L-14

Champion
NOTE BOOK

No. 1299
40 SHEETS

T.W.

T.W

Mean age diff. above 40 13·33

" 60 10·2

δt (sib. – gen prop) $= \sqrt{2} \times 6.6 = \underline{9.3 \text{ years}}$

A gaussian with this stand dev has a d_x max of

$$\sim \frac{0.4}{9.3} = 4.3\% > (d_x)^{max}_{theor} = \cancel{d_x}\ D_x$$

To comp. d_x(max) from life tables

$$\tau = \frac{0.4}{\sqrt{\cancel{2}n}} \frac{9.3}{0.4} \quad \text{or for } n \text{ small}$$

P(mu)

$\boxed{\tau \text{ between } 2 \text{ and } 5.5}$

$$\tau = \frac{9.3}{\sqrt{n}} \quad ; \quad \text{for } n = 3 \; ; \tau = 5.36 \text{ years}$$

$n = 9 \quad \tau = 3.1 \text{ years}$

$n = 16 \quad \tau = 2.32 \text{ years}$

In life tables corrected for those living at 40 $d_x(max) = 3.67$

Ratio $\frac{4.3}{3.67} = 1.17$

δt (pop) $= 1.17 \times \delta t$ (~~gen gen~~ gen gen) $= 1.17 \times 9.3 = 10.8$

$$(10.8)^2 - (9.3)^2 = [\delta t \text{ (non gen)}]^2$$

$$\underbrace{[(1.17)^2 - 1]}_{0.37} \underbrace{(9.3)^2}_{86.5} = [5.66]^2$$

$$0.37 \times 86.5 = (5.66)^2$$

~~comp with page of my book~~ H

The non genetic scatter

female non identical
twins dying both above 60

obs. mean age difference $\overline{\Delta}_{60} = 6.2$ years

corrected for those both
dying above 40 (on the basis of
T.W. factor 1.32 (1.3) =

$\overline{\Delta}_{40} = 6.2 \times 1.32 = 8.18$ years
8.05

stand dev.

$St(sis) = \frac{8.18}{1.13} = 7.24$ years $\quad \frac{8.05}{1.1} = 7.3$

For id twins above 60

$\overline{\delta}_{60} = 2.6$ years

~~corr~~ $\overline{\delta}_{40} = \delta_{60} \times 1.32 = 3.43$ years 3.38 $\quad st = \frac{3.43}{1.13} = 3.04 \quad \frac{3.38}{1.1} = 3.07$

$\left[St_{gen}(sist)\right]^2 = \left[7.24\right]^2 - \left[3.04\right]^2 = \left[6.57 \text{ years}\right]^2$

7.3 $\quad (3.07)^2$

52.3
− 9.2
43.1

53
− 9.4
43.6

6.62

Compare with p. 118 of my book

Check $(6.2)^2 - (2.6)^2 = (5.63)^2$

corrected for id twins $\quad \overline{\Delta}_{60}(g)$

38.5
6.8
31.7

$\overline{\Delta}_{40}(gen) = 5.63 \times 1.32 = 7.43$ years

$St_{gen}(sis) = \frac{7.43}{1.13} = 6.6$ years

O.K.

$n = 3 \qquad \cancel{\ldots} \; m = 23$

$$\left[\frac{80.5}{\cancel{7}5.36} + 3\right]^2 = A_W \, 4 \times 23$$

$$A_W = \frac{(18)^2}{4 \times 23} = \frac{325}{92} = 3.5$$

$$\left[\frac{80.5}{9.3}\sqrt{m} + n\right]^2 = A_W \times 4 \times m$$

$$76.5\,m + n^2 + 17.3 \times \sqrt{m} = A_W \, 4 \times m$$

See what exact formula would give for moving fraction

$$f_W = \sum_s \frac{15^s e^{-15}}{s!} e^{-\frac{(s+3)^2}{4 \times 23}} \quad \cancel{\ldots} = e^{-\text{what?}^2}$$

In general write:

$$f_W = \sum_s \frac{x^s}{s!} e^{-x} e^{-\frac{(s+r)^2}{4 \times m}}$$

$X_W = \alpha t$

at depth $t = t_0$

$x_0 = \alpha t_0$

$$2.5 < \frac{(x_0 + r)^2}{4m} < 3.5$$

$$f_W = \frac{x_0^s}{s!} e^{-x_0} \times e^{-\frac{(s+r)^2}{4m}} \approx e^{-\frac{(x_0+r)^2}{4m}}$$

~~Similar comparison for m = 30~~

~~m = 25~~

for $n = 3$

$$\tau \approx \frac{0.4}{\sqrt{3}} \frac{1}{dx} = \frac{0.231}{dx}$$

$$\tau = P_{max}(r\,n)\frac{1}{dx} = \frac{0.224}{dx}$$

less than 3% error

Other way of computing the
[illegible] with [illegible] tables

$d_x(max) = \frac{3.67}{100}$

$\frac{0.4}{St.dev\ pop} = \frac{3.67}{100}$

$St.dev\ (~~pop~~) = \frac{0.4 \cdot 100}{3.67} = \frac{40}{3.67} = 10.9$ years

$(10.9)^2 - (3.04)^2 = [Stand(pop\ gen)]^2$

$\begin{array}{r} 119.0 \\ -9.23 \\ \hline 109.3 \end{array}$ $= [\ 10.43\ ]^2$

Accordingly D_x

$D_x = \frac{0.4}{10.43} = \frac{3.83}{100}$

$\tau = \frac{0.4}{\sqrt{n}} \frac{1}{D_x} = \frac{10.85}{0.4} \frac{0.4}{\sqrt{n}} \frac{10.85}{0.4} = \frac{10.85}{\sqrt{n}}$

$n=3$; $\tau = 6$ years
$n=9$; 3.5 years
$n=16$; 2.6 years

τ between 2 and 6 years

Estimate of error for n which is not large say $n = 2.5$

$\tau \approx \frac{0.4}{\sqrt{n}} \frac{1}{d_x}$

$\approx \frac{0.253}{d_x}$

$\tau = \frac{P(r,n)}{d_x} = \frac{0.256}{d_x}$

$P(r,n)_{max} = \frac{n^r}{r!} e^{-n}$

$\frac{0.4}{} = 0.398$

$\sqrt{2.5} =$ $d_x = \frac{4.3}{100}$; $\tau(2.5) = 5.9$ years $n = 2.5$, $r = 2$

What does one hit do?

$$e^{-\left[\frac{(18+1)^2}{4m} - \frac{(18)^2}{4m}\right]} = e^{-\frac{37}{92}}$$

$$e^{-0.4} = 0.67032$$

Factor 2 would be (about 2 hits or ~10 years) and thus if ~~an~~ ~~[illegible]~~ ~~on~~ specific fault is carried which effect function of one organ, that organ is about 15 years older than the body as a whole

Male and Female!

$$\left[\frac{80.5}{9.3/\sqrt{n}} + n\right]^2 = A_W 4m$$

$$\boxed{p = \frac{n}{23}}$$

$$\left[\frac{80.5-3}{9.3/\sqrt{n}} + n + p\right]^2 = A_M 4m$$

$$\frac{A_M}{A_W} = \left(\frac{\frac{(80.5-3)\sqrt{n}}{9.3} + n + p}{\frac{80.5}{9.3}\times\sqrt{n} + n}\right)^2$$

$$\left[\frac{80.5}{9.3}\times\sqrt{n} + n\right]^2 = A_W\, 4\left(\frac{n}{23}\right)\times 23$$

$$\frac{\left[\frac{80.5}{9.3}\times\sqrt{n} + n\right]^2}{A_W\times 4\times 23} = p$$

$$p = \frac{\left[8.65\sqrt{n} + n\right]^2}{A_W\, 4\times 23}$$

$$p = \frac{75n + 173\sqrt{n} + n^2}{A_W\times 4\times 23}$$

$r = 5$

$\frac{15^5 \, e^{-15}}{5!}$

AW

s		$(s+r)^2$	$s+r$	Exp. %	e^{-z}	Pred
1						
2						
3	.0002	36	6	0.39	.6770	.
4	.0006	49	7	0.53	.5886	.0003
5	.0019	64	8	0.69	.5016	.0009
6	.0048	81	9	0.88	.4148	.0020
7	.0104	100	10	1.08	.3396	.0035
8	.0194	121	11	1.31	.2698	.0050
9	.0324	144	12	1.56	.2101	.0068
10	.0486	169	13	1.84	.1588	.0078
11	.0663	196	14	2.13	.1184	.0078
12	.0829	225	15	2.44	.0871	.0072
13	.0956	256	16	2.78	.0620	.0059
14	.1024	289	17	3.14	.0428	.0043
15	.1024	324	18	3.52	$\boxed{.0320}$	.0032
16	.0960	361	19	3.92	.0202	.0019
17	.0847	400	20	4.35	.0130	.0011
18	.0706	441	21	4.80	.0082	.0006
19	.0557	484	22	5.25	.0055	.0003
20	.0418	529	23	5.75	.0034	.0001
21	.0299	576	24	6.25	.0019	.0001
22	.0204	625	25			
23	.0133	676	26			
24	.0083	729	27			
25	.0050	784	28			
26	.0029	841	29			
27	.0016	900	30			
28	.0009	961	31			
29	.0004	1024	32			
30	.0002	1089	33			
31	.0001	1156	34			
32	.0001	1225	35			

.0688

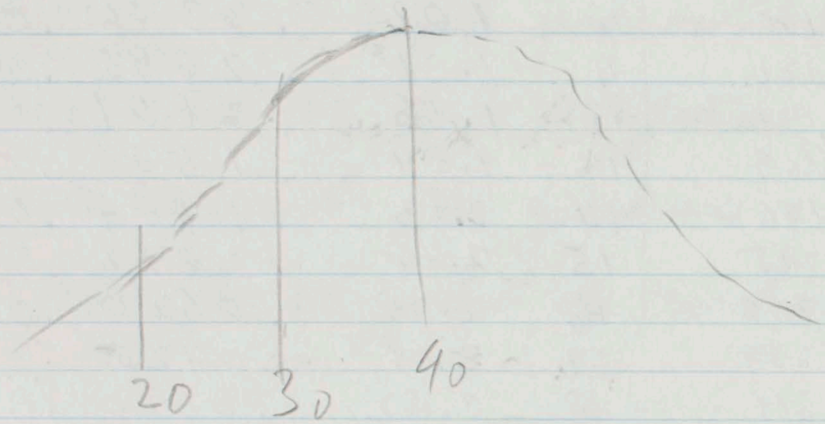
67

or about 7%

$\sim \frac{1}{14}$th

Material ~~for~~ selection for longevity:

Shape of curve giving number of women whose period stops is the same as curve for dx, but loss of faults is longer if n is longer



$$\begin{array}{r}1200\\1120\\\hline 2320\end{array}$$

$$\begin{array}{r}81\\467\\675\\\hline 1223\end{array}$$

$$\begin{array}{r}675\\467\\\hline 1142\end{array}$$

$$\cancel{p = \frac{75n + 17.3\sqrt{n}\,n + n^2}{Av\,4\times 23}} = \left(\frac{805}{9.3}\sqrt{n} + n\right)^2$$

$n = 3$, $Av = 3.5$ $\quad p = \dfrac{225 + 90 + \cancel{9}}{322} = \dfrac{324}{322}$

$n = 6$ $\quad p = \dfrac{450 + 254 + \cancel{36}}{322} \cong \dfrac{740}{322} \sim 2$

$n = 9$ $\quad p = \dfrac{675 + 467 + \cancel{81}}{322} = \dfrac{1142}{322} \sim 3.5$ ~~(3.8)~~

~~$n = 16$ $\quad p = \dfrac{2000 + 1100 + 256}{322} = \dfrac{3356}{322} \sim 10$~~

$n = 16$ $\quad p = \dfrac{1200 + 1120}{322} = 7.2$

neglecting 3 year difference in life span

H

$$\frac{A_M}{A_W} \cong \left(1 + \frac{p}{\left(\frac{80.5}{9.3}\times\sqrt{n} + n\right)}\right)^2$$

$$= \left(1 + \frac{\frac{80.5}{9.3}\times\sqrt{n} + n}{A_W \times 4 \times 23}\right)^2$$

$$\frac{A_M}{A_W} < 1.33 \qquad \sqrt{\frac{A_M}{A_W}} \leqq 1.15$$

(surviving in man $\frac{1}{e}$ time less)

$A_W \approx 3.5$

$$\frac{\frac{80.5}{9.3}\times\sqrt{n} + n}{3.5 \times 4 \times 23} \leqq 0.15$$

$$8.65\sqrt{n} + n \leqq 48$$

$n = 16$

34.5
16
50.5

If we demand

$$\frac{A_M}{A_W} < 1 + \frac{1}{6} \qquad \sqrt{e}$$

(surviving at depth in male feeder 1.65 times less cells)

$$\frac{\frac{80.5}{9.3}\times\sqrt{n} + n}{3.5 \times 4 \times 23} < 0.08$$

$\sqrt{1.167} = 1.08$

$$\underbrace{8.65\sqrt{n}}_{21} + \underbrace{n}_{+6} \leqq 25.8 \qquad = 25$$

$n = 6$

Mean age difference from life tables. (TW)

over 40 13.33

Standard dev. $\dfrac{13.33}{1.13} = 11.8$ years

white $\dfrac{0.4}{3.67} = 11$

Is factor 1.13 correct? Please check!

O.K.

~~death~~

$$\left[\frac{80.5}{9.3}\sqrt{n} + n\right]^2 - n^2 = A_F \quad 4\times 23 = 256$$

$A_F = 278$

$$\left[8.65\sqrt{n} + n\right]^2 - n^2 =$$

$n = 2.5$ | 13.7
2.5

$(16.2)^2 = 260$
$- 6$
254

De-Novo male ~ female | f_M, f_F

$$\left(\frac{80.5}{\tau(m)} + n\right)^2 - n^2 = A_F\, 4\rho m$$

$$\left(\frac{80.5-3}{\tau(m)} + n + p\right)^2 - n^2 = A_M\, 4\rho m$$

$$\tau(m) = \frac{9.3}{\sqrt{m}}$$

$$\frac{A_M}{A_F} = \frac{\left(\frac{77.5}{\tau(m)} + n + p\right)^2 - n^2}{\left(\frac{80.5}{\tau(m)} + n\right)^2 - n^2}$$

33.4
16
7.2
56.6

3200
− 256
2944

34.7 (176?)
$(50.7)^2 = 1650$
256

2570
256
2314

	$n=3$	$n=6$	$n=9$	$n=16$
	$p=1$	$p=2$	$p=3.5$	$p=7.2$
	$\tau=5.36$	$\tau=3.8$	$\tau=3.1$	$\tau=2.32$

n	$4\rho m A_M$	$4\rho m A_F$	$\frac{A_M}{A_F}=z$	$A_M - A_F$; $\boxed{A_F > 3}$	$e^{-(A_M-A_F)}$
3	332	316	1.05	> 0.15	0.86%
6	772	704	1.10	> 0.30	0.74%
9	1329	1144	1.16	> 0.48	0.62%
16	2944	2319	1.27	> 0.81	0.44%

n	p	τ				$A_M - A_F$ | $A_F > 2.5$
2.5	1	5.88				
4.5	2	4.38				
10	5	2.84	1690	1370	1.235	> 0.580 ~ 0.56

$\boxed{3\ 46}$

~~possibly~~ possibly between 3 or above 6

$\frac{77.5}{2.84} = 27.3$, $\frac{15}{(42.3)}$, $= 1790 - 100 = 1690$

$(38.3)^2 = 1468 - 100$
1368

De Moivo

$$p = \frac{75n + 17.3\sqrt{n}\,n}{Aw \times 4 \times 23}$$

$n = 2.5$
$p = 1$

$$A_F = \frac{75 \times 2.5 + 17.3 \times 2.5 \times 1.58}{p \times 4 \times 23}$$

187.5
68.3
255.3

$$\frac{255.3}{92} = \boxed{2.78} = A_F$$

$$e^{-2.78} = .06204$$

$$\frac{1}{16}$$

$$\boxed{2.78 \times 92 = 256}$$

$n = 4.5$

$p = \frac{513}{256} = 2$

375
193
568
$\cancel{2.78 \times 92}$

$= \frac{568}{256} \cong \cancel{2.22}$

.348
.165
513

$n = 9$
$p = 4.5$

675
467
1142
256

$n = 10$
$p = 5$

750
546
1296
256 =

173x

$T = 6.2$ | $p = 1$ | $n = 2.5$ what is A_F

$$\left(\frac{80.5}{6.2} + 2.5\right)^2 = 92 A_F$$

$$\frac{240}{92} = 2.6$$

$f_F \cong 0.0742$

$A_F = \frac{1}{13.5}$

"Childless" women — H

assume mean endof

period 43 years — St. dev. for 9.3

$w - 43$ — $\frac{23}{9.3} = 2.5$ St. dev.

Area beyond 2.5 St. dev. $\frac{6}{1000}$

$$\begin{array}{r} .5000 \\ .4938 \\ \hline .0062 \end{array}$$

Also: assume 5 to 7 years

lag between age and appearance

Does this help? No!

---

f at middle age

$$\left(\frac{40.25}{5.88} + 2.5\right)^2$$

$$\begin{array}{r} 6.85 \\ 2.5 \\ \hline \end{array}$$

$(9.35)^2 = 87.5 = A\,4.23$

$A = 0.95$

$f = e^{-0.95} = 38.67 \approx 40\%$

~~Effect of~~ Irradiation ~~dose~~ given the ones many generations.

assume mutation rate for faults 0.1 per gen and ~~mutati~~ average number of faults, doubling dose at low dose rates D_0

[$50 < D_0 < 150\ r$] Ultimate mutation load is $2n$, increase by n and ultimate life shortening

~~$\frac{9.3}{\sqrt{n}}$~~ ~~n~~ ~~A~~ As $n\tau = 9.3\sqrt{n}$ years

If $n = 2.5$ $n\tau = 16$ years

If we set as permissible life shortening 3 years, permissible exposure per generation

$$\text{Perm}/_{\text{gen}} = \frac{D_0 \times 3}{15} \approx \frac{D_0}{5}$$

If $n = 10$

$$n\tau = 29.4 \text{ years}$$

$$\text{Perm} = \frac{D_0 \times 3}{29} \sim \frac{D_0}{10}$$

$$5_r = \frac{50}{10} < \text{Perm}/_{\text{gen}} < \frac{150}{5} = 30 r$$

It takes however from 25 to 100 gen to reach 63% of final mutation load and life shortening

Correction of male — female calculation.

τ_M for males $\tau_F(1+\frac{1}{46})$

for $n = 10$, $p = 5$

$\tau F = 2.84$

$\tau_M = 2.84 + 6 = 2.90$

$\frac{77.5}{2.90} = 26.7$
15.0
$(41.7)^2$ to comp $\frac{77.5}{2.84} = 27.3$
15.0
$(42.3)^2$

$\shortparallel$

1740
-100
1640

1790
-100
1690

$\frac{A_F}{A_M} = \frac{1640}{1370} = 1.195$ to comp. $\frac{1690}{1370} = 1.233$

$0. = 2.5 \times 0.195 = 0.487$

$e^{-0.487} \simeq 0.615$ or 61%

of female fraction at death

Guesses about life shortening

mouse low dose rate 10^{-4} /r

" single dose $3\,10^{-4}$ /r Gowen & Stadler

" single dose 7×10^{-4} /r Rathlat

mouse neutrons 7.7×10^{-4} /r

offspring of mouse (neutrons to mature sperm male) 7.7×10^{-4} /r

same corrected by factor 3 to get 10^{-4} /r non mat sperm and doubled because both parents must be irradiated 5×10^{-4} /r or less if dom. lethals are taken into account

All above 60 —

Life tables ; $\frac{d_x}{.833} = \frac{3{,}446 \times 10^{-5}}{.833} = 4{,}140 \times 10^{-5}$

$\frac{0.4}{\text{stand dev (pop)}} = \frac{4.14}{100}$ $= \frac{4.14}{100}$

$\text{stand}_{60}^{60}(\text{pop}) = \frac{.4 \times 100}{4.14} = 9.67$ years

~~Sisters~~ $\Delta_{60}(\text{genet. sisters}) = 5.65$

$\Delta_{60}(\text{pop}) = \sqrt{2} \times 5.65 = 8$ years

$\underset{(60)}{\text{st. dev.}}\,\underset{\text{genetic}}{(\text{pop})}. = \frac{8}{1.113} = \underline{\underline{7.18 \text{ years}}}$

~~All pop~~

$(9.67)^2 - (7.18)^2 = (6.5)^2$ = st. scatter 60 (pop)

$$\begin{array}{r} 93.5 \\ -\ 51.5 \\ \hline 42.0 \end{array}$$

~~W~~ What effect on n^2?

$\left(\frac{80.5}{7.18} \times \sqrt{n} + n\right)^2 - n^2 = A_F\ 4 \times 23$

$(11.2\sqrt{n} + n)^2 - n^2 = \underbrace{A_F\ 4 \times 23}_{256}$ | $A_F = 2.78$

$n = 2.5$

17.7

2.5

$(21.2)^2 = 450$

~~$n = 3$ $11.2 \times \sqrt{3} = 19.4$ 3 22.4~~

n should be smaller!

Rate at which life is shortened per gen if doubling dose is given H

$$\cancel{0.1}\ \frac{\overline{\tau}}{10} = \frac{1}{10}\frac{9.3}{\sqrt{n}}$$

and $2.5 < n < 10$

$$0.34 < \frac{\overline{\tau}}{10} < 0.5 \text{ years} = .6 \text{ years}$$

$$0.3 < \frac{\overline{\tau}}{10} < .6 \text{ years}$$

Compute maternal selection for $n = 2.5$

Life shortening at low dose rate at low dose rate

If $\swarrow$ 170 r double mut. rate then it produces in irradiated gen. 1 faults should shorten life by say .6 years or 220 days or ~3 days/r

If at higher single doses 30 r doubles mut rate then life shortening 7 days/r

For the standard dev of the number of death over the scars we may write
For the mean age difference $\sigma = \tau\sqrt{n}$
at death $\bar{\Delta} \approx \frac{\tau\sqrt{n}}{1.13}$

~~[illegible]~~

~~we determine from experience $\bar{\Delta}$ as a function of n.~~

Now great the scatter is due to two causes in general pop.

$\boxed{NIH}$ Ratio for pop $\frac{{}_{40}\bar{\Delta}}{{}_{60}\bar{\Delta}} = 1.313$

${}_{40}\bar{\Delta} = 13.37$

${}_{60}\bar{\Delta} = 10.18$ ${}_{40}\sigma = \frac{13.37}{1.13} = 11.8$ years

σ_0 is genetic $\sigma_0^2 + \sigma_s^2 = \sigma^2$

General and specific "faults",
Homozygous selection
~~1000 gen faults~~

$\mu = \frac{2}{54000}$ ~~$\frac{1000}{\frac{1}{2}10^{-5}} = 2$ (frequency)^2~~

~~frequency $= \sqrt{\frac{1}{10}}\left(\frac{1}{2\,10^{5}}\right)^{1/2}$~~

$= \cancel{0.3}16\ 10^{-2}$

$\mu = \frac{1}{100000}$ ~~frequency~~ $= \cancel{[illegible]}\ 10^{-5/2}$

frequency $= \left(\frac{1}{2\,10^{5}}\right)^{1/2}$

$= 0.224 \times 10^{-2}$

~~1000~~ genes needed give 2.24 gen faults
900 " " " 2 faults

Paper

$\cancel{x = \alpha t}$ $x = \alpha t$

$\alpha = \frac{1}{\tau}$

$x = \frac{t}{\tau}$

τ is life shortening due to one hit.

$(x_0 + r)^2 \cong A = 4m \qquad m = 23 p$

life shortening due to one added "fault" is equal to life τ poisson distribution derived from $\tau = n$

and the number of death P in successive time intervalls τ would be given by $P = \frac{n^r}{r!} e^{-n}$

Crude theory would give a discrete distribution of death. Members of one cohort would die only in certain years separated by a time interval τ and no would occur death in between. –

Now you scatter –

Number of deaths per year $\frac{\tilde{P}}{\tau}$

where is the mean out poisson distribution which for large n goes over into a gaussian distribution

~~The The stand dev of the~~

~~distrib~~ the variance of this distribution is n and

$$\cancel{F} = \frac{\cancel{4 \times (900)^2}}{\cancel{X^2}}$$

~~frequency~~ probab. that 1 of the two genes is mutant

$$q = \frac{\text{number of mutant cont. cells}}{2}$$

loss 2 q^2

$$\frac{2}{F} = 2q^2$$

$$\cancel{\frac{q}{2}}$$

$$\frac{1}{F} = q^2$$

number of faults

$$\cancel{X = 1000\ N\ q}$$

used "1000" genes "2000"

$$\cancel{\frac{2N \text{ genes}}{F}} = 1$$

$$\frac{2}{F} = 2\left(\frac{\xi}{2}\right)^2$$

If $x = 2$

$$\frac{2}{1000} = \frac{2}{\sqrt{10^6}}$$

$$\xi^2 = \frac{4}{F} \qquad \xi = \frac{2}{\sqrt{F}}$$

$$X = 1000\ \xi$$

333 organ specific

would give 333 x .224 = 0.75 adult

about $\frac{1}{2}$ carry organ specific faults of value were 0.7 (check)

(no) org. spec. faults

Assume total of 8 x 13,000 = 10^4 genes

4 stillborn or ~~aborted~~ or "mutant" homozygous

$\frac{10^4}{2\,10^5} = \frac{1}{20}$ or 5%

Stillborn or aborted (homozygous for recessive lethal)

$2\frac{1}{2}$ %

$4\,10^6$ live birth

200,000 aborted due to genetic causes ($\frac{1}{2}$ of total

~~[illegible]~~

this is 5%

~~this~~

Assume another 10 non re. lethal

~~[illegible]~~

30 1 break for first a fault

20 x 30 = 600 r shortens by 6 years

~~[illegible]~~ = 3 days

600 r

~~[illegible]~~

$2\left(\frac{X}{2\times \cancel{900}}\right)^2 = \frac{2}{\cancel{F}\,1{,}00{,}000}$

~~F~~ $\left(\frac{1}{900}\right)^2$

~~Proper~~
Effect of Radiation

$\mu_1^* + \mu_2^* = \mu^*$ (transplanted, total) rec. ~~mutant~~ lethals

$\mu^* + \mu$(detr.)

~~[illegible]~~ $\mu_0 = 0.5$

$\mu^* = 0.1$

$\mu_1^* = 0.05$

Doubling dose = D_0

faults ~~from~~ dose D_0 (to both parents and to irrad prop.)

$2 \times 0.05 = 0.1$

$\tau \leq 6$ years; $10 D_0$ gives 1 fault

$10 D_0 \leq 6$ year = 2200 days

with $\delta d/\tau$

$\delta/\tau = 6$ day/τ

3 day $< \delta <$ 6 days

$36.5 R < D_0 < 73 R$

$10 D_0$ gives τ_0 365 days

one R unit gives δ days

D_0 gives $36.5\, \tau_0$ days

1 R " δ days

$D_0 = \frac{36.5}{\delta} \tau$ R unit

If we assume mutation rate twice as big $\mu_1^* = 0.2$; $D_0 = \frac{2 \times 36.5\, \tau/\text{year}}{\delta}$

~~[illegible]~~ Since τ can not be more than 6 years and δ can not be less " 3 days

$36.5 R < D_0 < 144 R$

Probability that a given
essential gene is a mutant
is ξ

$$\text{loss} = 2(\xi)^2$$

$$\text{gain} = \frac{2}{10^5} \qquad \text{loss} = \cancel{4}\,\tfrac{1}{2}\,10^{-6}$$

$$x = 2 \times 1000\,\xi \qquad \xi = \frac{1}{2000}$$

$n = 2.5$ but $\delta = 3$ days

then three years life shortening

D_{max} = permit 14.6 R / generation

If $n > 2.5$ D_{max} will be less!

Maternal selection

~~age~~ 18 + 43 = 25 years fertile period

6 years is $\frac{1}{4}$th but only $\frac{1}{\cancel{2}\,3}$ as

fertile as average

$\frac{1}{16}$ ~~$\frac{1}{12}$~~ ~~.01 .01 .083~~ ~~$\frac{1}{16}$~~ $\underbrace{\frac{1}{12} \times 2.5 \quad \frac{1}{2}}_{\approx \frac{1}{10}}$

~~almost as strong as mut rate~~

~~which is~~ loss per generation

this would then compensate fully

~~####~~ otherwise acquisition

of smaller type genes

$2 \times 5000 \; 10^{-5} = \frac{n}{50}$

$n = 5$

assuming that that maternal selection

is switched off life expectancy

would fall by $2.5 \times 5.88 \cong$ 15 years

6 days is $\frac{30,000}{6} = 2 \times 10^{-4}$

We might have

$5 \cdot 10^4$ genes, of which $\frac{1}{5}$ when mutant would be recessive lethals (essential genes)

10^4 ~~Rec. lethals~~ of which would be essential vegetative

mutation rate 10^{-5}/generation

$n\tau$ ~~Total~~ for doubling dose D_0

$$D_0 = \frac{36.5}{\delta}\tau$$

$$(n\tau)_{years} = \frac{n\,\delta_{days}}{36.5} D_0 \quad \text{for doubling dose } D_0$$

$$(n\tau)_{year/R\,unit} = \frac{n\,\delta_{days}}{36.5}$$

$\delta = 6$ days

most optimistic

for $n = 2.5$

$\frac{6n}{36.5}$ years/R unit

$\frac{15}{36.5}$ years/R unit

$= 0.41$ years

but it takes 50 generations

If we permit 3 years life shortening:

permissible $7.3R$ per generation.

$\frac{9.3}{\sqrt{n}} = \tau$

Life shortening of adult

$\tau = 9.3\sqrt{n}$ years

$n \geq 2\mu t$

Life short of adult $\Rightarrow \frac{\text{Dose/gen}}{D_0}$ 14.7 years

If $\mu^* = 0.05$ it would take $\frac{n}{2\mu^*} =$

$= 25$ generations to reach 63%

of new stationary value for n. —

~~If $D_0 = 36.5$ R and if dose/gen is ~7 R~~ If dose/gen $= D_0$

a woman of 65 as old as healthy 80

mutant if found 365r as double mur...

10^{-4}

$$\mu_1^* = \frac{\delta D_0 \sqrt{n}}{9.3 \times 365 \times 2}$$

365 r

$$\boxed{k\mu_1^* = \mu_2^*}$$

6 days/r

2200 days

Effect of Multiplication [illegible]
for Summary

~~$2\mu_1^*$~~

$\frac{1}{2\mu_1^*}$ is number of faults produced by D_0 in [illegible] offspring I [illegible] generation.

~~$\frac{1}{D_0} \frac{\tau_{years}}{2\mu_1^*} \times 365 = \delta_{days}$~~

~~$2\mu_1^* = \frac{\tau_{years}}{D_0 \delta} \cdot 365$~~

~~$\mu_1^* =$~~

~~$2\mu_1^* D_0 \tau_{years} \times 365 = \delta_{days}$~~

Shorten [illegible] produced by D_0 [illegible] $= 365\ \tau\ 2\mu_1^*$ independent of dose rate

$$\delta_{days} = \frac{365\,\tau_{years}\,2\mu_1^*}{D_0}$$

$$\mu_1^* = \frac{\delta_{day} D_0}{\tau \times 365 \times 2}$$

$\delta = 6$ days

$\tau = 6$ years

for $D_0 = 36.5$ R

$\mu_1^* = \frac{1}{20}$

~~$\mu_1^* = \frac{1}{20}$~~

Heterozygous selection 10% embryonal death

We obtain the same result if [illegible] the selection [illegible]

$\mu_1^* = \mu_2^*$

$K \geq 2$

$\boxed{\mu_2 = 0.1 \quad \cancel{K=2}}$

selection loss $= e^{-0.2} \simeq 1-0.2$
heterozygous

$2\mu_1 = 2 \times 2500 \times 10^{-5} = \frac{1}{20}$

It would take 20 generations to double $\cong$ ~~[illegible]~~

Category	Cat ~~[illegible]~~		
1 faults	2 disharmonic or infant death	3 death for lack of fuels or shelter	4 inherently reduced cap to procreate in fauna

$\cancel{\mu} = \frac{1}{2}$ means 25 000 genes which do something.

$\mu_t = 1$ means 50 000 genes which do something ~~[illegible]~~

36.5

If ~~[illegible]~~ rep. give $\frac{1}{2}$ chrom bundle [per haploid] and if each of these prod a mutation we would get from 10 D o = 5 mutations to get $\frac{1}{2}$ fault free haploid would mean N_t [illegible]

Simplex [illegible]

either [illegible] death or reduced prop. [illegible] — [illegible] death — death [illegible]

$N_t = N_1 + N_2 + N_3 + N_4$

$\mu_1 + \mu_2 + \mu_3 = \mu_t$

[illegible] death ~~[illegible]~~ reduced propensity for procreate [illegible] alive — reduced prop to procreate

$N_2 \quad \mu_2 \leq 1$

$e^{-\mu_2}$ survives

$1 - e^{-2\mu_2} \approx 2\mu_2$

assume [illegible] [illegible]

$\mu = 2 \times 10^{-2}$ ~~[illegible]~~ $N = 0$ dose 2×36.5 rep

assume doubling dose 36.5 rep

$\mu = 2\,10^{-5}$

$10\,D_0$ produces 1 fault

$10 \times 2 \times N_1\, 2\, 10^{-5} = 1$ fault

$N_1 = \frac{10^5}{40} = 2500$

We had to assume mutation rate rather dose D_0 rather small

$\boxed{N_2 = k N_1}$

$N_2 = 10^4$, $k = 4$

$\boxed{\mu_2 = 0.2}$

$\mu_2 = K$

$4 \frac{1}{10} \frac{9.5}{11\ 9.3} \frac{1}{2} = 0.2$

$\frac{\text{Solely } D_0 \sqrt{m}}{9.3 \times 365 \times 2} = \frac{6 \times 36.5 \times 1.585}{9.3 \times 2 \times 365}$

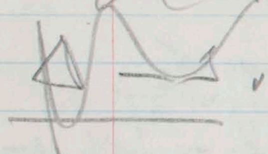
and of 36.5 rep x-ray make
$\frac{1}{2}$ break per [illegible]

If ratio ~~[illegible]~~ $\frac{f_P}{f_M} = 0.6$

$$\boxed{f_P = 0.56\, f_M = \frac{f_M}{\sqrt{e}}}$$

$\sqrt{e} \cong 1.6$

de Novo for paper



Neel

Ne Nano

pl

10×36.5 give ~~one~~ $\frac{1}{2}$ fault per haploid, but they give 5 breaks per haploid

if there are 100,000 genes

~~5 breaks give in 2,500 gene region only $\frac{5}{40}$ instead of $\frac{1}{2}$ mutations~~

~~Therefore we get about~~

and if 1000 give $\frac{1}{2}$ mut in 2500 genes

it gives 20 mut $= \frac{40}{2}$ in 10^5 genes

or we get 5 mutations per break

with X-rays.

what about fast neutrons?

If we assume $N_1 = 10000$; then we would get about 1 mut per break (if breaking dose is 30 rep X-ray)

If $N_1 = 5000$

$\mu = 10^{-5}$

$K = 2$

we have ~~same ...~~

~~...~~

$\mu z = \frac{1}{4} 10^4 10^{-5} = 0.1$ $\quad e^{-0.2}$

surviving

$\mu = 0.5$ means 50000 genes which do something —

~~$\frac{1}{10}$ of the DNA must be repetitive genes~~

if each break makes $\frac{1}{2}$ faults per haploid

Probab of i results of parents have S. and $P(S)$

$$\overline{\Delta}(\text{sibl}) = \sum_S \sum_{i,j} |i-j| \binom{S}{i}\left(\frac{1}{2}\right)^{S} \times \binom{S}{j}\left(\frac{1}{2}\right)^{S} P(S)$$

$$P(2S\lambda) = \frac{(2\lambda)^S}{S!} e^{-2\lambda}$$

$$\frac{\overline{\Delta}(\text{sibl})}{\tau} \cong \frac{\sqrt{\lambda} \times 1.13}{\sqrt{2}}$$ or

slightly ~~larger~~ smaller for small λ

In contrast for this prop not ~~[illegible]~~ sibling

Prob of i faults

Δ^*_{60} (sibl) =

$\Delta 60$ sibl =

$\Delta 40$ sibl. =

$$\frac{7.35 = \overline{\Delta}(\text{sibl-thers})}{\tau} = \frac{\sqrt{\lambda} \times 1.13}{\sqrt{2}}$$

or $$\tau = \frac{\sqrt{2}}{1.13} \Delta(\text{sibl-thers})$$

$\tau =$

$$\overline{\Delta}(\text{sibl-thers-gen}) = 7.35$$

$\theta =$

De Novo for paper

$\Delta - \sigma -$.

NIH. $\Delta(60) = 10.18$ years

$\Delta(40) = 13.37$ years

Ratio $\lambda = 1.31$

$\boxed{\lambda = 1.3}$

$$[\Delta_{60}(\text{Sib-gen})]^2 = [\Delta_{60}(\text{Sib-tot})]^2 - [\Delta_{60}(\text{Idhmirii})]^2$$

$$[5.65]^2 = [6.2]^2 - [2.6]^2$$

$$\boxed{\bar{\Delta}_{40} = \lambda \Delta_{60}}$$

$$\bar{\Delta}_{40}(\text{Sib-gen}) = 1.3\ \bar{\Delta}_{60}(\text{Sib-gen}) = 7.35$$

$$\bar{\Delta}_{40}(\text{Pop-gen}) = \sqrt{2}\ \bar{\Delta}_{40}(\text{Sib-gen}) = \underline{10.4}$$

$$\sigma(\text{pop}) = \frac{10.8}{1.13} = 9.3 \text{ years}$$

$$(\quad)^2 = \bar{\Delta}\ \cancel{\text{non gen}}(\text{pop} - \text{non gen})^2 = (13.37)^2 - (10.4)^2$$

$$(8.4)^2$$

$$\sigma(\text{pop} - \text{non gen}) = \frac{8.4}{1.13} = 7.43 \text{ years}$$

$$\cancel{\sigma(\text{pop} - \text{drivers})^2 = (7.43)^2 - (2.6 \times 1.3)^2}$$

$$(\bar{\Delta}(\text{pop-idiosync}))^2 = (8.4)^2 - (2.6 \times 1.3)^2$$

$$(8.4)^2 - (3.38)^2$$

$$(7.7)^2$$

$$\sigma(\text{pop-idiosync}) = \frac{7.7}{1.13} = 6.8 \text{ years}$$

6.2
3720
124
384
6.75
31.7

178
108
70

70.4
11.4
59

~~$N_1 = 1000$~~ ~~$\mu_{tot} = 0.2$~~

(ii) $D_0 = \frac{t}{\mu} \frac{365 \times 2}{K+1} \mu_{tot}$

$D_0 = 36.5$

$\frac{1}{2} \frac{1}{10} (K+1) = \mu_{tot}$

~~$K+1 = 5$~~

$\frac{5}{20} = 0.25 = \mu_{tot}$

$N_1 = \frac{\cancel{\mu_{tot}}}{\mu} \frac{1}{K+1}$; $\mu = 2\,10^{-5}$, $K+1 = 5$

$N_1 = \frac{1}{8 \times 10^{-5}} \frac{1}{5} = \frac{10^5}{40} = 2500$

to lower N_1 we would have to raise μ
or ~~the~~ increase $K+1$

but increasing $K+1$ would
lower D_0 below 36.5 unless
we ~~raise~~ μ_{tot} above 0.25.

If we lower these rate $\tau = 3$ days
then D_0 ~~[illegible]~~ goes up.

~~D_0~~ 2×36.5

mut per gen/rep

$= \frac{\mu}{D_0}$

If we want to set $K+1 = 10$
$D_0 = 36.5$, and (.) give μ_{tot} 0.5
$N_1 = 10000$ for $\mu = \frac{1}{200{,}000}$

$\mu_{tot} = 0.5$

$N = 10^5$

or

$N_1 = 5000$ / $\mu = 10^{-5}$ $\mu_{tot} = 0.5$

$N = 50{,}000$

6 days for mouse pf g = 6 years

De Novo $N_1 \times N_2$ X

η_1^+

$\mu_2 = K\mu_1 \quad 2 < K < 10$

365 rep produces $\frac{1}{2}$ fault per unploded set

$$\mu_1 = \frac{\delta D_0}{\tau \times 365 \times 2}$$

$$\mu N_1 = \frac{\delta D_0}{\tau \times 365 \times 2}$$

$$\mu_2 = K\mu_1 = \frac{K\,\delta D_0}{\tau \times 365 \times 2}$$

$$N_1 = \frac{\delta D_0}{\mu \times \tau \times 365 \times 2}$$

$D_0 = 36.5$; $\delta = 6$, $\tau = 6$

$$N_1 = \frac{1}{20\mu}$$

$$\mu_{tot} = \cancel{(1+K)} \times 10^4\, \mu = \frac{0.5}{}$$

$$\mu = \frac{1}{20{,}000}$$

$$\underline{\mu_{tot}} = (K+1)\,\mu_1 = (K+1)\frac{\delta D_0}{\tau \times 365 \times 2} = \underline{\underline{0.5}}$$

$$D_0 = \frac{\tau \times 365 \times 2 \times \mu_{tot}}{(K+1)\,\delta}$$

$$N_1 \mu = \frac{\mu_{tot}}{K+1}$$

$$N_1 = \frac{\mu_{tot}}{K+1}\,\frac{1}{\mu}$$

$$\boxed{\mu = \frac{\mu_{tot}}{K+1}\,\frac{1}{N_1}} \quad \boxed{N_1 = \frac{\mu_{tot}}{\mu}\,\frac{1}{K+1}}$$

$\frac{1}{10}$

De Novo emphasis

on μ_2

10 means $\frac{10}{50}$ die — this corresp. to $\mu_2 = 0.1$ in Heterozygous

~~We assume 5~~

K = 5 means ~~[illegible]~~ 10 Do make 1 fault

K = 5 4 mistakes! $\frac{5}{50}$

one $\frac{1}{10}$ would die

$\mu_1 = \frac{1}{\tau} \frac{\delta}{365} \frac{D_0}{2}$; if $\left\{ \begin{array}{l} D_0 > 36.5 \\ \mu_1 > 0.05 \end{array} \right\}$

K ~~is total~~ $\frac{N_1+N_2}{N_1}$ — N_2 goes down to average of $\frac{1}{100}$ lost per gen prior to adulthood

$K\mu_1$ is very probable < 0.5

$K\mu_1$ is almost certainly < 1

writing $K\mu_1 = 0.5$; $K = 10$

In heteroz. positive selection $\mu_t = 0.5$ means only e^{-1} procreates

1 fault $\frac{K}{100}$ death per person prior to adult hood

this means of life counts from conception loss of life expectance 10% of 80 years or 8 years

Text to pages before

if 1r produces δ (day) life shortening ~~...~~ the doubling dose D_0 produces δD_0 life shortening

On the other hand the number of faults produced by the doubling dose ~~...~~ is $2\mu_1$; where μ_1 is the spontaneous rate of mutations to a fault in the haploid set.

Thus we may write

$$2\mu_1 \tau = \frac{\delta}{365} D_0$$

or $\mu_1 = \frac{1}{\tau}\frac{\delta}{365}\frac{D_0}{2}$

$\delta = 365$ $\frac{1}{20}$ $\frac{1}{4}$ μ_1

~~The load of faults of each~~

If individual ~~faults~~ are eliminated in the heterozygotes ~~...~~ condition and on the average a fault persist ~~...~~ $\bar{n} = 50$ generations the load of faults

$$\frac{n^*}{50} = 2\mu_1 \; ; \quad \text{or} \quad \frac{n^*}{50} = \frac{\delta D_0}{365}$$

$$\mu_{tot} = \frac{1}{\tau}\frac{\delta}{365}\cdot\frac{D_0}{2}K$$

for $D_0 = 365$
$n^* = 5$

$n^* = \frac{50\,\delta D_0}{365}$

total fault load $= \frac{50\,\delta D_0}{365} K$

$$\frac{1}{\tau}\frac{0.4}{\sqrt{n}} = dx \qquad dx = \frac{3.67}{100}$$

$$\tau = \frac{.4}{\frac{3.67}{100}}\frac{1}{\sqrt{n}} = \frac{10.9}{\sqrt{n}}$$

or for $n = 2.5$
$\tau = 7.17$ years

for pulse prop. $\sigma = \frac{dx}{0.4} = \frac{0.4}{\frac{3.67}{100}} = \boxed{10.9}$ years

$$\bar{\Delta} = 10.9 \times 1.13 = \underline{\underline{12.32 \text{ years}}}$$

$$\sigma \text{ prop obs} = \underline{\underline{10.9}}$$

comp to

$$\underline{\underline{\sigma \text{ gen prop}}} = \frac{7.35\sqrt{2}}{1.13} = 9.2 \text{ years}$$

or raised by 5.5 % 9.5 years

$$(10.9)^2 - (9.2)^2 = (5.875)^2$$

$(9.5)^2 =$

119	119
84.5	90
34.5	29

$$\sigma \text{ scatter} = \underline{5.875 \text{ years}}$$

$$\underline{5.4 \text{ years}}$$

Compare with Poisson

for $n = 2.5$

$$\tau = \frac{P(2.5)}{3.67} = \frac{0.2565 \times 100}{3.67} = \underline{7 \text{ years}}$$

7 years for $n = 2.5$

$n = 10.0$

$$\tau = \frac{.1251}{\frac{3.67}{100}} = \underline{3.42 \text{ years}} \qquad P_{max} = 0.1251$$

~~But~~ How many mistakes n^* including faults?

$\mu_t = 0.35$ $\quad \bar{p} = 40$

per $2\mu_t = 1/\text{gen}$ $\quad \frac{n^*}{40} = .5$

$n^* = 20$

loss as embryo and infant $\frac{20}{100}$ to high?

$\boxed{K = 5}$

$n = \frac{n^*}{40} = 2K\mu_1$

$n = \frac{n^*}{K} = 2\mu_1\ 50$

"infant mort"

$\frac{25}{100}$ mortality

at present:

if $K = 5$; 5 mistakes produced for 1 fault

"infant mort" 5%, loss of life exp. at conception $\frac{80 \times 5}{100} = 4$ years

mutation rate of indiv. gene

$N_1 = 2500$ $\quad \mu = 2\,10^{-5}$ $\quad \mu_1 = \frac{1}{20}$

365 rep makes 5 mutations
should be 50 lesions. —
~~or 1 rep makes~~ $\frac{365}{5} = 73$ rep
makes 1 mutation
and 73 rep makes 1 lesion. —
Puck says 3 rep might make
1 chromosome break
at least 4 lesions per chrom
break

mutation load

~~25~~ 25
If we assume that selection
in the past was 50% due to
failure of the adult to procreate after under unspe- infancy
conditions
~~resulting attached~~
and ~~half~~ 50 to embryonic or genetically determined
~~death~~
or infant death

Idealistical [illegible] H

correction for general population

$$\frac{2.6 \cdot 13}{1.13} = \sigma_{twin} = 3 \text{ genes}$$

$$(10.9)^2 - (3)^2 = \left[10.5\right]^2$$

$$\begin{array}{r} 119 \\ -\ 9 \\ \hline 110 \end{array}$$

Ratio $\frac{10.9}{10.5} = 1.04$

raises 3.67 by factor 1.04

reduces τ from 7

to $\tau = 6.73$

for $n = 2.5$

2.75 %

2.7 %

5.5 % diff.

$$\Gamma n = (n-1)!$$

$$P(r) = \frac{n^r e^{-n}}{\Gamma(r+1)}$$

$$P(r) = \frac{(2.5)^r}{\Gamma(r+1)} e^{-2.5}$$

$$2.5^r = e^{r \ln 2.5}$$

$\ln 2.5 = 0.9163$

$(2.5)^r \times$

$\times .0821$

$(2.5)^r =$

r	$\ln(2.5)^r$	2.5^r	$\Gamma(r+1)$	$e^{-2.5}$	$P(r)$	~~[illegible]~~ for $n = r$
2	1.835	6.265	2.000	.514	.257	0.2565
2.1	1.925	6.855	2.198	.562	.25	0.255
2.2	2.015	7.500	2.424	.615		
2.3	2.105	8.210	2.683	.674		

is likely to be ~~very~~ well below 10 ~~very~~ —

Another argument that n is likely to be closer to 2.5 than to 10 is presented in the chapter dealing ~~with X ray damage~~ the production of faults by X-rays.

The assumption that $\rho = 1$ i.e. that a whole chromosome is destroyed "in one aging hit" is so far consistent with ~~every consideration~~ all the facts that I have hitherto considered and might in the end turn out ~~the~~ to fit the ~~known~~ ~~to establish~~ facts best. We shall ~~If we then assume $n = 2.5$ and~~ therefore assume for n the value $n = 2.5$ ~~for making~~ in computing some of the particular numerical data which might be of some interest.

Fraction of surviving cells at middle age:

Letting middle age for women at 40.25 years we have

$$f = e^{-\frac{\left(\frac{40.25}{\tau} + 2.5 - \frac{1}{2}\right)^2}{4m}} =$$

$\tau = 6.2$ $\qquad 6.5 + 2.0 = 8.5$

$\frac{40.25}{6.2}$

$$e^{-\frac{72.2}{92}} = e^{-0.785} =$$

40.5 / 80.5

15.5

7.7 hits

2.5

5.2 × 6.2

~~Effect of the last hit~~

$$e^{-A_0} \cdot e^{\frac{\sqrt{4mA_0}}{2m}} \approx e^{\frac{1}{3}} = \text{factor } 1.4 \qquad e^{-\frac{\left(\sqrt{4mA_0} - 1\right)^2}{4m}}$$

$$\frac{80.5}{\tau} + 2 = \frac{15}{46}$$

we may write

$$\left(\frac{70.5 + \tau p}{\tau} + n - \frac{1}{2}\right)^2 - n^2 = 4 m A_M$$

This gives for the three above listed pairs of q and n the values of $A_M =$ $A_M =$ and $A_M =$ and correspondingly for the fraction of the surviving sensitive cells for the male the values of $f_M =$ $f_M =$ and $f_M =$

And if we form the ratios $\frac{f_F}{f_M}$ we obtain correspondingly the values

$\frac{f_F}{f_M} =$ $\frac{f_F}{f_M} =$ $\frac{f_F}{f_M} =$

Since it does not seem likely that the ~~critical~~ fraction of the surv sens cells should be substantially lower for the male than for the female these ratios $\frac{f_F}{f_M}$ ~~may~~ should ~~be expected~~ not be ~~expected~~ ~~to be~~ very much higher than one, ~~The fraction~~ As may be seen above ~~these~~ the ratio increases with increasing values of q and n. ~~If~~ The ratio $\frac{f_F}{f_M}$ reaches . if q and n are ~~increased to~~ reach 5 and 10 respectively and this ratio may be ~~regarded as an~~ already as "too high". Thus we may say that p is likely to well below 5 and n

$$\frac{80.5}{\tau} = \sqrt{92A} - n$$

for $n = 0$ this gives min value for τ

$$\sqrt{\frac{A_1}{A_2}} = 1.0785 \quad \text{error } 8.5\%$$

$< \tau$

Check approx method:

$$e^{-\frac{15}{46}} = e^{-0.326} = \underline{0.722}$$

$1 - .722 = .278$

$(.278)^2 = .077284$

$\left(1 - \frac{1}{13}\right)^{46} = e^{-3.54}$ $1 - \text{this} = .92272$

$[.92272]^{46}$

approx
.674
.386
.148
$1 - \frac{1}{6.75}$

$\frac{46}{13} =$

726
719
1445
722

$1 - \quad 28$

~~log 2.2 − 2~~

~~1 − 0.02272~~

log 9.2272 − 1

1.9542 − 1

$.0458 \times 46 = \boxed{\cancel{21.1}}$

exact form

$\frac{1}{21.1}$

Therefore locher ~~all~~ any specific two (heterozygote) ~~...~~ corresponds to two τ and because of Bonhoeffer represents 3τ or 18 ~~...~~ years older. —

Wert per τ

$$\left(\frac{80.5}{\tau}\cancel{A}\right)^{A} = \cancel{\ldots}\sqrt{92\,A} - n$$

$$\tau = \frac{80.5}{9.6\sqrt{A} - (n - \frac{1}{2})}$$

bei Bethe $n = 0$

~~$A = 2.7$ $\sqrt{A} = 1.64$~~

$A = 2.5$ $9.6 \times \sqrt{A} - 2 = 15.15 - 2 = 13.15$

$A = 3$ $9.6\sqrt{A} - 2 = 16.6 - 2 = 14.6$

$\tau = \frac{80.5}{13.5} = 6.13$ | $\tau(n=0) = 5.3$

$\tau = \frac{80.5}{14.6} = 5.5$ | $\tau(n=0) = 4.85$

$$e^{-2.5} = 0.08208 = \frac{1}{12.2}$$

$$e^{-3} =$$

$$e^{-2.3} = \frac{1}{10}$$

$\frac{1}{15} = 0.0667 \simeq e^{2.7}$

$$e^{-3} = \frac{1}{2}$$

$$\left(1-\frac{2mx^2-x^3}{8m^3}\right)^{\frac{8m^3}{2mx^2-x^3}\, m} \; e^{-m} =$$

$$\left(\qquad\right)^{m} = e^{-m\,\frac{2mx^2-x^3}{8m^3}}$$

$$= e^{-\left(\frac{2x^2}{8m} - \frac{x^3}{8m^2}\right)}$$

$$= e^{-\frac{x^2}{4m} + \frac{x^3}{8m^2}}$$

$$\frac{x^2}{4m} - \frac{x^3}{8m^2} = 0$$

$$= e^{-\frac{x^2}{2m} + \frac{1}{2}\frac{x}{m}}$$

$$= e^{-\left(1-\frac{1}{2}\frac{x}{m}\right)\frac{x^2}{4m}}$$

To comp put $\frac{x}{2m} = \frac{1}{4}$

$$\left[1 - \left(1-e^{-\frac{1}{4}}\right)^2\right]^m \quad e \qquad \frac{15}{46} =$$

$$A = \left(\frac{1}{4}\right)^2 \; 1$$

$$\left(1-\frac{1}{13}\right)^{13\,\frac{23}{13}} = e^{-1.77}$$

$$\left(1-\frac{1}{13}\right)^{46}$$ in place of

if we want and $5^2 \cdot 3$ to be $e^{-2.3}$

$$\frac{x^2}{4m} = 3.4$$

$$e^{-1.65}$$

$$\frac{15^2}{92}\left(1-\frac{15}{46}\right)$$

$$\frac{1}{2.45 \times 0.325}$$

675

To comp with $e^{-\frac{(15)^2}{4m}} =$ 4

$= e^{-\frac{225}{92}} = e^{-2.45}$

Check $\left(1+\frac{1}{13}\right)^{13}$

1.077

0.0334
12
.0322 × 13   0.418   **2.62**

De Novo

$\left[1-\left(\frac{x}{2m}-\frac{1}{2}\frac{x^2}{4m^2}\right)^2\right]^m$

First term $\left[1-\frac{x^2}{4m^2}\right]^m =$

$\left(1-\frac{x^2}{4m^2}\right)^{\frac{4m^2}{x^2}m} = e^{-1\frac{x^2}{4m^2}m}$

corr

$\left(1-\frac{x^2}{4m^2}+\frac{x^3}{8m^3}\right)^m =$

$1-\frac{\cancel{2}m\,x^2-\cancel{4}\,x^3}{\cancel{4}\times 8\,m^3} = 1-\frac{2mx^2-x^3}{8m^3}$

exact formula?

$$\left[1-\left(1-e^{-\frac{\xi}{2m}}\right)^2\right]^m$$

$$\left[1-\left(1-2e^{-\frac{\xi}{2m}}+e^{-\frac{2\xi}{2m}}\right)\right]^m$$

$$\left[2e^{-\frac{\xi}{2m}}-e^{-\frac{2\xi}{2m}}\right]^m$$

$$\Big[1+\underbrace{2\left(e^{-\frac{\xi}{2m}}-1\right)}_{\alpha}-\underbrace{\left(e^{-\frac{2\xi}{2m}}-1\right)}_{\beta}\Big]^m$$

OK

$$(1+\alpha-\beta)^m$$

$$(1+\alpha-\beta)^{\frac{m}{\alpha-\beta}}\quad e^{m(\alpha-\beta)}$$

$$\cong e^{m\left[2\left(e^{-\frac{\xi}{2m}}-1\right)-\left(e^{-\frac{\xi}{m}}-1\right)\right]}$$

OK

$$\text{Exp}=m\left[2\left(-\frac{x}{2m}+\frac{1}{2}\left(\frac{x}{2m}\right)^2+\frac{1}{2\times3}\left(\frac{x}{2m}\right)^3+\dots\right)\right.$$

$$\left.+\frac{x}{m}-\frac{1}{2}\left(\frac{x}{m}\right)^2+\frac{1}{2\times3}\left(\frac{x}{m}\right)^3\right]$$

$$m\left[-2y+y^2-\frac{1}{3}y^3+\frac{1}{3\cdot4}y^4\right.$$

$$\left.+2y-\frac{1}{2}(2y)^2+\frac{1}{2\times3}(2y)^3-\frac{1}{2\cdot3\cdot4}(2y)^4\right]$$

$$\frac{1}{16}\cdot\frac{2}{24}\frac{x^4}{m^4}-\frac{1}{24}\frac{x^4}{m^4}$$

$$\text{Exp}=m\left(-y^2+y^3-\frac{7}{12}y^4\right)=\left[-\frac{x^2}{4m}+\frac{x^3}{8m^2}-\frac{7}{8}\frac{1}{24}\frac{x^4}{m^3}\right]$$

check!

~~Ref~~ Rate Formulation

$$\frac{80.5}{\tau} + \left(n-\tfrac{1}{2}\right) = X$$

$$-\xi_{xp} = \frac{X^2}{4m}\left(1 - \frac{X}{2m}\right)$$

$$\left(\xi_{xp} \cong \frac{X^2}{4m}\, e^{-\frac{X}{2m}}\right)?$$

~~$\tau = 6.2$~~

~~at $t = 2.5$~~ $\tau = 6.2$

$n = 2.5$ $\quad X = 15$ $\quad m = 23$ $\quad \frac{X}{2m} = \frac{15}{46} =$

$= 0.326$

$$\xi_{xp} = 2.45\, e^{-0.326}$$

$$2.45 \times 0.722 = 1.76$$

$$e^{-1.76} = 0.172 \quad \text{or} \quad \frac{1}{f} = \frac{1}{5.8}$$

Middle age

$$\frac{40.5}{6.2} + 2 = X_{middle} = 6.45 + 2 \cong 8.45$$

$$\xi_{xp} = \frac{70}{92}\left(e^{-\frac{8.45}{46}}\right) = \frac{70}{92}\, e^{-0.183} =$$

$$\frac{70}{92} \times e^{-0.183} = 0.832 \times \frac{70}{92} = 0.63$$

$$e^{-0.63} = 0.532 \approx 50\%$$

Effect of one hit at death

$$e^{-\frac{(x_0-1)^2}{4m}} = e^{-\frac{x_0^2}{4m}}\; e^{\pm\frac{2x_0}{4m}}$$

$$\frac{30}{92}$$

$$e^{-0.326} = \frac{1}{1.4}$$

or two hits factor $\underline{2}$

$$\frac{80.5}{\tau} + n - \frac{1}{2} = Z$$

$$\left(\frac{20.8}{92}\right)^2 \left(1 - \frac{20.8}{92}\right) - \frac{16}{92}$$

$$\psi(z) - \psi(n) > \frac{433}{92}\underbrace{\left(1 - \frac{20.8}{100}\right)}_{\frac{79}{100}} - \frac{17.4}{100} \quad \frac{12.2}{100}$$

$$\left(\text{"}\tau\text{"} = 3.8 = n - \frac{1}{2}\right)$$

$$3.68 - \frac{12.2}{100} \simeq 3.56$$

---

for $n = 2.5$ $\qquad \varepsilon(n) = 0.945$ $\qquad \sqrt{2\tfrac{1}{2}} = 1.58$

$$Z = \frac{\varepsilon(n)\sqrt{2.5}}{9.3}\, 80.5 + \underbrace{n - \frac{1}{2}}_{2}$$

$$Z = 0.945 \times 1.58 \times 8.65 + 2$$

$$Z = 12.9 + 2 = 14.9$$

$$(14.9)^2 = 222$$

$$\text{Gap} = \frac{222}{92}\underbrace{\left(1 - \frac{14.9}{92}\right)}_{\frac{16.2}{100}\ \to\ .838} - \frac{4}{92} \doteq 2.03$$

$$\frac{2^2}{4m} = \frac{1}{12m}\ \ \frac{2.42}{} = \frac{1}{1.73m}$$

$$\frac{1}{12m} = \frac{1^2}{1} \cdot \frac{1}{1.73m} \quad 2.42 \times 2.42 = \frac{2.42}{30.5} = \frac{6.13}{100}$$

$$2.02 - \frac{4.35}{100} \simeq 1.97$$

$$6613 \quad 3823 \quad 2.03/13$$

5

$$\tau = \frac{80.5}{Z - (n - \frac{1}{2})}$$

τ_{max} for $n = 2.5$ we take $\tau \approx 6$ years

$$\tau = \frac{9.3}{\sqrt{n}}$$

$$\frac{9.3}{\sqrt{n}} = \frac{80.5}{X - (n - \frac{1}{2})}$$

$$Z\frac{9.3}{\sqrt{n}} - \frac{9.3}{\sqrt{n}}(n - \tfrac{1}{2}) = 80.5$$

$$Z\frac{9.3}{\sqrt{n}}(1 - n + \tfrac{1}{2}) = 80.5$$

$$Z = \frac{\sqrt{n}}{\varepsilon(n)\,9.3}\,80.5 + n - \frac{1}{2}$$

for $\underline{n = 4}$

let us set

$$1 < \varphi(Z+n) - \varphi(n) < 3$$

$$Z = \frac{\varepsilon(n)\sqrt{n}}{\varepsilon(n)\,9.3} \times 80.5 + n - \frac{1}{2} \qquad \varepsilon(n)\sqrt{n}\;\; 8.65 + n - \frac{1}{2}$$

by $n = 4$ $\quad \varepsilon(n) = 1$ $\quad$ by setting $\varepsilon(n) = 1$ we decrease Z

$$Z = 17.3 + 4 - 0.5 = 20.8$$

21.3
0.5
.8

$$\boxed{\varepsilon_{ap} = \frac{Z^2}{4m}\left(1 - \frac{Z}{2m}\right) - \frac{\tau^2}{4m}\left(1 - \frac{\tau}{2m}\right)}$$

$$\varepsilon_{ap} = \frac{Z^2}{4m}\left(1 - \frac{Z}{2m} + \frac{7}{12m}\frac{Z^2}{4m}\right) - \frac{\tau^2}{4m}\left(1 - \frac{\tau}{2m}\right.$$

To paper

$\frac{0.4}{\sqrt{n}}$ | P_{max} | $P_{max} = \frac{0.4}{\lambda(n)\sqrt{n}}$

	$\frac{0.4}{\sqrt{n}}$	P_{max}			$\sqrt{n}$
$n = 2\frac{1}{2}$	0.253	0.257	$\lambda(n) = 0.985$	$2\frac{1}{2}$	1.581
$n = 3$	0.231	0.2315 (n)	$\lambda(n) = 0.998$	3	1.732
$n = 4$	0.200	0.195		4	2
$n = 2$	0.2825	0.2885	$\lambda(n) = 0.979$	$n = 2$	1.414

eff $\frac{0.6}{282} =$

$\lambda(n) = 1$ for n large

for $n = 3$

$\lambda(n) = 0.998$

for $n = 2.5$

$\boxed{\lambda(n) = 0.985}$

Γ $\frac{(2)^{1.5}}{\Gamma 2.5} \times e^{-2} =$

$\Gamma 2.5 \downarrow 1.329$ $\quad e^{-2} \downarrow .1353$

$n = 3$

$P_{max} = \frac{n^{n} e^{-n}}{\Gamma!}$

$\sqrt{n+1}$

$= \frac{3^{2.5} e^{-n}}{2.5!}$

0.2311.5

$P_{max}(3) = \frac{9 \times 1.73}{3.323} e^{-3} = 0.0497$

4.154

~~The [illegible] of B~~

$$\frac{77.5}{\tau} + g^{\tau} + n - \tfrac{1}{2} = Z$$

$$\tau = \frac{9.3}{\varepsilon(n)\sqrt{m}}$$

$$\mathrm{Exp}_M = \frac{Z^2}{mg}\left(1 - \frac{Z}{2mg} + \frac{7}{12mg}\frac{Z^2}{4mg}\right) - \frac{r^2}{4mg}\left(1 - \frac{r}{2mg}\right)$$

$$\boxed{\mathrm{Exp}_M = 3} \qquad \boxed{r = n - \tfrac{1}{2}}$$

~~gives what for n~~

~~$g = 1$ $g = 4$ $g = 6$ $g = 7$~~

$$\frac{80.5}{\tau} + n - \tfrac{1}{2} = Z$$

$$\tau = \frac{9.3}{\varepsilon(n)\sqrt{m}} \qquad \varepsilon(n) = 1$$

$$\mathrm{Exp}_F = \frac{Z^2}{mg}\left(\text{etc.}\right.$$

what the above values

Choose $\mathrm{Exp}_F = 1$

Choose $\mathrm{Exp}_F = 2.5$

table for g and n

what g and n give $\mathrm{Exp}_M = 1.5$

table for g and n

what g and n give $\mathrm{Exp}_M = 3$

Upper limit for n and lower limit for τ

Reasonable value for n

$n=2$ $\qquad z = x + r$

$$\frac{80.5}{\tau} + n - \frac{1}{2} = \underline{x + r_{max}}$$

$$\tau = \frac{9.2}{\sqrt{n}} \approx 6.5 \text{ years} \qquad \underline{\varepsilon(n) = 1}$$

$$\frac{80.5}{9.2}\sqrt{n} + n - \frac{1}{2} = x + r \qquad r = 2$$

$$8.75 \times 1.414 = 12.4 + 1.5 = \underline{13.9}$$

$$\varphi(x+r) - \varphi(r) = \qquad (13.9)^2 = 193$$

$$= \frac{193}{92}\left(1 - \frac{13.9}{184} + \right) - \frac{4}{92}\left(1 - \frac{2}{184}\right)$$

1.000
.755
.92.5

$$= 2.1 - \frac{4}{100} \approx \underline{1.96 = A^*}$$

$$A^* = \frac{14}{100} \text{ or } \sim \frac{1}{7}$$

$n = 3.0$ upper limit for n

$$\frac{80.5}{\tau} + 2\tfrac{1}{2} = x + r$$

$$8.75\sqrt{3.} + 2\tfrac{1}{2} = x + r = 17.5$$

1.73

$$(17.5)^2 = 306$$

3

$$\frac{306}{92}\left(1 - \frac{17.5}{184}\right) - \frac{9}{92}\left(1 - \right. \qquad \cancel{306} = 2.9$$

0.905

$$A^* = 5.5/100 = \frac{1}{18}$$

$$(x-a)(x-b)(x-c)=0$$

$$x^3 - cx^2 - ax^2 - bx^2$$

$$(ab+bc+ac)x = abc$$

$$x^3 - (a+b+c)x^2 + (ab+bc+ac)x - abc$$

$$\begin{cases} a+b+c = 1 \\ ab+bc+ac = 0 \\ abc = A \end{cases}$$

Correction

$$e^{\frac{x}{2m}}$$

$$X_r = X_0 - (0.8)\, r$$

$$\tau = P(r)\frac{dx}{dr}\frac{dt}{dx}$$

$$P(r)\frac{dx}{dr}\frac{dt}{dx} = P(r)\, 0.8 \times \tau =$$

$$t = \tau x$$

$$r = e^{-\frac{x}{2m}}\, r_0$$

~~at death of [illegible] prof. [illegible],~~

$$\cancel{\ln\frac{1}{\rho} = \frac{x_0^2}{4m}\left(1-\frac{x}{2m}\right)}$$ ~~therefore~~ $\frac{x}{2m}$

$$\cancel{4m \ln \rho}$$

~~OA 1005~~

<u>Comparison between species</u>

$$\cancel{\left(\frac{x_0}{\tau}\right)^2 =}$$

$$\ln\frac{1}{f^*} = \frac{x_0^2}{4m}\left(1-\frac{x_0}{2m}\right); \quad \cancel{x_0 = \psi\left(\ln\frac{1}{f^*}\right)}$$

$$x = \psi(f^*)$$

~~lifest~~

$$\frac{\text{Lifespan}}{\tau} = x$$

$$\frac{\text{Length of life}}{\tau} = x$$

$$\frac{\text{Length of life}}{\psi\left(\ln\frac{1}{f^*}\right)} \qquad \ln\frac{1}{f^*} = \cancel{m}\left(\frac{x}{2m}\right)^2\left(1-\frac{x}{2m}\right)$$

$$A = z^2(1-z)$$

$$\frac{A}{m} = z^2 - z^3$$

let us use first approx...

$$x_0 = \sqrt{4m\ln\frac{1}{f^*}}$$

~~Hyp of leng~~

~~$x_0 = \frac{\text{length of life}}{\tau}$~~

$$\frac{\text{length of life}}{\tau} = x_0$$

$$x_0 = \sqrt{4m\ln\frac{1}{f^*}}$$

$$\tau = \frac{\text{length of life}}{\sqrt{4m\ln\frac{1}{f^*}}}$$

$$\frac{\tau}{\text{length of life}} = \frac{1}{\sqrt{4m\ln\frac{1}{f^*}}}$$

check width $\ln\frac{1}{\varphi^*} = 1$ $\quad n = 2.5$

$x_r + r = \sqrt{92} - 1 = \boxed{8.6}$

$n = 2.5$

$$\frac{80.5}{2} + 2 = \sqrt{4m \ln\frac{1}{\varphi^*}} + \ln\frac{1}{\varphi^*} \qquad 6 \quad \frac{80}{6}$$

$$\frac{80.5}{\tau} = \sqrt{4m\ln\frac{1}{\varphi^*}} - 2 - \ln\frac{1}{\varphi^*}$$

$$\frac{80.5}{\sqrt{4m\ln\frac{1}{\varphi^*}} - 2 + \ln\frac{1}{\varphi^*}} = \tau \qquad \ln\frac{1}{\varphi^*} = 1.5$$

$$\frac{80.5}{138 - 3.5} = \frac{80}{11.758 - 3.5}$$

$\ln\frac{1}{\varphi^*} = 2$

$$\frac{80.5}{\sqrt{} - 2 - 2} = 8.5 \qquad \tau = 9.05$$

10

$$\ln\frac{1}{\varphi^*} = \frac{(x+r)^2}{4m}\left(1 - \frac{x+r}{2m}\right) \qquad \frac{(12.5)^2}{4m}(1 -$$

$$\cancel{\frac{(12)^2}{92}(1-}$$

$$\ln\frac{1}{\varphi^*} = \frac{(12)^2}{92}\left(1 - \frac{12}{46}\right) = 1.16$$

0.26

0.74

1.57 x

check $\frac{80.5}{10.3}$ 7.81

$r = 0$ 4

$$\frac{x}{2m} = \sqrt{\frac{1}{m}\ln\frac{1}{f^*}} - \frac{1}{2m}\ln\frac{1}{f^*}$$

~~at most~~ $n = 2$

$$\ln\frac{1}{f^*}$$

$$-\left(\sqrt{\frac{2}{23}} - \frac{2}{46}\right)$$

$$-(0.285 - 0.0435$$

$$e^{} = e = e^{-.241}$$

$$\boxed{e^{-.24} = 0.7866}$$

~~but if $\ln\frac{1}{f^*} = 1$~~

285
435
241

our τ should be multiple with 1.27

$n = 2.5$ $\quad 6.15 \times 1.27 = 7.8$ years

or if $\ln\frac{1}{f^*} = 1$

$$e^{-\sqrt{\frac{1}{23}} - \frac{1}{46}} =$$

$$e^{-(0.21 - 0.022}$$

$$e^{-0.19} = 0.827$$

$6.15 \times 0.827 =$

$\tau = 7.43$

$$4\left(\frac{80.5}{\tau}\right) + 2 \times 0.8 = 9.6 + 1 - 1.6 \qquad \ln\frac{1}{f^*} = 1$$

$8.6 -$

$$\frac{80.5}{\tau} = \underline{\underline{9}} \qquad \tau = \qquad f =$$

$$\boxed{\frac{80.5}{9} = \cancel{8.95}\ \tau\ \text{years}} \qquad e^{-0.196} = \boxed{0.82}$$

$$\tau = \frac{6.15}{0.82} = \underline{\underline{7.5\ \text{years}}}$$

$$\tau = \frac{80.5}{\ln\frac{1}{f^*} + \ln\frac{1}{f^*} - (n - \frac{1}{2})\varphi}$$

$$\ln\frac{1}{f^*} = \frac{\cancel{2}}{2} \qquad \frac{80.5}{14} = \qquad \varphi$$

$$\boxed{\tau = 7.14\ \text{years}}$$

$n = 2.5$

$\ln f^*$

n

$$\frac{80.5}{\tau} = 13.6 + 2 - 1.6 = 14$$

$$\varphi = e^{-\frac{14}{46}} = e^{-.32}$$

$$\boxed{\tau = 8.46 \qquad \varphi = \boxed{0.726}}$$

τ

$\ln\frac{1}{f^*} = 3$

$\tau \qquad \varphi \qquad 3$

f^*

$$\left(1 - \left(1 - e^{-\frac{\tau}{\tau}}\right)^2\right)^m$$

$m \ln$

De Moivre

$$y = \sqrt{\frac{1}{m} \ln \frac{1}{f^*}}$$

$$\ln \frac{1}{1-y} = \ln(1+y+y^2)$$

$$y + y^2 - \frac{1}{2}(y+y^2)^2$$

$$y + \frac{1}{2}y^2$$

$$x + r = \cancel{2\sqrt{\ln \frac{1}{f^*}}}$$

$$= 2m\left(y + \frac{1}{2}y^2\right) = \sqrt{4m \ln \frac{1}{f^*}} + \ln \frac{1}{f^*}$$

$$\ln \frac{1}{f^*} \approx 1 \qquad x_0 = \sqrt{4m \ln \frac{1}{f^*}} + \ln \frac{1}{f^*} \approx$$

$$\frac{x_0}{2m} = \frac{1}{46} \times (9.6 + 1) = \frac{10.6}{46} = 0.23$$

$$e^{-0.23} \approx \underline{0.8}$$

Tooth Lady

$$\frac{x_0}{2m} = \frac{1}{2m}\left(\sqrt{4m} + 1\right) = \frac{10.6}{2m} = \underline{0.23}$$

$$e^{-23} = 0.8$$

$$\cancel{\ln \frac{1}{f^*} =}$$

$$\ln \frac{1}{f^*} = 2 \qquad x_0 = \underbrace{\sqrt{184}}_{13.6} + 2 = 15.6$$

$$\frac{15.6}{2m} = 0.34$$

$$e^{-.34} = \underline{0.71} = E4$$

$$\ln\left(1-\sqrt{1-\frac{1}{\frac{1}{m}\ln f^*}}\right) = -y$$

$$y = \ln\frac{1}{1-\sqrt{[illegible]}} =$$

$$\sqrt{1-\frac{1}{\frac{1}{m}\ln f^*}} =$$

$$-\ln\frac{1}{f^*} = m\ln\left[1-(1-e^{-y})^2\right]$$

$$e^{-\frac{1}{m}\ln\frac{1}{f^*}} = 1-(1-e^{-y})^2$$

$$(1-e^{-y})^2 = 1-e^{-\frac{1}{m}\ln\frac{1}{f^*}}$$

$$1-e^{-y} = \sqrt{1-e^{-\frac{1}{m}\ln\frac{1}{f^*}}}$$

$$\boxed{1-\sqrt{1-e^{-\frac{1}{m}\ln\frac{1}{f^*}}} = e^{-y}}$$

$$1-\sqrt{\cancel{1}+\left(\frac{1}{m}\ln\frac{1}{f^*}-\frac{1}{2}\left(\frac{1}{m}\ln\frac{1}{f^*}\right)^2\right)} = e^{-y}$$

$$y = \ln\frac{1}{1-\sqrt{\frac{1}{m}\ln\frac{1}{f^*}-\frac{1}{2}\left(\frac{1}{m}\ln\frac{1}{f^*}\right)^2}} = [illegible]$$

$$\ln \frac{1}{p^*} = m \frac{1}{1-(1-e^{-y})^2}$$

$$\ln \frac{1}{p^*} = m\left(z + \frac{1}{2} z^2\right) = m\left[(1-e^{-y})^2 + \frac{1}{2}(1-e^{-y})^4\right]$$

$$= m\left[(1-2e^{-y}+e^{-2y}) + \frac{1}{2}(1-2e^{-y}+e^{-2y})^2\right.$$

$$= m\left[2y - 2y - 2\frac{y^2}{2} + 4\frac{y^2}{2} + \right.$$

$$\underbrace{\qquad}_{y^2}$$

$$m(y^2)$$

$$m \frac{x^2}{(2m)^2} =$$

$$\frac{1}{m} \ln \frac{1}{p^*} = \frac{1}{1-(1-e^{-y})^2}$$

$$\frac{1}{\frac{1}{m}\ln 1/p^*} = 1-(1-e^{-y})^2$$

$$\sqrt{1 - \frac{1}{\frac{1}{m}\ln 1/p^*}} = (1-e^{-y})$$

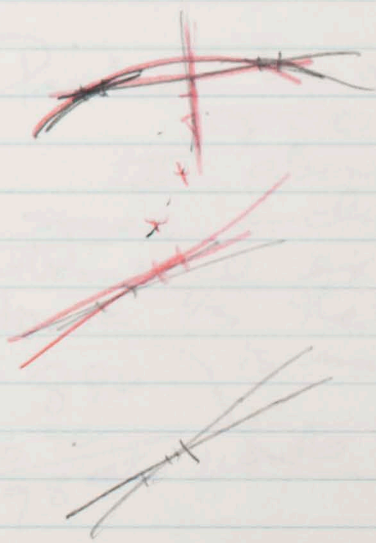
$$1 - \sqrt{1 - \frac{1}{\frac{1}{m}\ln\frac{1}{p^*}}} = e^{-y}$$

$$\ell y = \ln \frac{1}{1-\sqrt{\frac{1}{m}\ln\frac{1}{p^*}}\sqrt{1-\frac{1}{2}\frac{1}{m}\ln\frac{1}{p^*}}}\; p$$

$$f \approx \sqrt{\frac{1}{m}\ln\frac{1}{p^*}}\sqrt{1-\frac{1}{2m}\ln\frac{1}{p^*}} + \frac{1}{2}\frac{1}{m}\ln\frac{1}{p^*}\left(1-\frac{1}{2m}\ln\frac{1}{p^*}\right)$$

$$\underline{x} = \sqrt{4m\ln\frac{1}{p^*}}\left(1-\frac{1}{4m}\ln\frac{1}{p^*}\right) + 2\ln\frac{1}{p^*}\left(1-\frac{1}{2m}\ln\frac{1}{p^*}\right)$$

O.K.



Pigmentation in the Mouse

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I II

			1	~~24~~
			2	~~31~~
			3	~~32~~
			4	~~37~~
			4a	~~36~~
			4b	~~18~~
1	5	5	5	~~29~~
2	6	12	6	~~31~~
3	1	3	7	~~32~~
4	5	20	8	~~34~~
5	2	10	8a	~~35~~
6	2	12	8b	~~22~~
7	1	7	9	~~38~~
8	6	48	10	~~34~~
9	1	9	11	~~30~~
0	3	0	13	~~28~~
	32✓	126	14	~~22~~
			14A	~~18~~
			15	~~32~~
			16	~~30~~
			17	~~28~~
			18	~~23~~
			18a	~~38~~
			18b	~~36~~
			19	~~34~~
			20	~~17~~
			21	~~31~~
			22	~~22~~
			23	~~30~~
			24	~~14~~
			25	~~31~~
			26	~~36~~

20's	8	160
30's	20	600
10's	1	10
0's	3	0
	32✓	7700

7700
126
~~pages~~ ~~126~~ ~~[illegible]~~ -896

~ 11 words / line

Part I has about 10000 words
II about 4000.
In space including mathematical expressions, Estimate 1/3 the space is mathematical

896
896
9856 words

		I 1	~~24~~
		2	~~31~~
		3	~~32~~
		4	~~37~~
		4a	~~35~~
		4b	~~18~~
1 5	5	5	~~29~~
2 6	12	6	~~31~~
3 1	3	7	~~32~~
4 5	20	8	~~34~~
5 2	10	8a	~~35~~
6 2	12	8b	~~22~~
7 1	7	9	~~38~~
8 6	48	10	~~34~~
9 1	9	11	~~30~~
0 3	0	13	~~28~~
32✓	126	14	~~32~~
		14A	~~18~~
		15	~~32~~
		16	~~30~~
		17	~~28~~
		18	~~23~~
		18a	~~38~~
		18b	~~36~~
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		23	~~30~~
		24	~~14~~
		25	~~31~~
		26	~~36~~

20's	8	160
30's	20	600
10's	1	10
0's	3	0
	32✓	7700

7700
~~126~~ 126
pages ~~7826 lines~~ -896

II 1	28
2	31
3	15
4	29
4A	11
5	32
6	31
7	27
8	31
9	31
10	33
11	29
12	11

99
24
339 lines.
339
3729 words

65 characters/line.

11 words/line

Part I has about
10000 words
II about 4000.
In space including
mathematical expressions,
Estimate 1/3 the space
is mathematical

896
896
9856 words

Cardy Neel & Schull (Dec. 1957?)

~~Univ.~~ Neel — Human Biology 1958
— Article of heredity & pam. —

~~Handbook of Biological Data.~~ —
Spector, abstract of Atlas of Chromosome Numbers in animals. 1956. — Makino ~~...~~ (1956?)

Man: Tjio J. H. and Levan, A.
Hereditas, 1956, 42 pl.

Extracted from: Atti dell' Istituto Nazionale delle Assicurazioni. 1930. v. 2. p. 245-266 (Cassinis, G. Sull'impiego di alcune funzioni trascendenti nelle rappresentazioni empiriche.)

TAVOLA II.

Valori della funzione Γ (x)

con 5 cifre significative, per x compreso fra 0 e 10,9

x	,0	,1	,2	,3	,4	,5	,6	,7	,8	,9
0	∞	9,5135	4,5908	2,9916	2,2182	1,7725	1,4892	1,2981	1,1642	1,0686
1	1	0,95135	0,91817	0,89747	0,88726	0,88623	0,89352	0,90864	0,93138	0,96177
2	1	1,0465	1,1018	1,1667	1,2422	1,3293	1,4296	1,5447	1,6765	1,8274
3	2	2,1976	2,4240	2,6834	2,9812	3,3234	3,7170	4,1707	4,6942	5,2993
4	6	6,8126	7,7567	8,8553	10,136	11,632	13,381	15,431	17,838	20,667
5	24	27,932	32,578	38,078	44,599	52,343	61,554	72,528	85,622	101,27
6	120	142,45	169,41	201,81	240,83	287,89	344,70	413,41	496,61	597,49
7	720	868,96	1050,3	1271,4	1541,3	1871,3	2275,0	2769,8	3376,9	4122,7
8	5040	6169,6	7562,3	9281,4	11406	14034	17290	21328	26340	32569
9	40320	49974	62011	77036	95809	119290	148700	185550	231790	289870
10	362880	454760	570500	716430	900610	1133300	1427500	1799800	2271600	2869700

4 1.1997

2n = 5 $\boxed{0.993}$

Heaven

2n = 4 ; 1.067 / 0.9817 ; $\boxed{\Sigma = 1.048 \quad 2n=4}$

6 ; 1.322 / 0.99701 ; $\boxed{\Sigma = 1.32 \quad (2n=6)}$

$\omega_{eff}(2n=5) = 1.1997 \times .993$ $\boxed{= 1.192 \ (2n=5)}$

etc.

Proc. Natl. Acad. of Sci.

One copy has 110 pages.

47 lines per page

Average of 13 words per line or approximately 510 words per page.

~~4~~ 1.1997

$2n = 5$ $\boxed{0.993}$

Theorem

$2n = \underline{4}$; $\dfrac{1.067}{0.9817}$; $\boxed{\Sigma = 1.048 \quad (2n = 4)}$

6 ; $\dfrac{1.322}{0.99701}$; $\boxed{\Sigma = 1.3\cancel{22} \quad (2n = 6)}$

Diff $(2n = 5) = 1.1997 \times .993$ $\boxed{= 1.192 \quad (2n = 5)}$

etc.

$\underline{2n = 3}$ $\Sigma = 0.87972$ = $\boxed{0.87972 \quad (2n = 3)}$

not div.

Mrs Norma French. — *

Section on Theor. Statistics and Mathematics Biometrics Branch Sam W.
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$s = 1.224 \times 0.9595$ $= 1.176$

$s + \frac{1}{2} P(1)$

$$\begin{array}{r} 1.176 \\ + 0.017 \\ \hline 1.193 \end{array}$$

$\frac{0.0337}{2} = 0.0168 \approx 0.017$

$\text{diff} \cong \sqrt{\frac{2}{\pi}} \sqrt{n} = 1.58 \ (n = 25)$

$\times 0.798$

$= 1.26$

$\underbrace{\sqrt{\frac{2}{\pi}}}_{u}$

~~0.837~~

.798

63.7

7.98

Bullington and Day
page 85

~~MAD~~ MD = mae $= \sigma\sqrt{2/\pi}$

$$\sigma\sqrt{\frac{2}{\pi}} = 0.797880\,\sigma$$

mean ~~diff~~ abs diff.

$$\sqrt{2}\sqrt{\frac{2}{\pi}}\,\sigma = \frac{2}{\sqrt{\pi}}\,\sigma \approx 1.13\sigma$$

Heavon for $n = 2.5$

Diff $= 1.224$ $2n = 5$

check

$$\text{Diff} = \varepsilon(n)\sqrt{\frac{2n}{\pi}}$$

$n = 2.5$

$\boxed{\cancel{\varepsilon(n) = 0.9725}}$ 1.261

$\frac{1.224}{1.261} =$

$\varepsilon(n) = .945$

Heavon looks for $n = 2.5$ checks!!

$S = 2$ and larger

$$\frac{S = \cancel{\text{Sum}}\ \text{obtained}}{0.9595} = 1.224$$

left of $S = 1$
and $S = 2$

$S + P(1)$ $\frac{1}{2}$ | 0 $\frac{1}{4}$ | $\frac{1}{4}$

$S + \frac{1}{2}P(1)$ $\frac{1}{2}$ | $\frac{1}{4}$

Teller
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~~Flora T.~~
~~Emma~~ KIRZ

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