

Conservation Applications for Understanding Species Biology

Reproductive systems

- Sandhill crane
- Monogamous
- Mate for life



TABLE 1. Genotypes of Sandhill Crane families in Wisconsin that suggest extra-pair fertilizations. † indicates an allele that does not match one of the social parents.

Pair no.	Age ^a	Sex	Sample year ^b	Microsatellite locus											
				Gam1	Gam3	Gam5	Gam6	Gam7	Gam21						
1	A	M	1993	146	146	118	118	184	188	126	126	137	139	136	136
	A	F	1993	138	142	118	124	178	182	126	138	139	141	132	136
	C	M	1997	138	138 [†]	118	118	182	184	126	126	139	141	132 [†]	132
	C	F	2004	142	142 [†]	118	126 [†]	178	184	126	126	137	139	136	136
2	A	M	2001	138	142	122	124	178	184	122	138	137	139	136	136
	A	F	2001	140	146	118	126	186	186	122	126	139	141	136	136
	C	F	2001	136 [†]	138	118	122	184	186	126	138	137 [†]	137	136	136
3	A	M	1997	138	140	118	126	184	190	126	138	137	139	132	136
	A	F	1997	142	146	118	124	184	188	126	126	137	139	132	132
	C	F	1996	136 [†]	142	114 [†]	118	182 [†]	188	122 [†]	126	137	137	132	136
4	A	M	1998	138	146	118	122	182	182	122	126	139	141	132	136
	A	F	2003	146	146	118	122	184	190	122	126	137	141	132	136
	C	M	1998	146	146	118	126 [†]	184	184 [†]	126	126	137	139	132	132

^a A = adult, C = chick.

^b For chicks, sample year is same as hatch year.

- Swift foxes

- Monogamous

- Mate for life

- Colorado study (Kitchen et al. *Animal Behaviour* 71:1029-1038 (2006))

- 52% of offspring were not sired by apparent mate of mother



Determine sex

- Heterogamy
 - Mammals: X, Y
 - Birds: W, Z
- Strategies
 - amplify homologues on each chromosome
 - needs only 1 set of primers
 - if PCR products are same length, determine if RFLPs will distinguish them (Zfx/Zfy)
 - if products are different length—done (amelogenin, Zfx/Zfy)
 - amplify Y-(W-)specific loci
 - must co-amplify a positive control marker to ensure PCR worked (Sry , CHD)
 - amplify X-linked and Y-linked loci with separate primers (centromeric alphoid repeat)

Sex-biased dispersal

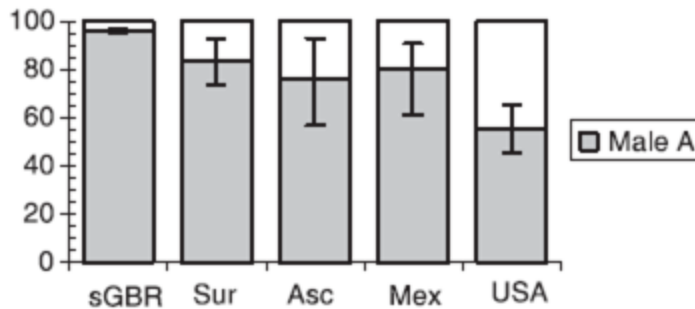
- Treat sexes as different populations inhabiting the same space
- Examine genetic parameters separately
- Dispersal introduces genotypes unlikely to arise from local allele frequencies, leading to a positive F_{IS} due to Wahlund effect
- Also can use assignment tests

Table 2 Deviation from Hardy–Weinberg expectation (F_{IS}), mean assignment (mAI_C) and variance assignment (vAI_C) values estimated separately for male and female common frogs. Significance (P) was assessed using the randomization method of Goudet *et al.* (2002)

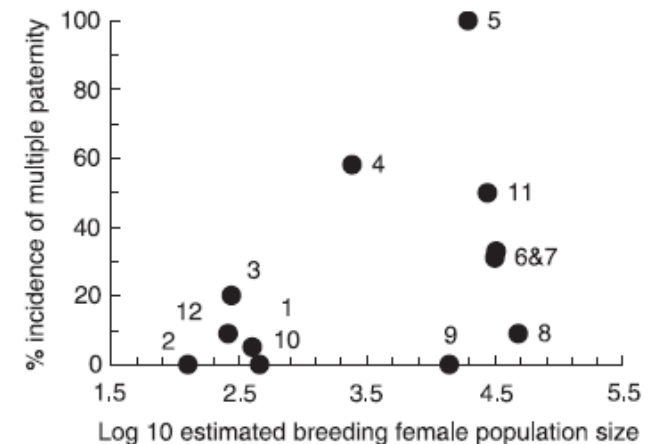
	N	F_{IS}	mAI_C	vAI_C
Females	109	0.089	-0.764	13.3
Males	206	-0.002	0.404	9.624
P		0.003	0.002	0.155



- Green turtle
- Ascension Island
- 3 clutches
- 20 eggs per clutch
- All clutches had ≥ 2 sires



J.S. Ireland et al. / J. Exp. Mar. Biol. Ecol. 291 (2003) 149–160



Questions About Parentage and Kinship



**How Important are
Extra-pair
Fertilizations to Male
Reproductive
Success?**

**Does Long-term Philopatry to
Specific Overwintering
Hibernacula Result in High
Levels of Inbreeding in Black
Rat Snakes?**



Black Rat Snake

Parentage and Kinship Analysis In Natural Populations

- Use of genetic markers to test hypothesis regarding the kinship relationships among specific individuals
- Kinship: estimating the genetic relatedness among individuals
- Parentage: identification of parents of specific offspring - subset of kinship analyses

Alaskan wolves (McNay)

- Highly exploited populations
- 94% of alpha females were pregnant
- 14 of 36 packs had >1 pregnant female
- Pregnancy in auxiliary females ranged from 40-80% (highest following intensive trapping)
- 53% of auxiliary pregnancies contributed pups to pack

Some Questions of Interest Related to Parentage Analysis

(Webster and Westneat 1998; Griffith et al. 2002)

- Do social relationships reflect mating relationships among males and females and how often are they wrong?
 - Extra-pair fertilizations (EPFs) are common in some species
 - Tree Swallows (> 80% young/nest result of EPFs)
 - Intraspecific brood parasitism (IBP) (egg dumping) occurs in some species (~5% in Eastern Bluebirds)
 - Requirement of using genetically-based parentage analysis in studies of mating systems and reproductive behaviour of individuals

Some Questions of Interest Related to Parentage Analysis (Webster and Westneat 1998)

- Who is mating with whom and what are the fitness consequences?
 - How does sexual selection act on male traits via EPFs?
 - What are the fitness benefits to females in seeking EPFs?
 - Which females lay parasitic eggs and under which conditions do they do so?

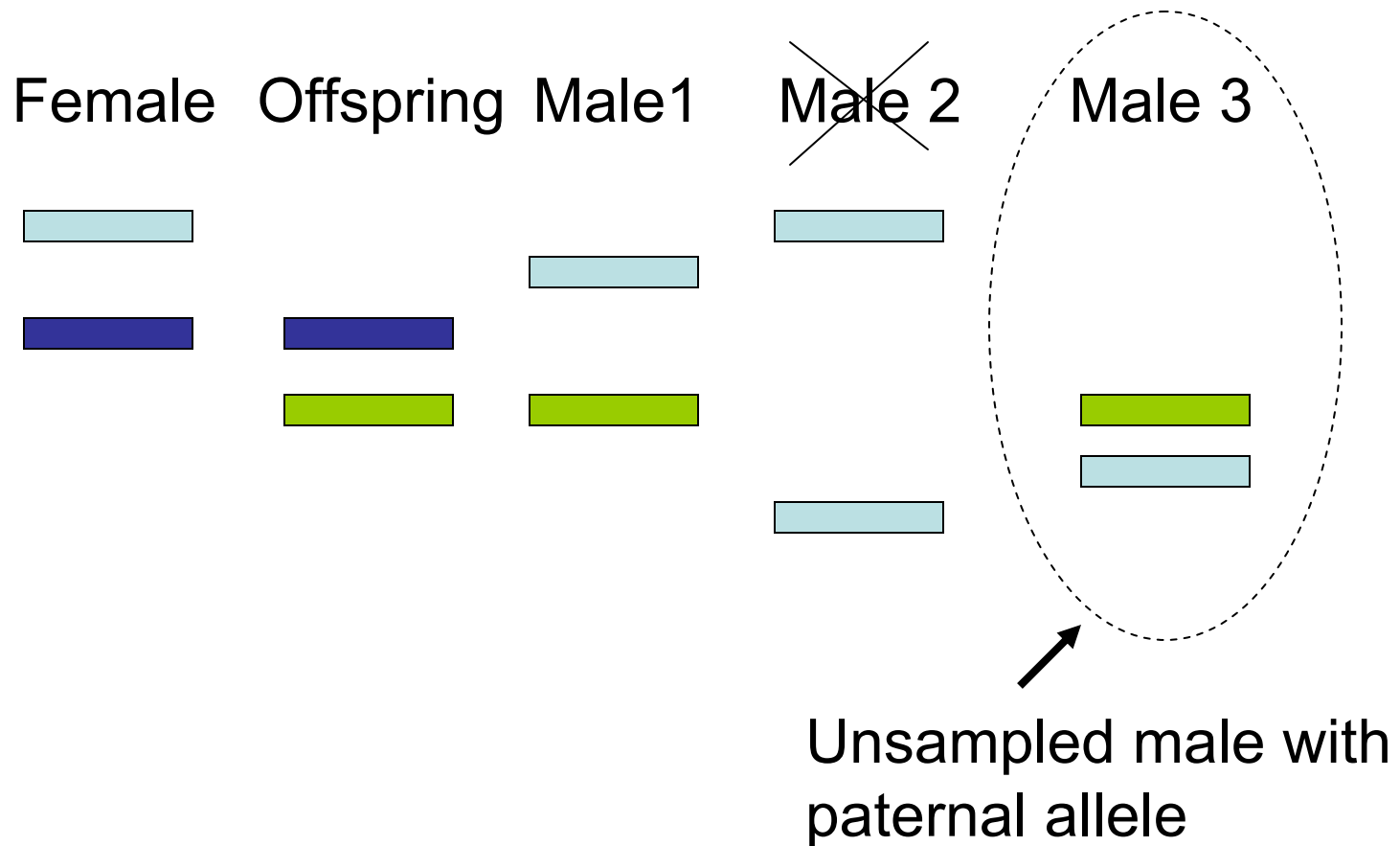
Some Questions of Interest Related to Kinship Analysis (Webster and Westneat 1998)

- What is the exact relatedness between pairs of individuals?
 - Tests of role of kin selection in the evolution of cooperative behaviour
 - Identification and assessment of the effects of inbreeding in wild populations
 - Design captive breeding programs for endangered species

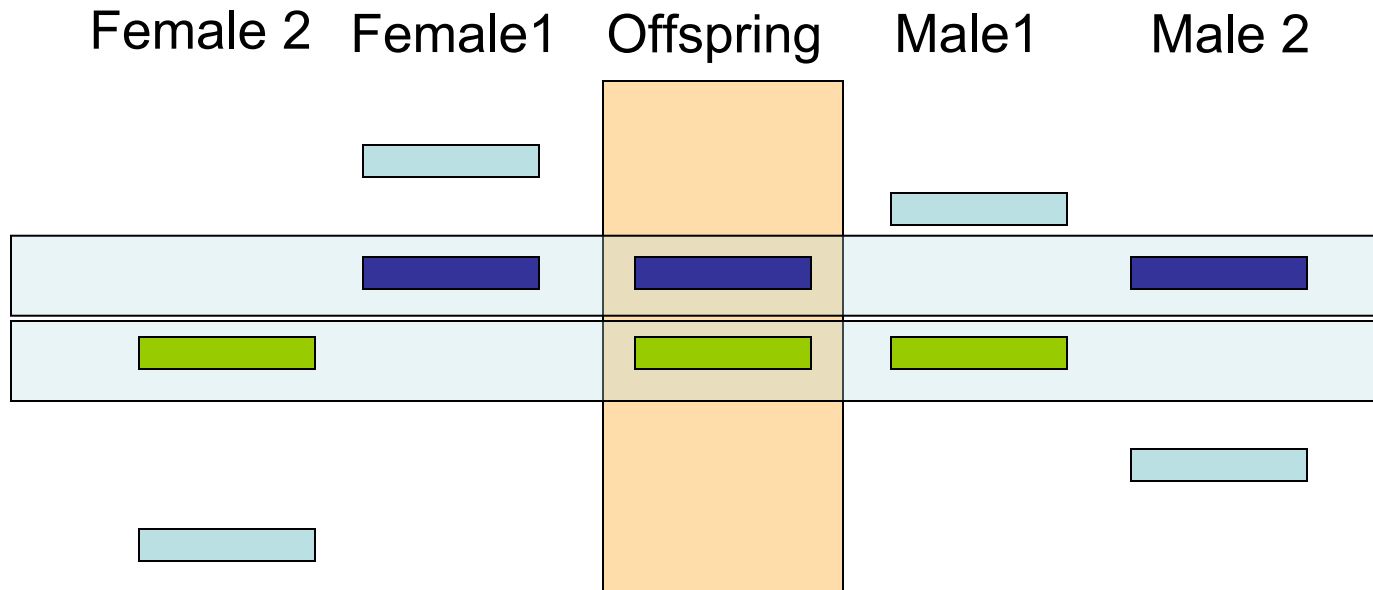
Role of Molecular Ecology In Parentage/Kinship Analyses

- Identification of genetic markers for high resolution parentage analyses
 - Highly-variable, co-dominant, single locus markers
- Development of methods for generating data
 - Inexpensive, rapid generation of large numbers of individual genotypes
- Statistical evaluation of data
 - Statistical confidence in parentage assignments
- End result: parentage/kinship data for testing evolutionary/ecological hypotheses

Parentage Analysis: Exclusion

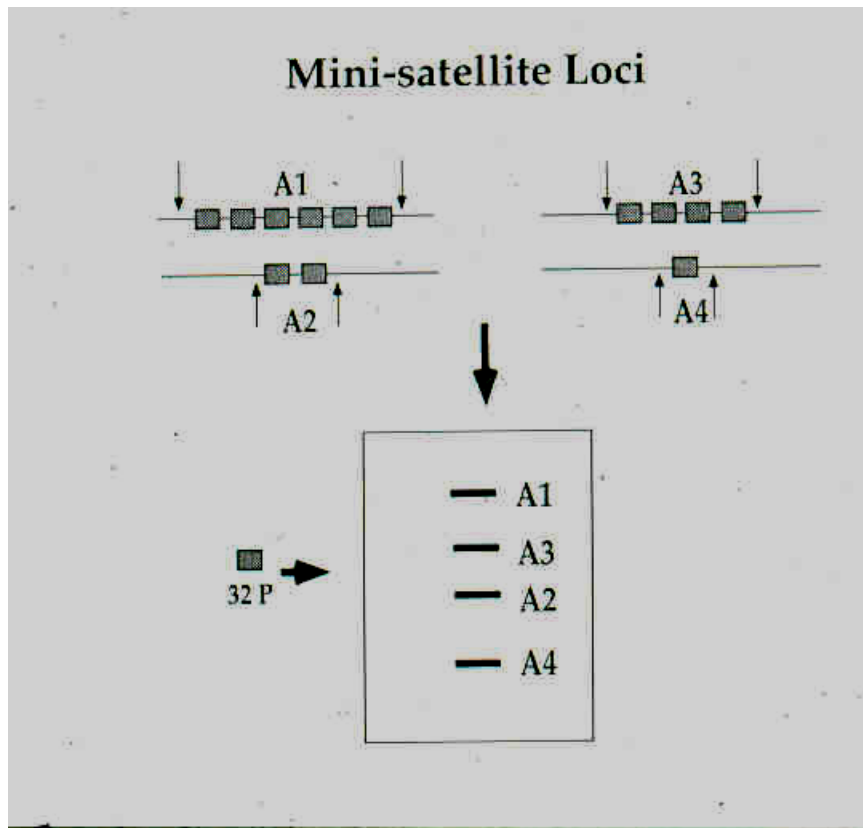


Parentage Analysis: Exclusion Based on Compatibility of Genotypes Between Males and Females

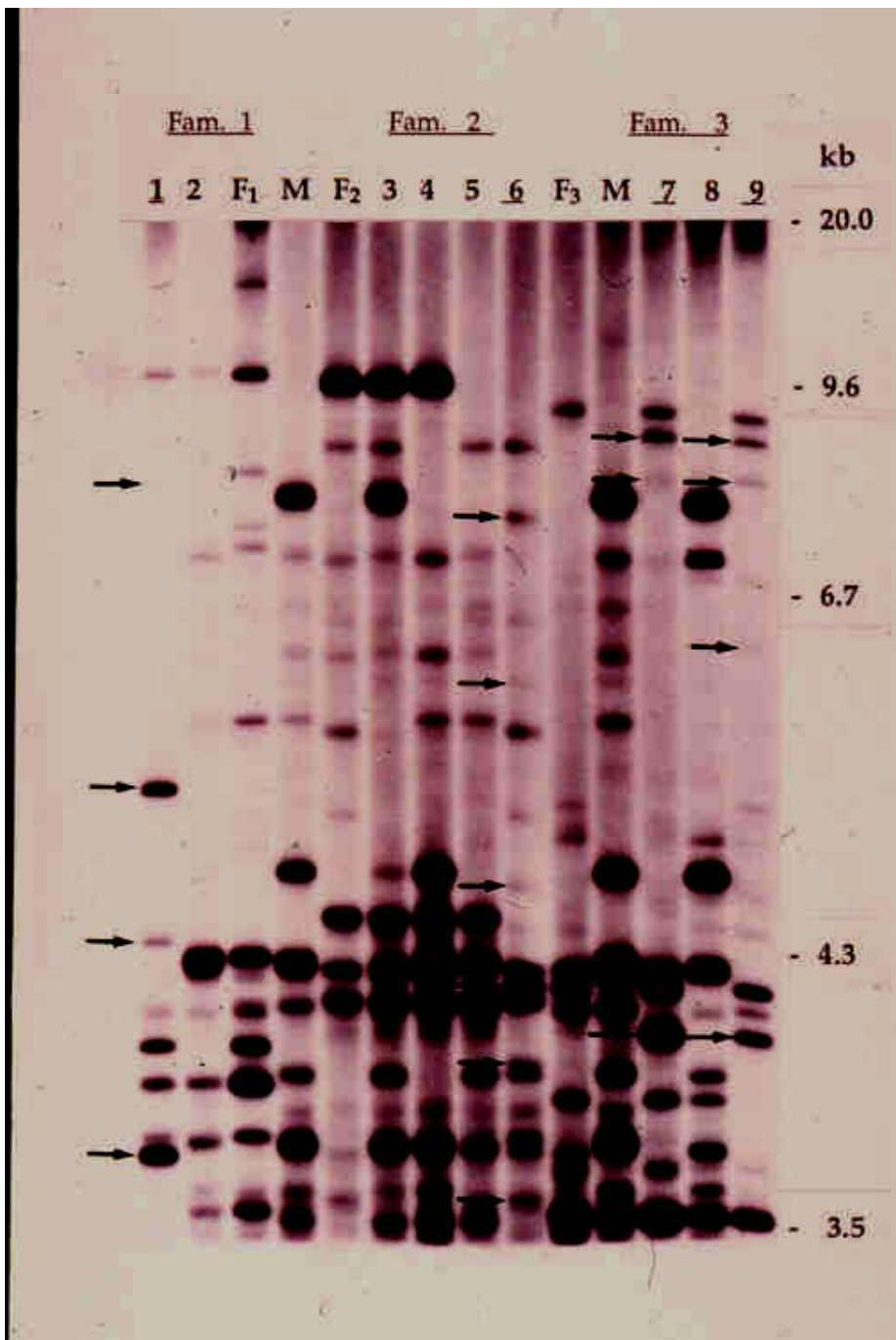


With no *a priori* knowledge F1/M1 or F2/M2 are equally likely sets of parents

DNA Minisatellites



- Tandem repeats of core sequences 15-30 bp in length
- Jeffreys 33.15, 33.6, M13, *Per* locus from *Drosophila*
- Detected using Southern blotting
- technical issues: DNA quality and amount; low probe homology; length of time required to generate data; scoring restricted to same blot

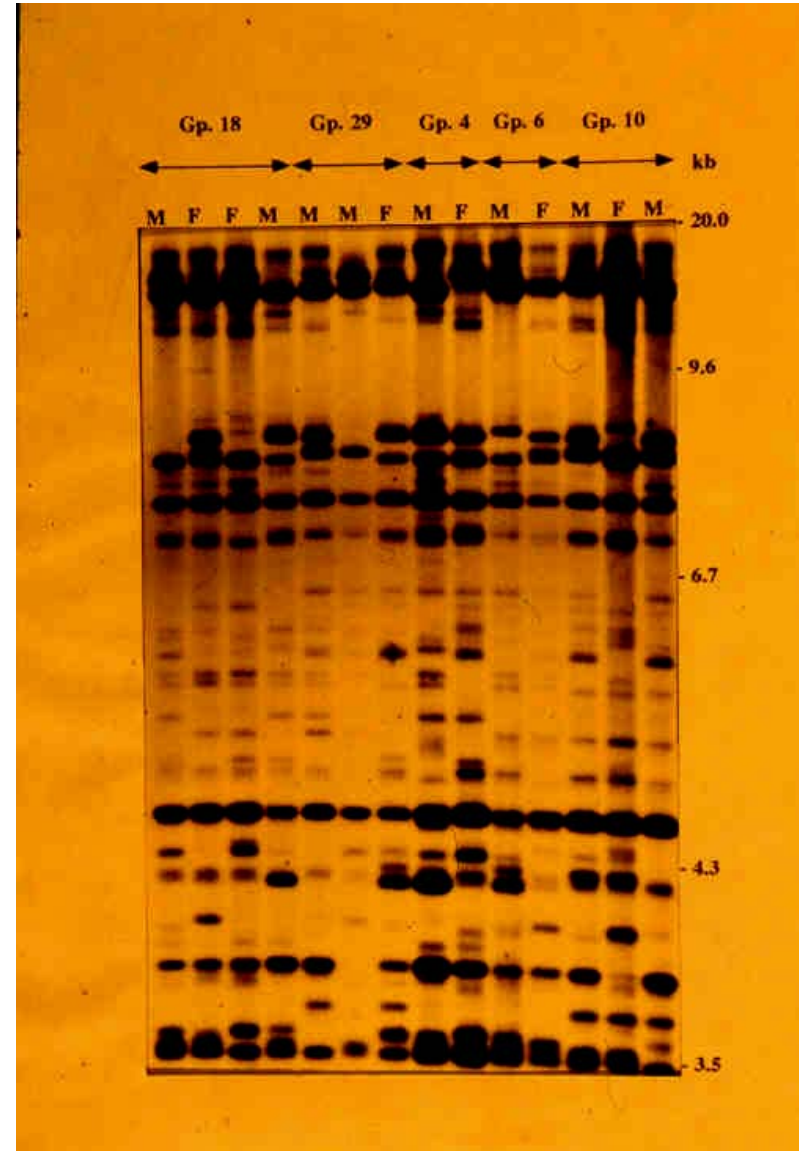


DNA fingerprints of Red-winged Blackbird families showing examples where resident male is excluded as the parent of chicks found on in nests on his territory. Arrows indicate bands (alleles) that exclude the resident male

Tasmanian Native Hens



Flightless bird with
polyandrous mating system
Island population founded from
~ 4 individuals
Population size currently ~300
Highly inbred



Genetic Markers Used for Parentage Analysis

- Multilocus
 - Assay many loci simultaneously
 - Highly variable but unable to separate between loci
 - DNA minisatellites (DNA “fingerprinting”)
- Single locus
 - Assay variation at single loci
 - Locus-specific information but less variable
 - DNA microsatellites

Other uses of genetics

- Capture-mark-recapture
 - use multilocus genotypes (DNA fingerprints) as “marks” on individuals
- Diet analysis
 - determine food items by identifying species in fecal material
- Dispersal
 - detect dispersers from other populations

Other uses of genetics

- Determine number of populations
- Determine habitats that impede/promote gene flow
- Forensics