO 26500
26494 DVCR(N)=0!
26500 PDCR(N)=P
26502 LPRINT " 3. COUP.AND REP.";
26504 LPRINT USING " PDCR(N)= #.##### ";PDCR(N);
26506 LPRINT USING " DVCR(N)= #.##### ";DVCR(N):GOTO 26509
26508 'LPRINT " 3. COUP. AND REP. - SQR(-) "
26509 RETURN
33343 '
33344 ' LOD SCORE CALCULATION
33345 ' GOSUB 33346 CALCULATION OF LOD SCORE FOR AGEN$ 1:1
33346 N1=SA(N,1):N2=SA(N,2)
33348 IF PAC(N)<0! OR PAC(N)>.5 THEN GOTO 33366
33350 P=PAC(N):LPRINT USING " PAC(N)= #.##### ";P;
33354 G1=FNZ3(P,N1)/FNW2(N1):G2=FNZ4(P,N2)/FNW2(N2)
33356 GG=G1*G2:IF GG<0! THEN GOTO 33362
33358 GS=LOG(GG)/TL
33360 LPRINT USING " SC=###.#### ";GS: GOTO 33400
33362 LPRINT " ODDS= 0. ":GOTO 33400
33366 IF PAR(N)<0! OR PAR(N)>.5 THEN GOTO 33400
33368 P=PAR(N):LPRINT USING " PAR(N)= #.##### ";P;
33370 G21=FNZ4(P,N1)/FNW2(N1):G22=FNZ3(P,N2)/FNW2(N2)
33372 GG2=G21*G22: IF GG2<0! THEN GOTO 33380
33374 GS2=LOG(GG2)/TL
33376 LPRINT USING " SC=###.#### ";GS2
33378 GOTO 33400

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33380 LPRINT "      ODDS= 0. "
33400 RETURN
34054 '
34055 ' GOSUB 34056 CALCULATION OF LOD SCORE FOR DGEN$ 3:1
34056 N1=SB(N,1):N2=SB(N,2)
34058 IF PDC(N)=<0! OR PDC(N)>.5 THEN GOTO 34076
34060 P=PDC(N):LPRINT USING " PDC(N)= #.####";P;
34061 G11=(3!-2!*P+P^2)/2.25:G1=G11^N1
34062 G22=(2!*P-P^2)/.75:G2=G22^N2
34066 GG=G1*G2:IF GG=<0! THEN GOTO 34072
34068 GS=LOG(GG)/TL
34070 LPRINT USING "      SC=###.#### ";GS: GOTO 34094
34072 LPRINT "      ODDS= 0. ":GOTO 34094
34076 IF PDR(N)=<0! OR PDR(N)>.5 THEN GOTO 34094
34078 P=PDR(N):LPRINT USING " PDR(N)= #.#### ";P;
34079 G211=(2!+P^2)/2.25:G21=G211^N1
34081 G222=(1!-P^2)/.75:G22=G222^N2
34082 GG2=G21*G22: IF GG2=<0! THEN GOTO 34090
34084 GS2=LOG(GG2)/TL
34086 LPRINT USING "      SC=###.#### ";GS2
34088 GOTO 34094
34090 LPRINT "      ODDS= 0. "
34094 IF LCR(N)=1 THEN GOTO 34114
34096 IF PACR(N)=<0! OR PACR(N)>.5 THEN GOTO 34110
34098 P=PACR(N):LPRINT:LPRINT USING " PACR(N)= #.#### ";P;
34099 H11=(2!+P-P^2)/2.25:H1=H11^N1
34101 H22=(1!-P+P^2)/.75:H2=H22^N2
34102 HH=H1*H2: IF HH =<0! THEN GOTO 34108
34104 HS=LOG(HH)/TL
34106 LPRINT USING "      SC=###.#### ";HS:GOTO 34114
34108 LPRINT "      ODDS= 0. ":GOTO 34114
34110 LPRINT " 0 > PACR(N) > 0.5 "
34114 RETURN
35175 '
35176 ' GOSUB 35177 CALCULATION OF LOD SCORE FOR AGEN$ 3:1
35177 N1=SA(N,1):N2=SA(N,2)
35178 IF PAC(N)=<0! OR PAC(N)>.5 THEN GOTO 35196
35180 P=PAC(N):LPRINT USING " PAC(N)= #.#### ";P;
35181 G11=(3!-2!*P+P^2)/2.25:G1=G11^N1
35182 G22=(2!*P-P^2)/.75:G2=G22^N2
35186 GG=G1*G2:IF GG=<0! THEN GOTO 35192
35188 GS=LOG(GG)/TL
35190 LPRINT USING "      SC=###.#### ";GS: GOTO 35214
35192 LPRINT "      ODDS= 0. ":GOTO 35214
35196 IF PAR(N)=<0! OR PAR(N)>.5 THEN GOTO 35209
35198 P=PAR(N):LPRINT USING " PAR(N)= #.#### ";P;
35199 G211=(2!+P^2)/2.25:G21=G211^N1
35201 G222=(1!-P^2)/.75:G22=G222^N2
35202 GG2=G21*G22: IF GG2=<0! THEN GOTO 35210
35204 GS2=LOG(GG2)/TL
35206 LPRINT USING "      SC=###.#### ";GS2
35208 GOTO 35214
35209 LPRINT " 0 > PAC(N) > 0.5 ":GOTO 35214
35210 LPRINT "      ODDS= 0. "
35214 IF LCR(N)=1 THEN GOTO 35231
35216 IF PACR(N)=<0! OR PACR(N)>.5 THEN GOTO 35230
35218 P=PACR(N):LPRINT:LPRINT USING " PACR(N)= #.#### ";P;
35219 H11=(2!+P-P^2)/2.25:H1=H11^N1
35221 H22=(1!-P+P^2)/.75:H2=H22^N2
35222 HH=H1*H2: IF HH =<0! THEN GOTO 35228
35224 HS=LOG(HH)/TL
35226 LPRINT USING "      SC=###.#### ";HS:GOTO 35231
35228 LPRINT "      ODDS= 0. ":GOTO 35231

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致死遺伝子座と標識遺伝子座, RFLP 座および RAPD 座との組換え価の計算プログラム (RECLD 20) (大庭他)

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35230 LPRINT " 0 > PACR(N) > 0.5 "
35231 RETURN
36056 '
36057 ' GOSUB 36058 CALCULATION OF LOD SCORE FOR DGEN$ 1:2:1
36058 N1=SB(N,1):N2=SB(N,2):N3=SB(N,3):N4=SB(N,1)+SB(N,3)
36060 IF PDC(N)=<0! OR PDC(N)>.5 THEN GOTO 36074
36062 P=PDC(N):LPRINT USING " PDC(N)= #.#### ";P;
36064 G1=FNZ8(P,N1)/FNW3(N1):G2=FNZ10(P,N2)/FNW3(N2):G3=FNZ6(P,N3)/FNW3(N3)
36066 GG=G1*G2*G3:IF GG=<0! THEN GOTO 36072
36068 GS=LOG(GG)/TL
36070 LPRINT USING " SC=###.#### ";GS:GOTO 36087
36072 LPRINT " ODDS= 0. ":GOTO 36090
36074 IF PDR(N)=<0! OR PDR(N)>.5 THEN GOTO 36090
36076 P=PDR(N):LPRINT USING " PDR(N)= #.#### ";P;
36078 G21=FNZ8(P,N3)/FNW3(N3):G22=FNZ10(P,N2)/FNW3(N2):G23=FNZ6(P,N1)/FNW3(N1)
36080 GG2=G21*G22*G23:IF GG2=<0! THEN GOTO 36088
36082 GS2=LOG(GG2)/TL
36084 LPRINT USING " SC=###.#### ";GS2
36086 GOTO 36090
36087 LPRINT " 0 > PDR(N) > 0.5 ":GOTO 36090
36088 LPRINT " ODDS= 0. "
36090 IF LCR(N)=1 THEN GOTO 36110
36092 IF PDCR(N)=<0! OR PDCR(N)>.5 THEN GOTO 36108
36094 P=PDCR(N)
36096 H1=FNZ10(P,N1)/FNW3(N1):H2=FNZ10(P,N3)/FNW3(N3):H3=FNZ14(P,N2)/FNW2(N2)
36098 HH=H1*H2*H3: IF HH <=0! THEN GOTO 36106
36100 HS=LOG(HH)/TL
36102 LPRINT:LPRINT USING " PDCR(N)= #.#### ";P;
36104 LPRINT USING " SC=###.#### ";HS:GOTO 36110
36106 LPRINT " ODDS= 0. ":GOTO 36110
36108 LPRINT " 0 > PDCR(N) > 0.5 "
36110 RETURN
59900 '
59901 '
59902 '
59903 DATA Iwao sugi self.1993(Test data)
59904 '
59905 DATA 2
59906 '
59907 '
59908 '
59909 DATA Dwarf,2,2,Lg,2,2,1
59910 '
59911 DATA 66,13,79
59912 DATA 15,22,37
59913 DATA 81,35,116
59914 '
59915 DATA Shd-1,3,3,Lg,2,2,1
59916 '
59917 DATA 7,47,1,55
59918 DATA 0,2,16,18
59919 DATA 7,49,17,73

```