Mean genotypic value ($\mu_{G_1G_1}$) for offspring of parent 5; ($f(G_1G_1)=p$; $f(G_1G_2)=q$)

$$\mu_{11}=\mu_{G_1G_1} = \underbrace{f(G_1G_1)}_{p}\cdot a + f(G_1G_2)\cdot d + f(G_2G_2)\cdot(-a)$$

$$= p\cdot a + q\cdot d + 0\cdot(-a)$$

$$= pa + q\cdot d$$

$$BV_{11} = 2(\mu_{11}-\mu)$$

$$= 2\cdot\left[p\cdot a + q\cdot d - \left[(p-q)a + 2pqd\right]\right]$$

$$= 2\left[pa + qd - pa + qa - 2pqd\right]$$

$$= 2\left[qd + qa - 2pqd\right]$$

$$= 2\left(qa + (1-2p)qd\right)$$

$$= 2q\left(a + \underbrace{(1-2p)}_{p+q}d\right)$$

$$= 2q\left(a + (q-p)d\right)$$

BV_{12} =

BV_{22} =